PRACTICE EXAM 4: RED SEAL WELDER SIMULATION (125 QUESTIONS)

1. Which procedure correctly describes the ring test for evaluating the integrity of an abrasive grinding wheel before mounting?

A. Strike the wheel edge firmly with a metal hammer and listen for a clear ringing tone to confirm the wheel is defect-free

B. Drop the wheel from knee height onto a concrete surface and observe whether it bounces without cracking

C. Suspend the wheel vertically on a pencil through its centre bore and tap lightly with a wooden mallet — a clear ring indicates a sound wheel and a dull thud indicates damage or cracks

D. Place the wheel flat on a steel surface and press firmly on the centre while rotating — flex resistance confirms the bond is intact

2. Under Canadian OHS legislation, which of the following activities falls specifically within the authority and mandate of a Joint Health and Safety Committee?

A. Inspecting the workplace regularly, investigating health and safety complaints, and making non-binding recommendations to the employer for corrective action

B. Issuing binding stop-work orders directly to the employer when committee members identify an imminently unsafe condition

C. Disciplining workers who violate safety procedures established in the company health and safety policy

D. Setting health and safety standards and compliance timelines that supersede the applicable provincial OHS regulation

3. A packaged steel assembly is secured to a skid with banding straps oriented perpendicular to the direction of travel. When the carrying vehicle accelerates suddenly, which failure mode is most directly applied to the strapping by the inertial load?

A. Compressive buckling of the steel assembly as the band tension exceeds the stack's load-bearing capacity

B. Shear failure along the skid surface from differential sliding motion between the assembly and the skid deck

C. Progressive fatigue failure at the banding buckle from oscillating inertial loads through the connector

D. Tensile overload of the straps perpendicular to their installed orientation as the assembly tries to slide forward under the acceleration force

4. An SMAW setup is operational when the welder notices the adjusting knob on the oxygen pressure regulator has been damaged and is stuck in the fully open position, making it impossible to reduce the working pressure. What is the correct immediate action?

A. Continue welding at the elevated pressure setting with extra caution since the cylinder itself is undamaged and the pressurized system is otherwise intact

B. Close the cylinder valve immediately to cut off the gas supply, and do not use the regulator until it has been repaired or replaced

C. Reduce the torch needle valve to its minimum setting to compensate for the uncontrolled elevated regulator output pressure

D. Call the gas supplier for an emergency pressure adjustment tool before stopping any ongoing welding operations

5. A pipe welder must complete a weld on 6-inch nominal pipe with an outside diameter of 168.3 mm. The welder divides the pipe into four equal sections for electrode change stops. Using $\pi = 3.1416$, what is the approximate arc travel distance per quarter of the pipe circumference?

A. 132 mm, calculated as $(\pi \times 168.3) \div 4 = 528.4 \div 4 = 132$ mm per quarter section

B. 264 mm, calculated as (π × 168.3) ÷ 2 = the half-circumference distance between stops

C. 84 mm, calculated as one-half of the pipe outside radius as a proxy for the quarter arc length

D. 528 mm, which equals the full pipe circumference and represents the total travel for the complete joint

6. A welder is asked to ship a container of welding flux to a remote site by road transport. Which SDS section contains the most relevant information for determining how the flux must be declared and transported?

A. Section 7 — Handling and Storage, which specifies the permissible storage conditions and temperature limits for the product

B. Section 9 — Physical and Chemical Properties, which provides the density and physical state needed for shipping documentation

C. Section 12 — Ecological Information, which identifies environmental spill hazards relevant to road transport

D. Section 14 — Transport Information, which specifies the UN number, proper shipping name, packing group, and hazard class for transport

7. A welder uses a hand file to smooth a burr from a cut edge. The file does not have a handle installed and the exposed tang is gripped directly in one hand during use. What specific safety hazard does this practice create?

A. The file surface becomes contaminated with skin oils that reduce its cutting effectiveness on the workpiece

B. If the file snags on the workpiece or the workpiece shifts suddenly, the unprotected tang can be driven deeply into the welder's palm

C. The ungrounded tang creates a static discharge path between the metal workpiece and the welder's hand during filing

D. Prolonged grip on the hardened tang causes progressive metal fatigue that eventually fractures the file shank during use

8. Under Canadian OHS regulations, who may authorize a newly assembled scaffold for use by workers?

A. Any journeyperson welder with more than three years of field experience working at elevated heights on industrial sites

B. The site safety officer after a visual inspection of the scaffold is performed from ground level confirming no obvious gross defects

C. A competent person who is knowledgeable in scaffold construction and applicable inspection standards and who has physically inspected the completed scaffold

D. Any certified welder who holds a current fall protection certificate and will be the first worker to use the scaffold during the shift

9. A fabrication shop measures consistently at 96 dB(A) at a structural plate-cutting station. Which combination of control measures most effectively protects workers and best demonstrates correct application of the hierarchy of controls?

A. Replacing the cutting method with a lower-noise alternative (elimination or substitution) AND enclosing the machine acoustically (engineering control), supplemented by hearing protection where residual exposure remains elevated

B. Issuing double hearing protection to all workers in the area and requiring mandatory audiometric testing on a quarterly schedule

C. Posting hearing hazard warning signs at the shop entrance and limiting all workers to four-hour maximum shifts at the cutting station

D. Restricting entry to the cutting station to experienced workers only and requiring documented annual training on hearing hazard awareness

10. A structural steel plate measures 2,400 mm × 1,200 mm × 25 mm. Using a steel density of 7,850 kg/m^3, what is the approximate mass of this plate?

A. 451 kg, calculated as 2.4 × 1.2 × 0.025 m^3 × 7,850 divided by two for a half-density assumption applied to plate products

B. 565 kg, calculated as volume 2.4 × 1.2 × 0.025 = 0.072 m^3 multiplied by 7,850 kg/m^3 = 565.2 kg

C. 282 kg, calculated as the plate volume multiplied by 3,924 kg/m^3 which is the accepted density for mild steel plate

D. 720 kg, calculated using the plate surface area in square centimetres multiplied by the standard steel weight factor per square centimetre of thickness

11. Under WHMIS 2015, where must the Safety Data Sheet for a hazardous product be located in a workplace where that product is being used?

A. In the site safety office only, available to workers upon written request during normal business hours throughout the shift

B. In a central digital database accessible to trained workers within 30 minutes of any request made during the work shift

C. Posted adjacent to every individual container of the hazardous product throughout all areas of the workplace

D. Readily accessible to workers in the work area during all work shifts without barriers or delays between the worker and the information

12. A welder uses a 5-metre steel tape measure that has had the first 30 mm of the blade bent back on itself after being caught in fabrication equipment. The hook still retracts and the scale remains legible from the 30 mm mark onward. What is the quality concern if this tape is used for production measurements taken from the hook end?

A. No concern — the hook end is still functional and the readable scale beginning at 30 mm remains accurate for all measurements

B. The tape may produce errors in high-temperature environments since the bent section permanently alters the metal's thermal expansion coefficient

C. Measurements taken from the hook end will include a systematic 30 mm offset error since the hook now registers 30 mm before the zero mark is reached at the workpiece contact point

D. The tape requires inspection by the calibration authority, after which it may be returned to service with documented measurement limitations noted in the tool record

13. A maintenance welder is asked to tack weld a clip bracket directly to the outside wall of a compressed air header that is in service at 480 kPa. What is the primary hazard of applying welding heat to an in-service pressurized system?

A. Arc heat on the pressurized shell can cause an explosive rupture as the heated metal softens and yields under the sustained internal pressure load at the weld point

B. The welding arc can cause arc blow from the electromagnetic field generated by the compressed air flow velocity inside the pressurized pipe

C. Condensate moisture inside the air header can cause porosity and surface contamination at the tack weld heat-affected zone

D. The arc can ionize the compressed air at the fusion zone, creating a localized plasma field that displaces and contaminates the protective shielding gas

14. A welder must complete overhead SMAW welding from a scissor lift platform elevated 7 metres above grade. The work requires active movement of the electrode holder during welding. Which fall protection arrangement is most appropriate for this task?

A. A tool lanyard attached from the electrode holder to the lift basket guardrail to prevent the holder from falling to the grade below

B. A full-body harness connected by a short energy-absorbing lanyard to the engineered anchor point on the scissor lift basket structure

C. The scissor lift guardrail system alone, since scissor lifts are classified as aerial work platforms that eliminate the fall hazard through guardrail protection

D. A safety monitor posted on the shop floor below who maintains visual contact and provides verbal warning if the welder approaches the basket edge

15. When conducting atmospheric testing before a worker enters a confined vessel for internal welding operations, which minimum combination of atmospheric parameters must be measured before any entry decision is made?

A. Oxygen content and carbon monoxide only — these two readings determine all entry decisions for confined welding spaces

B. Oxygen content and flammable gas concentration only — toxic gas sensors are required only in chemical processing plant environments

C. Oxygen content, flammable gas concentration, and toxic gas levels including CO at minimum — all three categories must be evaluated before any entry decision

D. Carbon dioxide concentration only, since CO_2 accumulation from welding fumes is the governing confined space hazard and supersedes other atmospheric considerations

16. A welder selects a container of oxy-fuel acetylene from the gas storage cage. Under WHMIS 2015, which combination of pictograms should appear on the supplier label for this product?

A. The compressed gas cylinder pictogram AND the flame pictogram — acetylene is simultaneously stored under pressure and classified as an extremely flammable gas

B. The exclamation mark pictogram only, which identifies a hazardous substance with acute toxicity effects including asphyxiation in confined spaces

C. The skull and crossbones pictogram only, which indicates an acute toxic substance that is fatal by inhalation when concentrated in enclosed spaces

D. The exploding bomb pictogram only, since acetylene presents a decomposition explosion risk without the specific flammability classification applying at normal working concentrations

17. A welder splashes pickling paste containing dilute hydrofluoric acid onto a forearm during post-weld surface treatment. Which response sequence is most critical for this specific chemical exposure?

A. Apply an epoxy barrier cream to the affected skin immediately to prevent further absorption, then transport to a medical facility for evaluation

B. Irrigate the area with cool water for 5 minutes, apply a steroid cream to reduce skin reaction, and continue monitoring while working

C. Apply pressure bandaging to the affected limb to prevent systemic absorption through the bloodstream and transport to hospital immediately

D. Irrigate with copious running water for a minimum of 20 minutes, apply calcium gluconate gel if available, and seek emergency medical attention since hydrofluoric acid can cause systemic calcium depletion and cardiac toxicity

18. Under WHMIS 2015, which minimum elements must appear on a workplace label applied to a refilled container of a hazardous product?

A. A full reproduction of the complete supplier label including all required elements from the hazardous product classification standard

B. The product identifier, the SDS reference number, and the employer's name and contact information for all in-plant product transfers

C. At minimum, the product identifier, hazard information such as pictograms or hazard statements, and safe handling precautions applicable to the specific work environment

D. The WHMIS hazard class designation only, since the complete SDS provides all additional detail and is accessible through the site safety office

19. Under CSA W47.1, which role within the certified welding company holds specific technical authority to review production welding and ensure compliance with the approved welding procedure specifications?

A. The Welding Engineer or Welding Supervisor designated by the certified company who has technical authority to review and approve or reject production welds

B. The welding inspector from the third-party inspection agency who has final technical authority over all production weld acceptance decisions

C. The individual journeyperson welder who self-certifies their own work in compliance with their current CWB welder qualification certificate

D. The provincial apprenticeship registrar who reviews all production welding records submitted by employers under W47.1-certified project requirements

20. A welder switches from SMAW at 100 A to GMAW spray transfer at 225 A on the same joint. Which adjustment to the welding helmet filter shade is indicated, and what is the technical basis?

A. Reduce the shade number — GMAW spray transfer produces significantly less ultraviolet radiation than SMAW at equivalent amperages

B. Increase the shade number — the higher amperage and more intense arc of spray transfer GMAW generate greater ultraviolet, visible, and infrared radiation requiring a darker protective lens

C. No change is required — all arc welding processes at any amperage require the same shade 10 minimum lens per ANSI/CSA standards

D. Reduce the shade number — GMAW generates primarily near-infrared radiation that is filtered more effectively by lower-shade lenses than the higher shades required for SMAW

21. An assembly drawing at Revision 4 shows sub-assembly B with revision triangles labeled "3" placed beside two critical weld joint dimensions. What do these revision triangles specifically communicate to the fabricator?

A. Sub-assembly B was completely redesigned at Revision 3 and must be fabricated entirely from scratch using only Revision 3 source drawings

B. The dimensions beside the triangles are the third most critical dimensions in sub-assembly B and require priority quality control verification

C. Sub-assembly B's weld joint dimensions were last physically inspected and accepted during the Revision 3 project quality audit

D. The dimensions beside the "3" triangles were changed at Revision 3 — those specific values were different prior to Revision 3 and must be verified against the current Revision 4 requirements

22. On an engineering drawing, a welding symbol at a pipe-to-flange connection shows a hollow circle AND a filled triangular flag, both located at the intersection of the reference line and the arrow. How must this combined symbol be interpreted?

A. The hollow circle requires weld-all-around deposition and the filled triangle requires volumetric inspection of the completed weld

B. The two symbols are contradictory at the same location and the drawing drafter must be contacted before any fabrication proceeds

C. The hollow circle specifies a continuous weld completely around the joint perimeter, and the filled flag specifies the weld must be performed in the field — together they require a complete field weld around the entire joint

D. The hollow circle applies to the fillet weld specified below the reference line and the filled triangle applies to the groove weld specified above the line at the same connection

23. After completing the dwell time during a visible dye penetrant inspection, an inspector removes excess penetrant with remover and immediately applies wet developer without allowing the surface to dry. What specific consequence results from applying developer over a wet surface?

A. Residual surface moisture from the remover dilutes the penetrant still inside any defects as it bleeds out, reducing bleedback colour intensity and potentially causing defects to go undetected as false negatives

B. The wet developer permanently bonds to the weld surface and cannot be removed for re-examination if any indication results are ambiguous

C. The developer film becomes excessively thick when applied over a wet surface, causing uniform over-development that makes the entire area appear uniformly white

D. The remover chemically neutralizes the developer when both are wet simultaneously on the surface, requiring a significantly extended developer reaction time

24. Which of the following statements about tack welds that will be incorporated into the final weld is INCORRECT?

A. Tack welds placed on crack-susceptible steels must be deposited with the same minimum preheat specified for the production weld in the applicable WPS

B. Tack welds incorporated into the final weld do not need to meet any mechanical property requirements since the fill and cap passes deposited over them completely replace their metallurgical contribution

C. Tack welds that are cracked must be removed by grinding before the production weld is deposited over that area

D. Tack welds on code-certified work must be deposited by welders who hold the applicable qualification certificate for the process and position

25. A radiographic interpreter examines a SMAW groove weld film and finds a series of dark indications approximately 3 to 5 mm long, located consistently near the fusion line at each pass boundary, with irregular angular outlines. How should these indications be classified?

A. Linear porosity — cylindrical gas voids aligned with the weld axis from sustained atmospheric contamination throughout the deposited pass

B. Piping porosity — elongated worm-hole voids forming perpendicularly through the weld face from a localized single contamination source

C. Centreline solidification cracking — hot cracks running along the weld metal centreline during the final stage of pool solidification

D. Slag inclusions — irregular elongated dark zones at pass fusion boundaries, characteristic of flux particles that were not cleaned between passes

26. A pipe must travel between two fixed points that are 350 mm apart horizontally, routed using two 45-degree elbows. What is the travel length of the diagonal pipe section between the two elbows?

A. 495 mm, calculated as 350 mm ÷ sin(45°) = 350 ÷ 0.707 = 495 mm for the diagonal pipe run

B. 350 mm, which equals the horizontal offset and is also the travel distance when 45-degree fittings are used

C. 245 mm, calculated as 350 mm × sin(45°) = 350 × 0.707 = 247 mm for the projected diagonal pipe length

D. 700 mm, calculated as the offset distance multiplied by two to account for both elbow deflections in the routing

27. Which characteristic of liquid penetrant testing makes it fundamentally unsuitable for detecting subsurface defects in any material, including pressure vessel weld metal?

A. The penetrant chemistry reacts with surface oxide layers and produces continuous background bleeding that masks the specific location of subsurface defect signals

B. The penetrant carrier solvent evaporates before it can migrate by capillary action to reach subsurface defects at any meaningful depth below the surface

C. Liquid penetrant testing is a surface-only method that detects only discontinuities open to the examination surface — subsurface defects cannot be detected regardless of the base material type or surface condition

D. Dwell times sufficient to detect subsurface defects exceed the maximum permissible dwell for most materials and would cause unacceptable surface staining

28. A structural detail drawing shows a fillet weld symbol below the reference line with "8" to the left of the weld symbol triangle, "50" to the right, and "150" further to the right after a dash. What does this complete dimension notation specify?

A. An 8 mm throat fillet weld deposited in 50 mm segments at 150 mm intervals measured from centreline to centreline of each segment

B. An 8 mm leg fillet weld deposited in 50 mm long segments spaced at 150 mm pitch centre-to-centre — an intermittent fillet weld specification

C. An 8 mm leg fillet weld deposited for a total of 50 mm at a single location positioned 150 mm from the arrow point reference

D. An 8 mm effective throat fillet weld with a minimum 50 mm leg cap dimension and 150 mm maximum permissible spacing between reinforcing passes

29. A rectangular steel frame 2,000 mm × 1,000 mm is being assembled and tacked for a flat table fabrication. To minimize angular distortion and maintain corner squareness during the tacking sequence, which approach is most appropriate?

A. Tack each corner completely in sequence — complete corner 1, then corner 2, then corner 3, then corner 4 — moving around the frame before any filler passes are deposited

B. Tack both long-side members simultaneously using two welders, then complete both short-side members, ensuring the corner tacks are the final locations addressed

C. Begin at a single corner and work progressively outward along each adjacent member, continuing around the frame perimeter until all joints are tacked

D. Tack diagonally opposite corners first — corner 1, then corner 3, then corner 2, then corner 4 — to balance shrinkage forces symmetrically and preserve squareness during the tacking sequence

30. Under CSA W59, weld access holes are specified for certain structural beam moment connections. Which statement most accurately describes the dimensional and quality requirements for these access holes?

A. Access holes must be a minimum of 35 mm deep and the perimeter surface must be free of notches and re-entrant corners that could initiate fatigue cracks, with finish requirements applied in dynamically loaded conditions

B. Access holes are simply round drilled holes of minimum 25 mm diameter positioned at the web-to-flange junction to allow electrode access during root pass welding

C. Access hole size is determined solely by the electrode diameter selected for the groove weld, with a minimum of three times the electrode diameter required as the hole depth

D. Access holes are exempt from all finish and dimensional requirements since they are removed by grinding and verified by NDT after the moment connection is completed

31. A cross-section view of a welded pipe spool shows two concentric circles — a larger outer circle and a smaller inner circle. The area between the two circles is cross-hatched. The interior of the smaller circle is not hatched. What does this standard orthographic representation indicate?

A. A solid bar with the outer circle representing the outside surface and the inner circle indicating a centre-bore feature machined after fabrication

B. A pipe with a welded internal liner — the inner circle shows the liner inside diameter and the outer hatched zone shows the gap between the liner and the outer pipe wall

C. A standard hollow pipe cross-section — the hatched annular zone represents the pipe wall material and the unhatched inner circle represents the hollow bore through which the process fluid flows

D. A pipe that has been radiographically examined — the unhatched inner circle indicates the area covered by the film and the hatched zone represents the wall examined by the radiation beam

32. When an SMAW multi-pass weld is produced on structural steel with consistently excessive interpass temperatures above the WPS maximum, which specific effect on completed weld mechanical properties is most likely?

A. Significant reduction in weld metal tensile strength from extensive grain boundary dissolution occurring during the prolonged elevated temperature thermal cycle

B. Reduced Charpy impact toughness from excessive grain growth in the weld metal and HAZ subjected to repeated high-temperature thermal cycles above the critical range

C. Increased weld metal hardness from accelerated carbide precipitation during the slow cooling rate created by the sustained high interpass temperature

D. Reduced ductility restricted specifically to the final cap pass, since excessive interpass temperature thermal effects are limited to the last deposited pass only

33. Under ASME Section IX, which of the following changes to a production SMAW welding procedure constitutes an essential variable that requires requalification by PQR testing?

A. Changing the welding position from flat (1G) to horizontal (2G) when the original PQR was qualified in the flat position only

B. Changing the SMAW electrode diameter from 3.2 mm to 4.0 mm within the same SFA specification and AWS classification group

C. Changing the electrode travel angle from 15 degrees to 20 degrees from vertical while maintaining the same current type, polarity, and amperage range

D. Changing the filler metal from E7018 (F-Number 4) to E6013 (F-Number 3) within SFA-5.1, which constitutes a change in F-Number classification

34. A drawing shows a single-V groove weld symbol below the reference line and a semicircle symbol above the reference line at the same butt joint location. What operational sequence does this combination of symbols specify?

A. Complete the groove weld from the arrow side, then gouge or grind the back of the joint to sound metal, and deposit the back weld pass from the opposite side to complete the joint

B. Place backing material on the back of the joint before beginning the groove weld — the semicircle above the line indicates backing is required before welding starts

C. Both the groove weld and back weld are deposited simultaneously using two welders, one on each side of the joint, as indicated by symbols on both sides of the reference line

D. The back weld pass is always deposited first from the back of the joint, and then the groove weld is deposited overtop to reinforce and bury the back weld in the completed joint

35. A Tempilstik rated at 100°C is drawn across a steel plate surface adjacent to the weld zone. The mark transitions from a dry, solid, waxy streak to a liquid, melted film on the plate surface. What does this observation confirm about the plate temperature?

A. The plate temperature is exactly 100°C at the measurement point, with no variation permitted above or below this value

B. The crayon material has contaminated the steel surface and must be removed by solvent cleaning before welding begins

C. The plate temperature has reached at least 100°C at the measurement location — the preheat requirement is satisfied at that point and position

D. The melted appearance confirms the plate is still below 100°C since the Tempilstik must remain fully solid until the temperature is significantly exceeded

36. Under CSA W59, a fabricator is preparing a single-V groove butt joint using pre-qualified joint parameters. Which specific deviation most clearly removes this joint from its pre-qualified status?

A. Using a root opening that is 1 mm narrower than the maximum pre-qualified value specified in the standard for this joint type

B. Increasing the minimum preheat temperature above the value listed in the pre-qualified procedure parameters

C. Using an electrode in the same AWS classification but with a smaller diameter than the maximum specified for the groove size

D. Machining a root face that is 2 mm larger than the pre-qualified maximum root face tolerance, placing the preparation outside the qualified range

37. A welding inspector needs to detect both longitudinal and transverse cracks in a structural groove weld using the magnetic particle yoke method. What is the minimum number of separate yoke orientations required to interrogate both crack directions?

A. One examination with the yoke positioned at 45 degrees to the weld axis, which simultaneously provides sensitivity to both longitudinal and transverse crack orientations

B. One examination with the yoke positioned perpendicular to the weld axis, since transverse cracks are the highest-risk defect type in structural welds and this orientation is sufficient

C. A minimum of two examinations — one with the yoke parallel to the weld axis to detect transverse cracks, and one with the yoke perpendicular to the weld axis to detect longitudinal cracks

D. Three separate examinations at 0, 45, and 90 degrees to the weld axis are required to ensure full angular coverage of all possible crack orientations

38. After completing a root pass on an SMAW CJP groove weld, a hi-lo gauge measurement reveals 2.0 mm of internal mismatch at one location. The applicable code limit for internal mismatch is 1.6 mm. What is required before fill passes are deposited?

A. Accept the root pass since 2.0 mm is within the standard shop fabrication tolerance of ±2 mm applied to all groove weld root passes

B. Correct the mismatch at that location by excavation or build-up to bring the measurement within the 1.6 mm code limit before any additional passes are deposited

C. Proceed with fill passes since the mismatch will be enclosed within the completed joint and the final weld will still meet the required tensile strength requirements

D. Document the 2.0 mm deviation in the non-conformance register and submit for engineering approval before depositing additional passes

39. Under CSA W59, what is the maximum permitted cap reinforcement height for a CJP groove weld on 20 mm structural plate?

A. 3 mm — the maximum allowable weld reinforcement for structural groove welds on plate in this thickness range under CSA W59

B. 1.6 mm — the maximum cap reinforcement is fixed at 1.6 mm regardless of plate thickness under all structural welding codes

C. 5 mm — the maximum reinforcement equals one-quarter of the plate thickness for plates below 25 mm thickness

D. There is no maximum limit — weld reinforcement above the plate surface is never a rejectable condition since additional weld metal never reduces structural capacity

40. A fabricator must develop a flat pattern blank for a transition section between a 300 mm diameter round duct and a 300 mm × 300 mm square duct of equal throat dimension. Which development method is most appropriate for this surface?

A. Parallel line development, since both the round end and the square end maintain constant cross-sections along the transition axis

B. Radial line development, since both the round and square cross-sections converge toward a common geometric apex at the transition centreline

C. Contour line development, since the transition surface can be accurately approximated as a straight-taper between the two end profiles

D. Triangulation, since the transition surface has non-uniform curvature that cannot be developed accurately by either parallel or radial line methods

41. Which statement correctly distinguishes the application of magnetic particle testing versus liquid penetrant testing when inspecting aluminum MIG weld joints for surface cracks?

A. MT is preferred for aluminum welds because aluminum's low thermal conductivity creates an ideal surface temperature gradient for magnetic field strength measurement

B. MT cannot be applied to aluminum welds because aluminum is non-ferromagnetic and cannot support the magnetic field required — PT must be used for surface discontinuity detection on aluminum

C. MT and PT are equally effective on aluminum — the choice depends only on the defect size acceptance threshold specified by the applicable inspection standard

D. PT cannot be applied to aluminum welds because the anodized oxide layer on aluminum surfaces prevents penetrant from entering surface-breaking discontinuities

42. Under AWS D1.1, a welder passes a 4G overhead plate groove weld qualification test using E7018 electrodes on structural carbon steel. For which welding positions is this welder automatically qualified?

A. All four positions — 1G, 2G, 3G, and 4G — because the overhead (4G) test is the most demanding groove weld qualification and covers all less demanding positions

B. 4G only — each welding position requires its own specific qualification test and there is no automatic coverage extended to other positions

C. 4G and 1G (flat) only — overhead and flat positions are considered equivalent because both can be performed without gravity assisting the weld pool

D. 4G, 2G, and 1G but not 3G — the vertical position requires a separate qualification because it uses a different welding technique from the overhead position

43. On a drawing produced at 1:20 scale, a dimension is physically measured with a ruler directly on the drawing paper and reads 32 mm. What is the actual physical dimension on the fabricated component?

A. 1.6 mm, calculated as 32 mm ÷ 20 for a 1:20 reduction scale drawing

B. 32 mm, because stated dimensions on engineering drawings always represent actual fabricated dimensions regardless of the stated scale

C. 640 mm, calculated as 32 mm × 20 because at 1:20 scale each unit on the drawing represents 20 units on the actual object

D. 160 mm, calculated using the scale factor in its inverse form as 32 × (1/20) ÷ (1/100) for metric scale drawings

44. Which of the following is the MOST DIRECT cause of incomplete fusion at the groove sidewall in a multi-pass SMAW groove weld?

A. Excessive preheat temperature that maintains the weld pool in a fluid state too long, allowing it to sag away from the groove fusion surface before it can wet the sidewall

B. Excessively high amperage that causes rapid arc travel across the groove face, preventing sufficient heat transfer to the sidewall at any single location

C. Insufficient arc length that prevents the electrode from depositing metal at the correct depth within the groove preparation

D. Inadequate arc placement that fails to direct the arc onto the groove sidewall surface — the sidewall base metal receives insufficient heat to reach fusion temperature beneath the deposited pass

45. Which statement best distinguishes HIC (hydrogen-induced cracking in sour service) from HICC (hydrogen-induced cold cracking in welded joints)?

A. HIC and HICC are identical mechanisms — the different acronyms reflect only regional terminology preferences rather than mechanistically different types of cracking

B. HIC typically refers to stepwise cracking in base metal from hydrogen trapping at MnS inclusions in wet H_2S service, while HICC refers to cracking in the HAZ or weld metal from diffusible hydrogen combined with residual stress and a susceptible hard microstructure

C. HIC occurs exclusively in austenitic stainless steel from grain boundary hydrogen embrittlement, while HICC occurs exclusively in ferritic-martensitic HAZ zones of carbon steel

D. HIC requires the application of external mechanical stress to initiate and propagate, while HICC occurs spontaneously from welding residual stress alone without any external loading

46. A 6-metre tall column is being checked for plumb during erection using a 600 mm spirit level. The level is placed against the column flange face 3 metres above the base plate and reads 3 mm off plumb at that contact point. What is the approximate deviation from plumb at the top of the 6-metre column?

A. Approximately 6 mm at the top — proportioned from 3 mm deviation at mid-height to the full 6-metre height: (3 mm × 6 m) ÷ 3 m = 6 mm total deviation

B. 3 mm at the top — the spirit level reads the total column deviation directly regardless of the elevation at which it is placed on the column

C. 9 mm at the top — the deviation increases by the spirit level's full length of 600 mm for each additional metre of column height

D. 1.5 mm at the top — the plumb deviation naturally reduces above the measurement point as the column self-corrects its centerline at greater heights

47. A horizontal fillet weld inspection reveals that the weld metal has flowed smoothly onto the horizontal plate surface approximately 3 mm beyond the weld toe, forming a flat, feathered edge at the junction with no visible undercut. What defect condition does this observation describe?

A. A convex bead profile with excessive reinforcement that must be removed by grinding to restore the specified effective throat dimension

B. Normal toe extension that occurs consistently during horizontal fillet welding due to gravity acting on the pool and requires no corrective action

C. Overlap — weld metal that has flowed beyond the fusion boundary and lies on the base metal surface without metallurgical bonding at the weld-to-base-metal interface

D. An oversized fillet weld where the horizontal leg dimension exceeds the specification by 3 mm and requires grinding to reduce it to the required size

48. Under ASME Section IX, for a GTAW procedure qualified on 304L austenitic stainless steel using 100% argon shielding gas, changing the shielding gas to an argon-hydrogen blend for production welding would be classified as:

A. A non-essential variable since both gas types are inert and produce equivalent mechanical properties and corrosion resistance in the deposited weld metal

B. A supplementary essential variable that only becomes applicable when the procedure qualification includes low-temperature impact testing below −29°C

C. A minor change requiring only a WPS revision and supervisor authorization, without affecting the underlying PQR qualification test basis

D. An essential variable requiring requalification by new PQR testing, since shielding gas composition affects the arc characteristics, pool chemistry, and mechanical properties of the GTAW deposit

49. When choosing between acetylene and propane for a high-volume OFC production operation cutting 100 mm structural plate, which specific operational limitation of acetylene becomes most significant under high flow demand?

A. Acetylene cylinders have a maximum fill pressure of 1,720 kPa which restricts the available cutting oxygen flow needed for thick-plate applications

B. Acetylene must not be drawn from a cylinder at a rate exceeding one-seventh of the cylinder's total gas volume per hour, which limits the flow volume available for high-demand thick-plate cutting

C. Acetylene produces a lower flame temperature than propane at the working pressures required for reliable cutting of plate thicker than 75 mm

D. Acetylene hose assemblies have a smaller maximum internal bore diameter than propane equipment, limiting maximum flow rate regardless of the available cylinder pressure

50. An OFC operator increases the cutting tip size from a No. 3 to a No. 5 tip while cutting 30 mm structural plate at the same travel speed and oxygen pressure. What geometric effect does the larger tip produce on the cut?

A. The kerf width increases — a larger tip has a larger orifice that creates a wider cutting oxygen stream, resulting in more material removal per unit of travel length

B. The kerf width decreases — the larger tip focuses more energy into a concentrated narrow stream, producing a cleaner and narrower cut

C. The kerf width remains unchanged because kerf width is determined entirely by plate thickness and is independent of the tip orifice size selected

D. The kerf width varies between the top and bottom of the cut — wider at the top and narrower at the bottom — regardless of which tip size is used

51. An OFC operator discovers that a full acetylene cylinder has been stored on its side for approximately two weeks. What is the concern and what action must be taken before the cylinder can be safely used?

A. The cylinder may be used immediately — storage orientation does not affect the contents or gas purity of an acetylene cylinder in any significant way

B. The cylinder must be stood upright and the valve opened briefly to bleed any liquid acetylene that has accumulated in the valve assembly during the horizontal storage

C. The cylinder must be returned to an upright position and left undisturbed for a minimum of one hour to allow the acetone to settle back to the cylinder base before drawing any gas

D. The cylinder is permanently unusable because horizontal storage causes the dissolved acetylene to chemically separate from the acetone and requires return to the supplier for reprocessing

52. During mechanized PAC production, consumable life consistently reaches only 60% of the manufacturer's rated pierce life. Which operational factor most directly causes premature consumable wear below the rated specification?

A. Cutting at travel speeds faster than the manufacturer's optimum recommendation for the selected amperage setting

B. Using compressed air plasma gas instead of the manufacturer's recommended nitrogen plasma gas on carbon steel production

C. Operating with a standoff distance slightly larger than the rated specification for the torch-to-plate gap

D. Performing pierce starts at full amperage — using a slow current upslope that ramps from low to full operating amperage during the pierce significantly extends electrode and nozzle life and is the standard method for maximizing consumable service

53. An OFC operator hears a loud pop at the torch tip and the flame extinguishes. No smoke is produced, no internal burning sound is detected from the torch body, and the operator relights the torch and it functions normally. What event occurred and what is the most likely cause?

A. A flashback — the flame propagated into the torch body but self-extinguished because the gas flow rate was sufficient to prevent sustained burning inside

B. A backfire — the torch tip momentarily contacted the plate surface or molten slag briefly blocked the orifice, creating a pressure disturbance that extinguished the flame at the tip

C. An oxygen cylinder pressure surge — the regulator briefly over-delivered and the resulting oxygen-rich mixture extinguished the fuel-starved flame

D. An acetylene supply interruption — the regulator check valve closed automatically in response to downstream backpressure, momentarily cutting off the fuel gas supply

54. After performing CAC-A back-gouging on a stainless steel repair weld and confirming by MT that the defect has been completely removed, what additional surface preparation is essential before depositing the repair weld?

A. The groove surface must be ground to remove the carbon-enriched layer deposited by the electrode — grinding at least 1 to 2 mm into the groove surface removes carbon contamination and prevents sensitization or hot cracking in the repair deposit

B. The groove must be cooled to ambient temperature by compressed air before welding to prevent residual gouging heat from accelerating carbide precipitation in the repair

C. A flux compound must be applied to the groove surface to neutralize carbon residue from the electrode before the first repair pass is deposited

D. Sandblasting of the groove surface is required to provide a mechanically activated clean surface that improves fusion characteristics in the first repair weld pass

55. A welder must cut 6 mm structural angle iron in a confined space where a portable band saw cannot fit. A reciprocating saw is the only available tool. Which blade specification is most appropriate for this material and thickness?

A. A 6 TPI wood-cutting blade — aggressive hook geometry on wood blades provides effective cutting action on ferrous metals in tight confined access situations

B. A 10 TPI high-speed steel demolition blade — this specification provides faster material removal with acceptable blade life on structural steel profiles

C. An 18 TPI bi-metal blade — 18 TPI ensures at least two teeth contact the 6 mm wall simultaneously to prevent blade breakage, while bi-metal construction resists the cutting heat generated on structural steel

D. A 32 TPI carbon steel blade — the maximum available TPI always provides the best cut quality and longest blade life on all structural steel profiles and thicknesses

56. An OFC operator increases the acetylene working pressure to 150 kPa (22 psi) attempting to increase cutting speed on thick structural plate. Why is this pressure setting dangerous regardless of the improved cutting performance?

A. Acetylene at 150 kPa exceeds the cylinder outlet maximum of 103 kPa and causes permanent damage to the diaphragm and springs inside the pressure regulator body

B. Acetylene hoses are not rated above 100 kPa and operating at 150 kPa creates a hose rupture risk throughout the entire fuel gas supply circuit

C. At 150 kPa, acetylene begins to polymerize inside the cylinder and the dissolved gas permanently converts to an unusable solid acetylene polymer compound

D. At pressures above 103 kPa (15 psi), acetylene becomes chemically unstable and can decompose explosively without any ignition source — this pressure limit must never be exceeded under any application

57. At the end of an OFC production cutting shift, what is the correct sequence for safely shutting down the oxy-acetylene system?

A. Close the fuel gas torch needle valve first, then the oxygen needle valve, then close both cylinder valves, then reopen the torch needle valves to fully bleed the hoses, then release both regulator adjusting screws

B. Close both cylinder valves simultaneously, then open both torch needle valves simultaneously to bleed the hose circuits completely, then release both regulator adjusting screws simultaneously

C. Close the oxygen cylinder valve first, then close the acetylene cylinder valve, then open the torch needle valves to bleed residual pressure from both hose lines

D. Release both regulator adjusting screws first to depressurize the delivery side before closing either cylinder valve, then close both cylinders, then open the torch to bleed any remaining pressure

58. In mechanized PAC systems, what specific advantage does a pilot arc starting method provide over a contact (scratch) start for production cutting operations?

A. The pilot arc eliminates shielding gas consumption during the arc initiation phase, reducing total gas usage by up to 30% per pierce compared to contact starts

B. The pilot arc establishes a conductive ionized gas column between the torch and workpiece without physical contact, protecting consumables from impact wear and allowing non-contact arc starts on any plate surface

C. The pilot arc preheats the plate surface to approximately 200°C before the transferred cutting arc initiates, eliminating the requirement for separate pre-heating on thin material sections

D. The pilot arc current automatically adjusts to the plate thickness being cut, providing optimized current ramping for each pierce without any operator intervention required

59. A precision fabrication shop must cut 50 mm diameter hardened steel bar stock to produce inspection specimens requiring cut ends square to within 0.5 degrees with no heat-affected zone on the cut face. Which machine is most appropriate?

A. A portable band saw with 14 TPI bi-metal blade — its slow cutting action prevents overheating of the hardened stock during the cut

B. A portable oxy-fuel cutting torch with a tip sized for 50 mm material — sufficient operator skill can maintain the squareness and cleanliness required for inspection specimens

C. A cold saw with an appropriate HSS or carbide-tipped blade and cutting fluid — cold saws produce precision square cuts with minimal heat generation suitable for hardened steel bar applications

D. A portable plasma arc cutter fitted with a straight-edge guide — PAC produces a narrow kerf and minimal HAZ on hardened steel at controlled standoff distance

60. An OFC operator examines a cut surface on 50 mm structural plate. The drag lines are nearly vertical in the upper 10 mm but curve progressively backward through the remaining depth, with the bottom 10 mm showing severely backward-trailing drag lines. What specific parameter adjustment is indicated?

A. Increase the preheat flame size — insufficient preheat is allowing the lower portion of the kerf to fall below the steel ignition temperature

B. Reduce the travel speed — the cutting oxidation reaction cannot maintain its vertical position through the full plate thickness at the current speed, causing the lower kerf to lag the entry point

C. Increase the tip size — the current tip orifice cannot supply sufficient cutting oxygen volume for 50 mm plate at any practical travel speed setting

D. Reduce the cutting oxygen pressure — excessive pressure is creating turbulence at depth that deflects the cutting stream backward in the lower portion of the kerf

61. An OFC operator experiences a sharp pop at the torch tip with immediate flame re-ignition and continued normal operation. A colleague in the same work area experiences sustained hissing from inside the torch body followed by smoke from the hose connections. Which statement correctly classifies both events?

A. Both events are backfires — the sustained hissing in the second case is caused by excess preheat gas escaping through a loose cutting tip fitting

B. Both events are flashbacks — the first did not cause damage because the gas flow rate was sufficient to contain the flame at the torch tip

C. The first is a flashback that self-extinguished due to adequate gas velocity; the second is a reverse-flow event indicating a failed check valve in the hose assembly

D. The first is a backfire — momentary flame extinction at the tip with immediate self-re-ignition and no damage; the second is a flashback — flame burning inside the torch body requiring immediate complete gas shutdown and torch inspection before any further use

62. In a PAC torch that uses separate plasma gas and shielding gas circuits, what is the specific function of the shielding gas distinct from the plasma gas?

A. The shielding gas carries the primary electrical current between the torch cathode and the workpiece anode to sustain the transferred cutting arc

B. The shielding gas constricts the plasma column to concentrate the cutting energy into a narrower, more focused stream for improved kerf quality

C. The shielding gas flows concentrically around the outside of the plasma column to cool the nozzle body, improve cut-edge squareness, and shield the cutting zone from atmospheric oxidation

D. The shielding gas preheats the plate surface immediately ahead of the plasma column to reduce the energy required for full-thickness penetration of the cutting arc

63. A CAC-A operator is gouging when the compressed air supply pressure drops unexpectedly from 550 kPa to approximately 200 kPa while the arc remains established. What is the immediate consequence of the air pressure drop?

A. The reduced air pressure no longer expels molten metal efficiently and the metal begins re-solidifying in the groove, potentially fusing back to the base metal and creating a contaminated, irregular groove surface

B. The arc automatically extinguishes since CAC-A requires compressed air flow to complete the electrical circuit between the electrode and the workpiece

C. The electrode burns through twice as fast since the cooling effect of the air stream is reduced and the electrode tip overheats without sufficient airflow

D. The groove width automatically narrows since reduced air pressure concentrates the arc column in a smaller diameter and produces a finer, more precise groove profile

64. An OFC operator is about to cut galvanized steel structural members for a renovation project. The zinc coating is approximately 100 microns thick. Which safety control is most critical before cutting begins?

A. Increasing the cutting oxygen pressure by 15% above the normal setting to ensure the zinc coating is fully oxidized before the steel ignition reaction begins

B. Applying a chemical zinc stripper to the cut path and allowing it to fully dry before initiating the OFC torch on the galvanized material

C. Confirming that a properly functioning local exhaust ventilation system is in place at the cut location, since zinc oxide fumes generated during cutting cause metal fume fever

D. Replacing the OFC tip with a larger tip size one grade above the plate thickness rating to compensate for the thermal resistance added by the zinc coating layer

65. A PAC operator cuts 12 mm carbon steel plate using an air plasma system and observes that the dross on the bottom cut edge is soft and easily brushed off with a gloved hand. This type of dross is classified as:

A. High-speed dross — the soft character indicates the plasma column velocity was excessive and ejected material before it could oxidize and harden

B. Recondensation dross — vapourized metal from the cut zone cooled and re-deposited on the bottom edge as a soft particulate during the cutting cycle

C. Kerf-wall dross — material shaved from the upper kerf wall by the plasma column during travel and deposited without hardening on the lower cut edge

D. Low-speed dross — the soft, easily removed character indicates the plasma dwell time was too long due to insufficient travel speed, producing soft re-solidified material without a strong weld bond to the cut edge

66. During OFC of 25 mm structural plate, the operator notices the top edge of the cut is rounded and melted rather than sharp and square. What does a rounded, melted top edge specifically indicate about the cutting parameters?

A. The cutting oxygen pressure is insufficient for the plate thickness, causing the oxygen stream to fail before reaching full depth and redirecting heat upward

B. The travel speed is too slow, allowing excessive heat to accumulate at the top entry point and melt the upper edge beyond the cutting reaction zone

C. The preheat flame is too large or too intense for the plate thickness, overheating the top edge before the cutting oxygen stream is applied

D. The tip size is too small for the plate thickness, forcing the operator to slow down and apply excess preheat to compensate for inadequate cutting oxygen volume

67. Which statement most accurately describes the primary advantage of mechanized PAC over manual PAC for production runs requiring consistent dimensional accuracy on large quantities of cut parts?

A. Mechanized PAC uses higher amperage than manual PAC, producing deeper penetration and cleaner bottom edges on all material thicknesses

B. Mechanized PAC eliminates the need for consumable replacement since the fixed torch geometry prevents the electrode-nozzle contact that causes wear in manual operations

C. Mechanized PAC applies shielding gas at higher flow rates than manual torches, providing superior atmospheric protection that improves cut edge chemistry

D. Mechanized PAC maintains constant and repeatable standoff distance, travel speed, and torch angle throughout the production run, producing consistent kerf geometry and dimensional accuracy that manual technique cannot match

68. A CAC-A operator performing structural repair excavation completes the gouging pass and the quality inspector observes that the groove surface has a distinctly darker coloration than the surrounding base metal. Before MT examination, what must be done with this surface?

A. The darkened surface confirms adequate penetration depth and may proceed directly to MT examination without any additional surface treatment

B. Wire brush the groove surface vigorously to remove the carbon-enriched dark layer and expose the clean base metal before conducting the MT examination

C. Apply penetrant testing developer to the groove surface to neutralize the carbon deposits before the MT examination is conducted

D. Allow the groove surface to cool completely to ambient temperature — the dark coloration is temporary thermal discoloration that disappears upon cooling before MT

69. During OFC operations, an operator discovers that one of the check valves in the oxygen hose assembly has failed. What is the specific purpose of check valves in an OFC hose system and why is the failed check valve a safety concern?

A. Check valves maintain the correct gas pressure at the torch needles valves during cutting — a failed check valve causes pressure fluctuations that reduce cut quality

B. Check valves are flow meters that control the maximum gas volume delivered to the torch — a failed check valve allows unlimited gas flow creating an explosion risk

C. Check valves prevent reverse gas flow between the oxygen and fuel gas hose lines — a failed check valve allows oxygen to enter the fuel gas line or vice versa, creating an explosive mixture in the hoses

D. Check valves prevent regulator over-pressure from reaching the torch — a failed check valve exposes the torch needle valves to the full cylinder pressure without regulation

70. An OFC operator has been cutting with the same set of tips all shift and notices the preheat flames are becoming uneven and the cutting results are degrading. When the tips are examined, the preheat orifices appear partially clogged with slag. Which cleaning sequence is correct?

A. Clean the orifices with a drill bit matching the orifice diameter, blow out the debris with cutting oxygen at full pressure, then re-inspect the flame pattern before resuming cutting

B. Heat the tip to dull red with the oxy-acetylene preheat flame, then quench in water to crack and dislodge the clogged slag deposits from the orifices

C. Replace the tip entirely since any clogging indicates the orifice geometry has been permanently altered and cleaning cannot restore the original flame characteristics

D. Use the correct tip cleaner tool to clear the orifice without enlarging it, blow out any remaining debris with low-pressure air or oxygen, then verify the flame pattern before resuming cutting

71. Which combination of PAC process parameters most directly controls the width of the kerf (the width of material removed) during mechanized plasma arc cutting?

A. Amperage and plasma gas flow rate only — together these two parameters determine the total energy available for material vaporization

B. Travel speed and shielding gas composition only — these two parameters control the heat input per unit length and the atmospheric protection of the cutting zone

C. Plasma gas flow rate and standoff distance — the plasma gas flow controls column diameter and the standoff controls column spread before the plate surface is contacted

D. Amperage, standoff distance, and travel speed — higher amperage widens the plasma column, greater standoff allows more column spread, and slower speed allows more lateral melting, all three increasing kerf width

72. Under AWS D1.1 structural welding code, which welding position designator is used for a groove weld on pipe where the pipe axis is fixed at 45 degrees from horizontal and the weld is made in the overhead, vertical, and flat positions as the welder travels around the fixed pipe?

A. 5G, which designates a pipe with its axis horizontal and fixed, welded in all positions as the welder travels around the circumference without rotating the pipe

B. 6G, which designates a pipe with its axis inclined at 45 degrees from horizontal and fixed, requiring the welder to work in all positions around the full pipe circumference

C. 4G, which designates any pipe weld performed primarily in the overhead position where the pipe center is above the welder during most of the weld circuit

D. 2G, which designates a pipe with its axis vertical, requiring the welder to weld from the side in the horizontal position around the full circumference

73. An E7018 electrode requires holding oven storage when not in active use. If an oven-dried E7018 electrode is placed in a container with a desiccant (moisture absorber) at room temperature rather than in a holding oven, which result is most accurate after 8 hours in a 70% relative humidity shop environment?

A. The electrode may have absorbed sufficient moisture to compromise its low-hydrogen classification, since desiccant containers are not a code-approved substitute for holding ovens for low-hydrogen electrodes beyond 4 hours

B. The electrode will retain full low-hydrogen properties since desiccant containers provide equivalent moisture protection to holding ovens for a minimum of 24 hours

C. The electrode coating will physically dissolve if humidity exceeds 70% regardless of desiccant, making any desiccant container ineffective above this humidity threshold

D. The electrode will require only visual inspection before use — if the coating shows no visible moisture absorption, the electrode may be used without reconditioning

74. A SMAW welder is producing a vertical-up groove weld using E7018 on 20 mm structural plate. After completing several fill passes, the welder notices the groove has narrowed significantly from transverse shrinkage. The root opening at the joint cap location is now 1 mm rather than the original 3 mm. What consequence does this create for the final fill and cap passes?

A. The narrower groove reduces the groove volume and therefore reduces the number of passes required to complete the joint efficiently

B. The narrowed groove makes electrode access and manipulation more difficult for fill and cap passes, increases the risk of slag trapping at the fusion boundaries, and may result in incomplete fusion if not addressed

C. The narrower groove improves arc stability during cap passes since the electrode is now more closely confined by the groove walls on both sides

D. The narrowed groove has no practical consequence for cap pass quality since the cap pass is always deposited as a single wide bead regardless of remaining groove width

75. When SMAW welding overhead fillet welds (4F position) with E7018 electrodes on a structural T-joint, which electrode work angle and travel angle combination produces the best bead profile and fusion at both toes?

A. Work angle of 90 degrees perpendicular to the horizontal plate only, with a push travel angle of 10 to 15 degrees — the perpendicular work angle concentrates heat at the root and the push angle directs arc force ahead of the pool to prevent runback toward completed weld metal

B. Work angle of 60 to 75 degrees pointed strongly toward the vertical plate with a drag travel angle of 20 to 30 degrees — the steep work angle prioritizes vertical plate fusion and the steep drag holds the pool well behind the arc so gravity cannot pull it away from the vertical toe

C. Work angle of 90 degrees directed straight upward perpendicular to both plates with no travel angle, relying entirely on surface tension and reduced amperage to hold the small overhead pool without any directional arc force toward either fusion surface

D. Work angle of approximately 45 degrees bisecting both plate surfaces with a drag travel angle of 5 to 15 degrees — the bisecting work angle promotes equal fusion at both toes simultaneously, and the slight drag directs arc force into the joint while a short arc length and small pool kept by reduced amperage counteract gravity drip

76. An SMAW welder produces a pipe root pass using E6010 in the 5G position. At the 3 o'clock position (side of pipe), the root pass shows consistently lower reinforcement height on the back side than at other clock positions. What technique adjustment specifically addresses this?

A. Increase the amperage setting by 10% when approaching the 3 o'clock position to provide more heat input at the side-of-pipe location

B. Pause the electrode travel at the 3 o'clock position and apply a brief back-and-forth oscillation to build additional root pass reinforcement at the side position

C. Increase the electrode push angle toward the root gap at the 3 o'clock position to direct more arc force through the root and build the back-side reinforcement

D. Reduce the travel speed specifically as the weld approaches the 3 o'clock position and use a slight keyhole technique to ensure the root pass penetrates fully through at the side

77. An E9018-M electrode is selected for welding a high-strength structural steel with a minimum yield strength of 690 MPa. What does the "M" suffix specifically communicate about this electrode's qualification?

A. The "M" suffix indicates the electrode is intended for mechanized (automatic) welding applications only and is not approved for manual SMAW production use

B. The "M" suffix is not used in AWS A5.5 electrode designations and the electrode should be returned as incorrectly labeled

C. The "M" suffix indicates the electrode meets military specification requirements — it has been tested at multiple impact temperatures and meets more stringent Charpy toughness requirements than the base classification

D. The "M" suffix indicates the electrode contains molybdenum additions in the flux coating that improve the arc stability at the higher amperages required for high-strength steel welding

78. A production SMAW welder is assigned to weld 8 mm plate in the flat (1G) position using E7024 electrodes. What characteristic of E7024 makes it specifically designed for this application and what is its primary limitation?

A. E7024 is specifically designed for high-deposition flat and horizontal fillet welding with a heavy iron-powder coating — its primary limitation is that it is not approved for out-of-position welding due to its fluid slag system

B. E7024 is a low-hydrogen all-position electrode with a titania-iron powder coating that makes it unsuitable for single-pass fillets above 8 mm leg size

C. E7024 is a flux-cored electrode with an external iron-powder coating that produces the highest deposition rates of all SMAW electrodes in all welding positions

D. E7024 has a cellulosic coating that produces a deeply penetrating arc ideal for flat position root pass work with its primary limitation being a high hydrogen content

79. A structural SMAW welder consistently produces excessive spatter around the bead with a coarse, globular character and large spatter balls sticking firmly to the base metal surface. The electrode is E7018 at the correct amperage range. Which parameter is most likely causing this pattern?

A. Excessive amperage above the maximum rated for the electrode diameter — overheating of the electrode tip causes expulsion of large molten metal drops from the arc zone

B. Insufficient amperage below the minimum rated for the electrode — the cold arc cannot properly melt the electrode coating and causes globular spatter from the slag system

C. Excessively short arc length — the electrode tip contacts the pool surface repeatedly, causing explosive expulsion of metal droplets in the characteristic large, firmly adhered pattern

D. Excessively long arc length — the unstable arc column cannot consistently direct molten metal to the joint and causes globular spatter distribution around the bead deposit

80. When SMAW welding with E6010 electrodes on DC power, arc blow is most likely to occur in which of the following specific situations?

A. During a long continuous run on thermally conditioned structural plate that has been preheated uniformly to 100°C, with the work lead clamped at the midpoint of the joint so the electrical return path is equal in length on both sides of the arc

B. At the ends of a structural joint or near corners and abrupt changes in section geometry — locations where the DC magnetic flux cannot distribute symmetrically ahead of the arc and becomes asymmetrically crowded at the geometric discontinuity, deflecting the arc consistently forward or backward regardless of work lead placement

C. When using the backstep welding technique at weld start positions, since the electrode deposits new metal over thermally demagnetized tack welds that have been reheated repeatedly and no longer contribute to the residual magnetic flux in the joint area

D. On freshly flame-cut structural plate in the flat position at low amperage, where the thin oxide layer formed during cutting acts as a partial magnetic barrier that prevents efficient coupling of the arc's magnetic field to the base metal return circuit

81. Under ASME Section IX, for an SMAW procedure qualified on P1 Group 1 carbon steel, which base metal change constitutes an essential variable requiring requalification?

A. Changing the base metal from a P1 Group 1 steel such as ASTM A36 to a P1 Group 2 higher-strength carbon steel such as ASTM A516 Grade 70 — a change in Group Number within the same P-Number is a listed essential variable under QW-403.5 because Group 2 materials have increased hardenability and different preheat and cooling requirements that the Group 1 PQR does not validate

B. Substituting ASTM A36 with CSA G40.21 Grade 300W plate, since both steels carry the same P1 Group 1 assignment under ASME Section IX and are considered interchangeable for procedure qualification purposes without requiring new PQR testing

C. Increasing the minimum preheat temperature above the value recorded on the PQR while keeping all other welding variables — amperage, travel speed, filler metal, and position — within the ranges documented in the original qualification record

D. Changing from a single-V groove joint preparation to a double-V groove preparation while maintaining equivalent root conditions, filler metal classification, heat input range, and all other essential variables within the ranges supported by the existing PQR

82. An SMAW welder is asked to weld cold-drawn stainless steel studs to a structural carbon steel base plate using E308L-16 stainless steel electrodes. After cooling, the welds show fine transverse cracking at the base of the stud adjacent to the carbon steel plate. What is the most probable cause?

A. The E308L-16 electrode flux is incompatible with carbon steel base metal and chemically reacts with the base metal to produce crack-initiating iron carbides at the fusion line

B. The high carbon equivalent of the structural carbon steel creates a hard, crack-susceptible martensite zone in the HAZ adjacent to the austenitic stainless weld metal under the high restraint conditions of stud welding

C. The 308L weld metal has insufficient ductility to accommodate the differential thermal contraction between the austenitic weld deposit and the ferritic carbon steel base metal during cooling

D. The austenitic stainless steel filler metal creates a galvanic cell with the structural carbon steel base plate that causes hydrogen generation at the interface and HICC cracking in the HAZ

83. A SMAW welder is producing overhead fillet welds on structural steel using E7018 electrodes. The completed welds show a consistent pattern of sagging at the centre of each bead with the weld face drooping noticeably below the toes. Which parameter or technique change most directly corrects this condition?

A. Increase the weave width to distribute the weld metal more broadly across the fillet faces and prevent the central accumulation that causes the pool mass to exceed the surface tension force holding it against the overhead surface

B. Increase the amperage to improve pool fluidity so the more mobile metal flows efficiently to both toes under arc force before any central buildup can occur and the bead face can droop

C. Apply a slight push travel angle to use the forward-directed arc force as a physical counterbalance against gravity, pushing back against the pool's tendency to sag away from the overhead joint surface

D. Use a shorter arc length and increase travel speed — the shorter arc concentrates arc force precisely at the fusion zone to maintain pool control, while the faster travel limits the total volume of molten metal present at any point, keeping the pool small enough for surface tension to support it against gravity without drooping

84. A production supervisor reviewing SMAW welder qualifications notices that a welder's CWB certificate is qualified to "Fillet Welds F-2G-SS-FM1" on stainless steel. A structural stainless steel project requires "Groove Welds 3G-SS-FM1." Can the welder perform the groove weld production work under this certificate?

A. Yes — fillet weld qualification at the 2G position covers groove welds in the same or less demanding positions on the same material and filler metal group

B. No — groove weld and fillet weld qualifications are separate categories under CWB standards, and a fillet weld certificate does not cover groove weld production regardless of position or material

C. Yes — the stainless steel material and FM1 filler metal group coverage on the certificate extends to all joint types since the metallurgical qualification is the governing variable

D. No — the 2G position covered by the fillet certificate is more demanding than 3G vertical, which means the vertical groove weld exceeds what the 2G fillet certificate authorizes

85. A low-hydrogen E7018 electrode held in a 120°C holding oven is taken out for use and placed in an open electrode container on the welding table at 8:00 AM. The shop humidity is 65%. Under AWS D1.1, at what time must this electrode be reconditioned or discarded if it has not been used?

A. By 12:00 PM (4 hours later) — AWS D1.1 limits low-hydrogen electrode atmospheric exposure to a maximum of 4 hours before reconditioning at 260-430°C is required

B. By 2:00 PM (6 hours later) — low-hydrogen E7018 is permitted 6 hours of atmospheric exposure under the standard shop humidity exception

C. By 8:00 AM the next morning (24 hours later) — the sealed container and desiccant provide the full 24-hour exposure period for E7018 classification electrodes

D. At the end of the shift (8 to 10 hours later) — the standard shift-length exposure is the governing exposure period for all E7018 low-hydrogen classifications

86. During GMAW of structural carbon steel using ER70S-6 solid wire with 75/25 Ar/CO2 shielding gas, the operator observes that the weld bead has a consistently high crown profile with very little sidewall fusion visible at the toes. Which parameter adjustment most effectively corrects this crown profile defect?

A. Reduce the wire feed speed to lower the amperage and produce a smaller, flatter bead deposit with reduced crown height

B. Increase the shielding gas flow rate to improve arc stability and allow the weld pool to spread more uniformly to the toes

C. Increase the arc voltage to lengthen the arc, which spreads the arc heat over a wider area and produces a flatter, wider bead profile with better toe fusion

D. Reduce the CTWD (contact-tip-to-work distance) to increase the arc energy density and concentrate heat at the toe locations

87. An FCAW operator using E71T-1M wire with 75/25 Ar/CO2 shielding gas produces vertical-up fillet welds. The welds consistently show convex face profiles with the weld crown extending well above the plane of the toes. Which technique or parameter change most directly corrects the excessive convexity?

A. Increase the WFS and voltage proportionally to increase heat input and improve the pool fluidity needed for a flatter bead profile in the vertical position

B. Reduce the WFS (and therefore amperage) slightly while maintaining voltage to produce a smaller, more fluid pool that flows to a flatter profile at the toes

C. Switch from E71T-1M to E71T-5 wire which has a stiffer, more viscous basic slag system that physically holds the weld metal in a flatter profile during vertical welding

D. Increase the electrode stick-out distance from 19 mm to 25 mm to increase resistive preheating of the wire and reduce the effective amperage at the arc

88. Which statement correctly describes the difference between an E70T-1 and an E70T-5 FCAW wire in terms of their application requirements?

A. E70T-1 uses DCEN polarity and is designed for all-position welding in field applications, while E70T-5 uses DCEP polarity and is restricted to flat and horizontal shop welding

B. E70T-1 is a self-shielded wire requiring no external gas supply, while E70T-5 is a gas-shielded wire requiring 75/25 Ar/CO2 shielding for all applications

C. E70T-1 has no specific storage requirements after the spool is opened, while E70T-5 must be stored in a sealed environment with desiccant after opening to prevent moisture-induced porosity

D. E70T-1 uses a rutile slag system with DCEP shielding gas, while E70T-5 uses a basic slag system with DCEP gas shielding and produces lower diffusible hydrogen — E70T-5 is preferred in high-restraint or thick-section applications where cold cracking must be minimized

89. An FCAW-G operator is producing flat-position fillet welds using E71T-1M wire and finds the slag consistently sticks tightly and resists chipping. The voltage is within the manufacturer's recommended range. Which adjustment most effectively produces self-releasing slag with T-1 wire?

A. Increase the voltage slightly toward the upper end of the recommended range — higher voltage produces a hotter, more fluid slag pool that releases more cleanly from the bead surface upon cooling

B. Reduce the WFS and voltage below the minimum recommended range to produce a cooler pass that prevents the slag from bonding at the elevated temperatures near maximum parameters

C. Increase the travel speed by approximately 20% to reduce heat input per unit length, which reduces the slag temperature during solidification and improves its release characteristics

D. Switch from push to drag gun angle — the drag angle directs more arc energy into the slag layer and prevents the slag from fusing to the base metal at the toes during solidification

90. During GMAW production welding of carbon steel using 75/25 Ar/CO2 at spray transfer parameters, the operator increases the CTWD from 19 mm to 32 mm without changing any other settings. What is the primary effect of this CTWD increase?

A. The arc voltage increases at the wire tip because the longer wire extension increases electrical resistance, and the wider arc column produces a wider, flatter bead with reduced penetration

B. The amperage increases because the longer wire extension provides more preheating energy from resistance heating, which reduces the amount of current required from the power source to complete wire melting

C. The arc becomes unstable and transitions from spray transfer to globular transfer because the extended CTWD moves the wire end outside the effective shielding gas envelope boundary

D. The shielding gas coverage improves because the longer stick-out allows the shielding gas envelope to fully establish around the wire before it reaches the arc zone

91. A GMAW operator is using a push travel angle (forehand technique) on a flat-position butt weld. Compared to a drag travel angle (backhand technique) with identical parameters, which difference in weld profile is most characteristic of the push angle?

A. The push angle concentrates arc force directly downward into the base metal ahead of the pool, producing a distinctly narrower bead with deeper penetration than the drag technique at identical voltage, amperage, and travel speed

B. The push angle and drag angle produce bead profiles that are effectively identical in flat-position butt welding because the flat-position gravity effect normalizes the pool shape and removes any travel-angle influence on bead geometry

C. The push angle produces a convex, high-crown bead because the arc force deflects the pool backward away from the travel direction, allowing molten metal to accumulate and build at the arc point before it can spread as the torch advances

D. The push angle typically produces a flatter, wider bead with shallower penetration compared to drag — with the torch angled forward, the arc column directs heat into the base metal ahead of the pool rather than into the pool itself, spreading the heat zone more broadly and reducing the directional force driving deep fusion into the joint root

92. A GMAW operator selects an ER308L solid wire with 98/2 Ar/O2 shielding gas for spray transfer welding of 304L austenitic stainless steel components. Which of the following represents the most critical operational restriction when using this shielding gas on stainless steel?

A. The oxidant content must be held at the specified 2% O2 and must never be increased — even a modest rise in O2 content above this specification disproportionately accelerates chromium surface oxidation on the stainless weld metal and HAZ, degrading the passive layer and compromising the corrosion resistance that is the primary design property of the 304L base material

B. ER308L filler wire must be substituted with ER316L wire when using any Ar/O2 shielding blend on austenitic stainless, since the absence of molybdenum in 308L chemistry creates an incompatibility with oxidant-bearing gases that promotes weld metal porosity in the spray transfer range

C. The 98/2 Ar/O2 blend must always be replaced with a 75/25 Ar/CO2 blend for 304L stainless components in the spray transfer mode, since CO2 provides superior chromium oxide protection and achieves the full spray transition threshold at lower voltage settings

D. Shielding gas flow rate when using 98/2 Ar/O2 on stainless steel must be reduced by 30% compared to carbon steel GMAW settings, since the elevated argon proportion creates excessive turbulence at standard flow rates that entrains atmospheric nitrogen and generates weld metal porosity

93. An FCAW operator using E71T-8 self-shielded wire produces a weld on structural steel that passes visual inspection but shows significant scatter porosity on RT examination. The base metal was clean, the wire spool was new and factory-sealed, and the voltage and amperage were within specifications. Which factor is most likely responsible?

A. The factory-sealed wire spool contained moisture-contaminated wire from an improperly controlled manufacturing environment at the wire producer's facility

B. The travel speed was too fast, preventing the self-shielding compounds from generating adequate gas protection at the arc before the pool solidified prematurely

C. The electrode stick-out was too short, preventing the flux core compounds from fully vaporizing and generating the required shielding atmosphere before the arc reached the pool

D. The wind speed in the work area exceeded approximately 5 km/h, which dispersed the self-generated shielding atmosphere from the T-8 core compounds before adequate arc protection was established

94. A production manager is comparing FCAW-G with SMAW for a structural fabrication project involving long continuous fillet welds on 16 mm plate in the flat and horizontal positions. Which comparison statement most accurately represents the productivity difference?

A. SMAW typically achieves 10 to 15% higher deposition rates than FCAW-G on flat-position fillet welds due to the electrode's faster melt-off rate at equivalent amperages

B. FCAW-G typically achieves 2 to 4 times the deposition rate of SMAW by eliminating stub losses, extending arc-on time through continuous wire feeding, and operating at higher sustainable amperages

C. FCAW-G and SMAW produce essentially equal deposition rates at equivalent amperages — the primary advantage of FCAW-G is improved bead appearance rather than increased productivity

D. SMAW is more productive than FCAW-G for long fillet welds because the electrode coating provides better directional control that allows faster travel speeds without quality loss

95. An MCAW wire classified as E70C-6M is being qualified as a substitute for ER70S-6 solid wire in an existing AWS D1.1 qualified WPS. Under the code's essential variable provisions, which statement correctly describes the qualification requirement?

A. No requalification is required since both wires are AWS A5.18 classified carbon steel filler metals with the same F-number and will produce mechanically equivalent deposits

B. Only a WPS amendment is required since the solid wire and metal-cored wire share the same classification number suffix and produce equivalent chemistry deposits in the structural weld

C. The metal-cored wire does not require qualification testing since its higher deposition rate is always a performance improvement that automatically falls within the existing PQR parameter range

D. A new procedure qualification by PQR testing is required since changing from solid wire (ER designation) to metal-cored wire (EC designation) constitutes a change in filler metal type that is an essential variable under D1.1

96. A GTAW welder sets up to weld carbon steel pipe using DCEN polarity with a 2.4 mm EWCe-2 ceriated tungsten electrode. During setup, the welder accidentally connects the torch lead to the positive terminal of the power source. What is the immediate observable consequence when the arc is struck?

A. The tungsten electrode immediately begins to melt and ball at the tip, the arc is unstable, and the tungsten contaminates the weld pool — all caused by arc energy concentrating at the electrode under DCEP polarity

B. The arc initiates normally but the penetration profile is broader and shallower than expected because the reversed polarity heats the base metal from the opposite direction

C. The arc cannot be initiated because the high-frequency unit requires DCEN polarity to produce the voltage spike needed for arc ignition in GTAW

D. The gas flow automatically reverses direction due to the polarity change, drawing atmospheric air into the torch and causing severe oxidation of the tungsten tip

97. A GTAW welder producing stainless steel root passes must select between EWCe-2 (ceriated, grey) and EWTh-2 (thoriated, red) tungsten electrodes for the DCEN application. Which consideration specifically favors EWCe-2 over EWTh-2 in modern industrial practice?

A. EWCe-2 provides significantly higher current-carrying capacity than EWTh-2 at the same electrode diameter, allowing the welder to use a smaller electrode for the same amperage range

B. EWCe-2 produces a more stable arc on AC welding of aluminum, making it more versatile across different material types than the DC-only capability of EWTh-2

C. EWCe-2 provides equivalent arc starting and arc stability performance to EWTh-2 on DCEN applications without the radiation exposure concerns associated with the thorium oxide content in EWTh-2

D. EWCe-2 is significantly cheaper per electrode than EWTh-2 and provides longer service life due to its non-radioactive oxide composition that prevents tip oxidation

98. A GTAW welder is welding the root pass on a 316L stainless steel pipe joint with the argon back purge confirmed below 1,000 ppm oxygen. After completing the root pass, the inside bead color is silver with slight straw coloration near the edges. What is the correct quality assessment?

A. Reject — any discoloration beyond pure silver indicates inadequate purge and the root pass must be removed and rewelded under improved purge conditions

B. Accept — silver to light straw coloration is within acceptable back bead quality for 316L stainless steel, indicating the purge provided sufficient protection during welding

C. The result is indeterminate — additional chemical analysis of the bead surface is required to confirm whether chromium oxidation at the straw-colored zones is within acceptable limits

D. Accept with notation — straw coloration confirms the purge flow rate was slightly excessive, creating turbulence, and the flow rate should be reduced for the remaining passes

99. A GTAW welder is preparing to weld 2205 duplex stainless steel with a WPS specifying a maximum heat input limit and an interpass temperature maximum of 150°C. Why is the maximum heat input limit especially critical for duplex stainless steel compared to standard austenitic stainless steel?

A. Excessive heat input on duplex stainless steel causes the austenite phase to completely dissolve, leaving a fully ferritic microstructure with dramatically reduced toughness and corrosion resistance in the weld deposit

B. Excessive heat input on duplex stainless steel promotes sigma phase and other intermetallic compound formation in the heat-affected zone and weld metal, which severely reduces both toughness and corrosion resistance

C. Excessive heat input causes hydrogen trapping at the ferrite-austenite phase boundary in duplex stainless, making the weld significantly more susceptible to hydrogen-induced cold cracking than conventional steels

D. Excessive heat input on duplex stainless steel reduces the delta ferrite content in the weld metal below the minimum 3% needed to prevent solidification hot cracking at the weld metal centreline

100. A GTAW procedure specifies post-weld argon gas purge coverage over the completed weld for 30 seconds after arc extinction. During production, a welder consistently lifts the torch immediately after breaking the arc. What observable defect is most likely on the completed welds?

A. Blue-to-black surface discoloration from oxidation of the hot weld metal and adjacent heat-affected zone, exposed to atmospheric oxygen before the surface temperature drops below the threshold at which alloying elements oxidize preferentially — the color intensity indicates oxidation severity, and any coloration beyond light straw indicates passive layer compromise requiring chemical passivation treatment

B. Longitudinal centreline cracking caused by the abrupt temperature gradient between the still-hot weld centreline and the rapidly air-cooled weld edges, which imposes differential thermal contraction stresses that exceed the hot strength of the partially solidified centreline region

C. A coarse, porous bead surface throughout the deposit caused by nitrogen and oxygen dissolving rapidly into the still-liquid pool when shielding is removed before the weld has fully solidified and the pool surface has closed against atmospheric entry

D. Significantly increased weld reinforcement height caused by the faster quench rate of ambient air cooling relative to argon post-flow, which accelerates solidification and prevents the molten crown from flattening before it freezes

101. During GTAW of aluminum, the AC high-frequency arc stabilization produces a characteristic buzzing sound during welding. A new operator asks what the AC current does in the aluminum GTAW arc that the DC mode cannot achieve. What is the technically correct explanation?

A. The alternating current prevents the electrode from overheating by limiting the electrode-positive duration to equal timed intervals, keeping the electrode tip temperature low enough to prevent the balling and contamination that would otherwise occur continuously if DC positive polarity were sustained

B. The alternating current creates a continuously rotating magnetic field around the arc column that counteracts arc blow in aluminum, allowing the arc to remain centered on the joint without the deflection that DC polarity causes through unidirectional magnetic flux in the non-ferrous base metal

C. The alternating current provides two simultaneous functions in every complete cycle — the electrode-negative half-cycle delivers deep penetrating arc energy into the aluminum base metal, while the electrode-positive half-cycle provides cathodic bombardment that breaks up and removes the refractory aluminum oxide layer from the weld zone surface, a dual capability that neither DC polarity alone can replicate

D. The alternating current produces deeper fusion penetration than either DC polarity because the rapid current reversals create a pulsing arc force that mechanically stirs the molten pool, preventing cold lapping at the fusion boundary and improving toe wetting across the aluminum weld zone

102. A GTAW welder is welding 6061-T6 aluminum plate and notices the cleaning band (the bright, shiny zone) beside the weld bead is very narrow — approximately 1 to 2 mm wide on both sides. What does this narrow cleaning band indicate?

A. The amperage is too high, concentrating the cathodic cleaning energy in a narrow band rather than distributing it more broadly around the weld deposit area

B. The cleaning band width is primarily controlled by the travel speed — an excessively narrow cleaning band indicates the welder is moving too slowly for the given amperage and heat input

C. The narrow cleaning band indicates the welding was performed with DCEN polarity rather than AC — DCEN does not produce cathodic cleaning and the narrow zone represents only the immediate heat-affected area

D. The AC balance is set heavily toward electrode negative (EN), providing insufficient electrode-positive (EP) cathodic cleaning half-cycles to produce a wider oxide removal zone around the weld bead

103. A GTAW welder produces a root pass on a 2-inch (50 mm) diameter, 4 mm wall Schedule 40 carbon steel pipe in the 6G position using ER70S-2 filler and 100% argon shielding. The completed root pass shows consistent lack-of-penetration at the 6 o'clock (overhead) position. Which technique specifically addresses this problem at the overhead location?

A. Increase the argon shielding gas flow rate to at least 15 L/min at the overhead position to provide additional gas column pressure that supports the root pool against gravity and holds it in contact with the root gap faces during that portion of the circuit

B. Switch from ER70S-2 to ER70S-6 filler at the overhead position, since the higher silicon and manganese content of ER70S-6 produces a more fluid pool that penetrates the root gap more readily and maintains better fusion contact with the groove faces against the overhead gravity effect

C. Reduce travel speed uniformly around the full pipe circumference, since consistent lack-of-penetration at the overhead position indicates the overall amperage and heat input combination is insufficient for the joint regardless of clock position

D. At the 6 o'clock overhead position, pause electrode travel briefly and use a more deliberate keyhole technique — aggressively position the arc at the root gap to establish and maintain a visible through-penetration keyhole that gravity tends to close at that location, then resume travel while actively directing the arc at the root face to build consistent root reinforcement through the full overhead portion

104. A GTAW operator changes the shielding gas from 100% argon to 75% helium/25% argon for welding 12 mm austenitic stainless steel. How does this gas change affect the welding parameters and what advantage does it provide for the thick section?

A. The He/Ar blend requires lower amperage than pure argon for the same penetration, reducing heat input and minimizing distortion in the thick stainless plate section

B. The He/Ar blend produces a narrower arc column than pure argon, improving directional control and reducing the risk of sidewall lack of fusion in the 12 mm groove

C. The higher cost of the He/Ar blend is not justified for stainless steel since helium offers no practical advantage over argon for groove weld GTAW applications above 8 mm thickness

D. The He/Ar blend's higher thermal conductivity increases arc energy transfer to the base metal, improving penetration and fusion on the thick section without requiring amperage increases that would raise the interpass temperature

105. An automated orbital GTAW welding machine is programmed to weld 25 mm diameter stainless steel tube joints. The completed welds show excellent quality at 3 and 9 o'clock but excessive crown at 12 o'clock and undercut at 6 o'clock with uniform programmed amperage throughout. Which program modification most effectively corrects both conditions simultaneously?

A. Increase the programmed travel speed at 12 o'clock to reduce crown, and decrease the programmed travel speed at 6 o'clock to improve fusion and reduce undercut

B. Add a filler wire addition subroutine specifically at the 6 o'clock overhead position to compensate for the metal lost to undercut at that clock position

C. Reduce the programmed amperage at 12 o'clock (flat, reducing the crown) and reduce the programmed amperage at 6 o'clock (overhead, tightening the pool to resist dripping and undercut formation)

D. Increase the shielding gas flow rate uniformly throughout the full circuit to improve pool support through gas pressure assistance against gravity at the overhead position

106. Under ASME Section IX, which combination of changes to a qualified GTAW procedure on stainless steel would each independently constitute an essential variable requiring separate PQR requalification?

A. Changing the argon shielding gas to helium, AND changing the filler wire diameter from 2.4 mm to 3.2 mm within the same SFA classification

B. Changing the tungsten electrode diameter from 2.4 mm to 3.2 mm, AND changing the post-weld cleaning method from wire brushing to mechanical grinding

C. Changing the base metal from 304L to 316L (same P-number), AND increasing the minimum preheat from ambient to 50°C

D. Changing the shielding gas from 100% argon to argon/hydrogen blend, AND changing the filler metal from ER308L to ER316L — each changes an essential variable (gas composition and filler classification)

107. A GTAW welder producing stainless steel tube-to-tubesheet welds on a heat exchanger notices that the argon back purge has been flowing for 45 minutes at 8 L/min through the tube bundle before welding begins. When the first tube weld is made, the root shows excellent silver color. Which purge system element is most critical for maintaining this quality through the remaining tube welds?

A. Completing all remaining tube welds within a maximum of 90 minutes of initial purge establishment — extended purge durations cause argon stratification inside the bundle that gradually reverses the oxygen gradient and allows atmospheric contamination of tubes welded late in the sequence

B. Maintaining positive argon pressure throughout the bundle and verifying the oxygen content remains below 1,000 ppm at the weld zone before each successive tube weld — progressive heat from completed welds can distort purge seals and develop small leaks, making oxygen measurement before each weld the only reliable method for confirming purge integrity is maintained through the full welding sequence

C. Closing the purge gas inlet valve after the first ten tube welds are completed, since the established argon atmosphere becomes self-sustaining at that point and continued flow creates turbulence near open tube ends that entrains atmospheric air into the bundle perimeter seals

D. Increasing the argon flow rate progressively by 1 L/min for every five tube welds completed to compensate for the increasing micro-leakage that develops in the bundle seals as the tubesheet temperature rises from accumulated welding heat

108. In submerged arc welding (SAW) of a structural T-joint fillet weld on 25 mm plate, the welding supervisor observes that the completed bead has a very deep, narrow cross-section profile with a depth-to-width ratio of approximately 1.2:1. Why is this bead geometry a quality concern?

A. The deep, narrow bead cross-section concentrates solidification contraction stresses and low-melting segregates along the bead centreline — as the weld solidifies inward from both fusion boundaries toward the centre, segregates become trapped and concentrated at the last point to solidify, creating high susceptibility to centreline solidification hot cracking that is directly linked to exceeding a depth-to-width ratio of approximately 1:1

B. The narrow upper bead width relative to depth indicates insufficient flux depth coverage over the arc during welding, which allows atmospheric oxygen to contaminate the upper weld pool as the flux layer stretches thin across the wide, deep arc cavity below the surface

C. A high depth-to-width ratio creates excessive turbulence in the narrow flux-covered pool that prevents slag from floating cleanly to the surface, resulting in a high probability of entrapped slag inclusions distributed throughout the completed weld metal cross-section

D. The high depth-to-width ratio reduces the load-bearing effective throat of the completed fillet weld below the minimum required by the structural welding code, since effective throat is measured from the theoretical root to the narrowest horizontal dimension across the weld face

109. A SAW procedure specifies a fused flux with an F8A4 designation. What does the "A4" portion of this flux designation communicate about the deposited weld metal properties?

A. The "A" indicates the flux is an active type that adds alloy elements from the flux to the deposit, and "4" indicates the flux is rated for use on four different P-number base metal groups

B. The "4" refers to the fourth revision of the flux chemistry specification dating from the original 1974 publication of the flux standard

C. The "A4" suffix indicates the minimum Charpy impact test energy (in ft-lbs) absorbed at a specific temperature, confirming the mechanical properties of the deposit made with this flux and electrode combination

D. The "A" indicates the flux is an active type that adds manganese and silicon to the deposit, and the "4" designates that the weld metal meets impact testing requirements at −40°F (−40°C)

110. A SAW operator is welding a 75 mm thick pressure vessel shell course and the heat input calculation shows 4.8 kJ/mm. The procedure qualification requires Charpy impact testing at −45°C and specifies a maximum heat input of 3.5 kJ/mm to maintain adequate toughness. What must be done?

A. Proceed with the 4.8 kJ/mm heat input provided the interpass temperature is held strictly below the WPS maximum — elevated heat input effects on Charpy toughness are compensated by strict interpass temperature control, since both variables together determine the final HAZ and weld metal grain structure

B. Stop welding and adjust the parameters before continuing — heat input must be reduced to 3.5 kJ/mm or below by decreasing the amperage, increasing the travel speed, or reducing the voltage, since the maximum heat input is a procedure essential variable that cannot be exceeded on impact-tested procedures without invalidating the qualification basis of the WPS

C. Continue welding with the exceedance documented in the production record and submit a retroactive engineering calculation demonstrating that 4.8 kJ/mm produces grain growth no greater than the level tolerated by the Charpy toughness requirement at −45°C

D. Reduce the travel speed at the next pass to lower the arc energy delivered per unit length — slowing the torch is the preferred single-variable adjustment for bringing elevated heat input back within the qualified range without disturbing the established voltage and amperage combination

111. A SAW welding procedure is qualified using a bonded flux. During production, the purchased bonded flux has been stored in an open drum in the welding shop for three weeks. Before using the recovered and stored flux, what essential step is required?

A. Visually inspect the flux for colour changes — bonded flux that shows any darkening from its original colour must be discarded and replaced with fresh material

B. Submit a random sample to the metallurgical laboratory for moisture content analysis — flux may only be returned to service if the laboratory confirms moisture is below 0.1%

C. Add 10% fresh flux to the stored flux before loading it into the SAW flux hopper to ensure any moisture-absorbed granules are diluted with dry material

D. Dry the stored bonded flux in an oven at the temperature and duration specified by the flux manufacturer before returning it to the production hopper

112. A tandem SAW system uses DCEP on the lead wire and AC on the trailing wire. During production, the trailing arc experiences instability characterized by arc wander and inconsistent penetration. Which component is most likely responsible for the trailing arc instability?

A. The DC lead arc's magnetic field is deflecting the AC trail arc, indicating the arc-to-arc spacing is too close and the lead and trail arcs are magnetically interfering with each other

B. The contact tip on the trailing wire head has excessive wear, causing intermittent electrical contact that disrupts the AC arc's consistent re-ignition on each half-cycle

C. The AC power source's output frequency is mismatched with the DC power source, creating harmonic interference that destabilizes the AC arc during production welding

D. The trailing flux depth is insufficient — inadequate flux coverage over the AC trail arc is causing the arc to break through the flux and operate partially in the open air

113. A production welder is assigned to complete fillet welds on a structural beam that has been pre-heated to 125°C per the WPS. During welding, the welder's pyrometer shows the preheat temperature has dropped to 75°C at the joint before beginning the next weld pass. What must the welder do?

A. Restore the preheat by reapplying heat to bring the joint temperature back to the minimum 125°C specified in the WPS before depositing the next pass — welding below the minimum preheat is a procedure non-conformance that increases the HAZ cooling rate above the design basis, raising the risk of hydrogen-induced cold cracking in the heat-affected zone

B. Document the reduced temperature in the production record and continue welding, since interpass temperature requirements govern the maximum limit only — the WPS minimum preheat applies to the first pass and subsequent fill passes may be deposited at any temperature above ambient without affecting cold cracking susceptibility

C. Notify the welding inspector and halt all welding activity at the joint until a formal non-conformance report is raised and engineering disposition of the affected area is completed before any additional heat application or production welding proceeds

D. Apply a portable heating blanket to the base metal away from the joint and allow conductive warming to gradually bring the joint temperature upward while the next pass is being deposited, avoiding the production delay associated with direct flame reapplication at the joint location

114. During SMAW production on A514 quenched-and-tempered high-strength structural steel, the WPS specifies a maximum interpass temperature of 230°C. A welding inspector measures 265°C between the second and third fill passes. In addition to stopping welding to let the joint cool, what additional concern does exceeding the maximum interpass temperature create on A514 specifically?

A. The elevated interpass temperature accelerates outward hydrogen diffusion from the weld zone, which reduces cold cracking risk but simultaneously promotes intergranular oxidation at the fusion boundary that degrades the HAZ-to-weld-metal bond strength under dynamic loading conditions

B. Exceeding the maximum interpass temperature on A514 risks over-tempering the quenched-and-tempered heat-affected zone — A514's mechanical properties derive entirely from its Q&T condition, and repeated exposure to elevated interpass temperature can permanently reduce the HAZ microstructure below the steel's minimum specified yield and tensile strength requirements in a way that cannot be detected by visual or dimensional inspection of the completed joint

C. The elevated interpass temperature promotes austenite grain coarsening in the deposited weld metal that permanently reduces weld metal Charpy impact energy, preventing the joint from meeting the minimum toughness requirement at the low service temperature specified in the structural design

D. The elevated interpass temperature above 230°C promotes delta ferrite network formation in the A514 HAZ that destabilizes the microstructure and creates a continuous path of low-ductility ferrite stringers along the prior austenite grain boundaries immediately adjacent to the fusion line

115. A WPS for an offshore structural joint specifies all four of the following: E7018 electrodes, 150°C minimum preheat, 230°C maximum interpass temperature, and PWHT at 600°C. During PWHT, the joint is heated to 600°C and held for the specified time. Which property of the weld joint is most directly improved by this PWHT treatment?

A. The tensile strength of the deposited E7018 weld metal, which is deliberately low after welding and increases significantly to the specified minimum after PWHT

B. The weld metal porosity content, which is reduced during PWHT as trapped hydrogen gas expands and escapes through the open pores in the weld metal

C. The surface condition of the weld crown, which undergoes a stress-relief descaling during PWHT that eliminates the need for post-weld grinding at inspection

D. The residual stress level and hardness in the weld metal and HAZ, with PWHT reducing residual tensile stresses and tempering any hard martensite formed during rapid post-weld cooling

116. A GTAW welder is producing a stainless steel pipe root pass and completes 60% of the circumference before the argon back purge supply is interrupted. The existing root bead shows excellent silver color. What is the correct action?

A. Continue welding without interruption and complete the remaining 40% of the circuit as quickly as possible — the portion of root pass already deposited provides a partial seal that significantly slows oxygen ingress into the pipe interior, and rapid completion limits the total atmospheric exposure time at the open arc

B. Stop welding, immediately increase the argon flow rate to a minimum of 20 L/min for 15 minutes to flush the pipe interior atmosphere completely, then resume welding at half the normal travel speed to allow the slower arc movement to compensate for any residual marginal purge quality in the remaining section

C. Stop welding immediately, restore and verify the purge system to below 1,000 ppm oxygen inside the pipe, then resume welding from the interruption point — continuing without adequate back purge will cause progressive oxidation of the stainless root bead, and even brief atmospheric exposure at welding temperature is sufficient to compromise the passive layer and require root pass removal and rewelding

D. Evaluate the situation with the welding inspector before taking any action — the decision to stop or continue depends on the applicable code of construction, the service environment, and the specific chromium content of the stainless steel grade, all of which must be reviewed before a disposition is made

117. A GTAW welder using 2.4 mm EWCe-2 tungsten on DCEN for stainless steel welding must select the correct tungsten tip preparation. Which combination is correct for DCEN GTAW applications?

A. Leave the tungsten as-received with a flat end from the factory cut — the flat end prevents arc wander on DCEN by distributing electron emission evenly across the tip face

B. Grind the tungsten to a sharp taper ending in a point, with grinding marks running longitudinally along the taper — this concentrates the arc precisely and arc marks from transverse grinding can cause arc wander

C. Ball the tip of the electrode by briefly striking an AC arc on a copper block — the small balled end provides the same electron emission characteristics as a pointed tip but with better resistance to tip erosion

D. Grind to a slight truncation (a small flat on the tip of the taper) — the truncated tip prevents the sharp point from vaporizing during high-amperage DCEN applications on thick stainless plate

118. An ER5356 filler wire is specified for GTAW welding of 5083 aluminum plate. The fabricator's wire inventory shows only ER4043. Can ER4043 be substituted for ER5356 on this application, and what is the governing concern?

A. ER4043 may be freely substituted for ER5356 on any aluminum alloy base metal since both classifications fall within SFA-5.10 and the code considers them mechanically interchangeable within their common aluminum filler wire classification group

B. ER4043 may be substituted for ER5356 on 5083 provided a 15% reduction in travel speed is applied throughout the weld to compensate for the higher fluidity of the silicon-alloyed 4043 pool, which spreads more rapidly at standard ER5356 travel speed and may fail to fuse the groove sidewalls

C. ER4043 requires pre-qualification with a trial weld before substitution is permitted — a transverse tensile test of the trial weld confirms whether the 4043 deposit achieves the minimum ultimate tensile strength specified for the 5083 aluminum application

D. ER4043 is generally not an acceptable substitute for ER5356 on 5083 aluminum — the silicon content of 4043 combines with the high magnesium content of 5083 to promote Mg_2Si formation at the fusion zone, reducing joint ductility and crack resistance, and the 4043 deposit produces a dark, mottled discoloration that makes it incompatible with any application requiring post-weld anodizing

119. A GTAW welder is producing a multi-pass weld on duplex stainless steel (UNS S31803) and the WPS specifies a nitrogen-containing backing gas (90% N2/10% H2) for back purging the root pass. What is the technical reason nitrogen is beneficial in the duplex stainless steel back purge compared to 100% argon?

A. Nitrogen is an austenite-stabilizing element in duplex stainless steel — without nitrogen in the purge atmosphere, the root bead surface and adjacent HAZ lose nitrogen to the gas environment during solidification and cooling, shifting the microstructure toward excessive ferrite; nitrogen in the purge compensates for this surface depletion and maintains the target ferrite-austenite balance required for the toughness and corrosion resistance the alloy was specified to provide

B. Nitrogen provides a more aggressive oxide-breaking action than argon at the root bead surface, chemically reducing chromium oxides that form during solidification and preventing the passive layer degradation that causes discoloration in the duplex stainless root zone when argon alone is used as the purge gas

C. Nitrogen maintains a lower atmospheric dew point in the purge circuit than argon at the same flow rate, preventing moisture from the compressed gas supply from condensing at the root bead surface and causing hydrogen porosity in the first solidifying layer of the duplex deposit

D. Nitrogen produces a higher purge gas displacement velocity than argon at the same regulator setting due to its lower molecular weight, evacuating residual oxygen from the pipe interior more rapidly and establishing the required sub-1,000 ppm atmosphere in a shorter purge time before the first root pass begins

120. A GTAW operator completing stainless steel pressure pipe welds notices a consistent dark blue discoloration appearing on the base metal surface approximately 5 to 8 mm from the weld edge on both sides. The weld face itself shows normal silver-gold color. What does this zone of discoloration represent and what concern does it create?

A. The discoloration represents normal surface scale from mill coating burning off during welding — it has no significance for weld quality and will be removed by post-weld chemical cleaning

B. The discoloration is caused by temporary moisture condensation from the compressed air ventilation system and will evaporate without leaving any metallurgical effect on the stainless surface

C. The discoloration represents chromium oxide forming in the base metal HAZ surface at elevated temperature — while lighter than the root purge issue, it indicates atmospheric exposure of the hot stainless surface and compromises the passive layer in the discolored zone requiring attention

D. The discoloration indicates the shielding gas cup was too far from the weld and is a normal result of reduced gas coverage at the outer edge of the cup's effective shielding radius

121. A SAW procedure uses a neutral fused flux paired with an EH14 wire (high manganese, high silicon) to achieve specific weld metal properties on a structural application. The welding engineer proposes switching to an active flux (F7A4) with the same EH14 wire to improve weld pool fluidity. What chemistry concern must be evaluated before approving this change?

A. Active flux combined with high-alloy wire increases arc turbulence and the rate of base metal dilution beyond the range verified in the original procedure qualification, potentially reducing the weld metal tensile strength below the minimum required for the structural application

B. Switching from neutral fused flux to active flux with the same wire removes any out-of-position welding coverage included in the original qualification — active fluxes are restricted to flat and horizontal positions, making the change a procedure essential variable under the applicable welding code

C. Active flux generates significantly higher fume emission rates than neutral fused flux when paired with high-alloy wire, requiring new occupational exposure measurements and potential ventilation upgrades before the change can be implemented in the production environment

D. The switch to active flux with a high-Mn, high-Si wire risks significantly increasing manganese and silicon pickup from both the flux and the wire simultaneously — active flux adds these elements to the deposit through arc-driven flux reactions, and combined with the EH14 wire's already elevated Mn and Si content, the resulting deposit chemistry may exceed the maximum weld metal composition limits and reduce Charpy toughness below the impact-tested minimum for the procedure

122. A SAW operator needs to verify that the wire feed speed, voltage, and travel speed during production are consistent with those used during procedure qualification. The PQR records show: 500 A, 32 V, 450 mm/min for a single-wire system. During production monitoring, the parameters read 525 A, 34 V, 480 mm/min. What calculated value most concisely confirms whether the heat input remains within the qualified range?

A. Compare the wire feed speed alone — if the WFS is within ±10% of the PQR value, the heat input is automatically within the qualified maximum regardless of voltage and travel speed

B. Calculate the heat input for both sets of parameters and compare — production HI = (34 × 525 × 60) ÷ (480 × 1,000) = 2.23 kJ/mm versus PQR HI = (32 × 500 × 60) ÷ (450 × 1,000) = 2.13 kJ/mm — both are within typical code tolerance bands for heat input acceptance

C. Compare only the amperage and voltage product (kVA) — if the product increases by more than 15%, the combination requires new PQR documentation regardless of travel speed

D. Calculate the arc energy density per unit volume of deposited metal — this value is the definitive heat input metric used in all applicable welding codes

123. An SAW welding operator discovers a weld discontinuity described in the inspection record as "a dark, low-density linear indication oriented perpendicular to the weld axis, approximately 15 mm long, located in the weld metal centreline at mid-thickness." Based on this description, which defect type is most consistent?

A. A transverse solidification crack — narrow dark linear indications perpendicular to the weld axis at the weld metal centreline are characteristic of hot cracks that form when transverse contraction stresses during the final stage of solidification pull apart the last-to-solidify centreline metal before it has developed sufficient strength to resist separation

B. A copper inclusion from backing bar contact — copper contamination in SAW deposits produces bright, high-density spots on RT film due to copper's greater X-ray absorption coefficient relative to steel, which is the opposite of the dark, low-density character of the indication described

C. A slag inclusion — while slag inclusions do appear dark on RT film due to lower density than weld metal, they produce irregular elongated zones at pass fusion boundaries rather than the narrow, linear, perpendicular centreline indication described in the inspection record

D. A lamellar tear — lamellar tears are step-like planar discontinuities oriented parallel to the plate rolling surface in the base metal beneath the weld, not narrow linear perpendicular indications located at mid-thickness of the weld metal deposit itself

124. A fabrication shop is evaluating whether to implement SAW or FCAW-G for welding 50 mm thick pressure vessel shell seams. Which comparison statement most accurately describes the production advantage of SAW over FCAW-G for this specific application?

A. SAW is preferred because it can be performed in all welding positions including vertical and overhead, which FCAW-G cannot achieve reliably on thick sections

B. FCAW-G is preferred over SAW for this application because FCAW-G produces lower heat input per pass, allowing more passes and better interpass temperature control on thick plate

C. SAW and FCAW-G produce equivalent productivity on thick pressure vessel seams — the choice depends only on the code acceptance requirements for each process

D. SAW achieves substantially higher deposition rates and heat input per pass than FCAW-G, allowing fewer passes to fill the thick groove and reducing total arc time on long production seams

125. A SAW procedure must be developed for a structural application requiring impact-tested weld metal at −40°C. The welding engineer selects an F7A6 classified flux. What does the "6" in the flux-wire deposit designation communicate about the qualification testing performed?

A. The number "6" designates the minimum average Charpy impact energy in ft-lbs absorbed at the specified test temperature — it provides a direct quantitative guarantee of the weld metal toughness level rather than identifying the temperature at which impact qualification testing was conducted

B. The "6" designates that the flux-wire composite deposit has been Charpy V-notch impact tested at −60°F and meets the minimum energy requirement at that temperature — since −40°C equals −40°F, the F7A6 qualification test was performed at the more demanding −60°F condition, confirming the deposit is suitable for the −40°C application requirement with additional temperature margin

C. The number "6" is a manufacturer-assigned lot quality code indicating the flux production batch achieved six consecutive qualification test cycles without a Charpy impact failure during statistical process control testing at the flux manufacturer's facility

D. The "6" indicates this flux classification requires a minimum of 6 hours of conditioning at 300 to 350°C before production use, as mandated by the AWS A5.17 standard for active bonded flux types to ensure fully moisture-free flux chemistry at the arc

Practice Exam 4: Answer Key and Explanations

1. C — The ring test requires suspending the wheel vertically on a pencil through its bore and tapping lightly with a non-metallic mallet. A clear ring indicates the wheel is structurally sound; a dull thud indicates internal cracks or damage. A metal hammer must never be used for the ring test — it can crack the wheel during the test itself.

2. A — A JHSC's legislative mandate is advisory and investigative. It inspects the workplace, investigates health and safety concerns, and makes non-binding recommendations to the employer for corrective action. JHSCs have no enforcement powers, cannot issue binding orders, and cannot discipline workers or set standards superseding legislation.

3. D — When a vehicle accelerates, inertial force acts on the load in the direction opposite to motion — the load tries to stay behind while the vehicle moves forward. Banding straps oriented perpendicular to travel must resist this forward sliding force in tension. If the acceleration force exceeds the strap's rated tensile capacity, the straps fail under that tensile load.

4. B — When any pressure-regulating device malfunctions and cannot be controlled, the supply must be isolated at the cylinder valve to eliminate the pressure hazard. Continuing to work with an uncontrolled pressure output is an immediate danger regardless of other system integrity. The regulator must not be used again until professionally repaired or replaced.

5. A — Circumference = $\pi \times D = 3.1416 \times 168.3 = 528.4$ mm. One quarter = $528.4 \div 4 = 132.1$ mm ≈ 132 mm. This dimension determines the arc travel distance between electrode change stops when the pipe is divided into four equal sections.

6. D — Section 14 (Transport Information) of the SDS is structured specifically to provide the regulatory classification data required before shipping hazardous materials — UN number, proper shipping name, hazard class, and packing group. This section is the primary reference for compliance with Transportation of Dangerous Goods regulations.

7. B — A file tang is a hardened, pointed spike designed for insertion into a handle. When gripped bare-handed and the file snags on the workpiece, the inertial force of the file's abrupt stop transfers directly into the palm through the unprotected tang with enough force to cause deep puncture injury. The handle absorbs these impact forces and keeps the tang away from the hand.

8. C — Only a competent person — one with verified knowledge, training, and experience in scaffold construction and applicable inspection standards — may authorize a scaffold for worker use after physically inspecting the completed structure. A ground-level visual check, general field experience, or a fall protection certificate alone do not constitute the competency required for scaffold authorization.

9. A — The hierarchy of controls ranks elimination and substitution highest, followed by engineering controls, then administrative controls, with PPE as the last line of defense. Substituting a lower-noise cutting method addresses the source; acoustic enclosure is an engineering control. Hearing protection alone (PPE) supplements — it does not replace — higher-level controls.

10. B — Volume = 2.4 m × 1.2 m × 0.025 m = 0.072 m^3. Mass = 0.072 m^3 × 7,850 kg/m^3 = 565.2 kg. This standard steel density of 7,850 kg/m^3 is used for load planning, lifting, and transport calculations across all structural carbon steel applications.

11. D — WHMIS 2015 requires SDSs to be readily accessible to workers in the work area during every shift without delays, barriers, or the need to request access through intermediaries. Restricting SDS access to an office, digital database with a 30-minute retrieval window, or requiring written requests violates the fundamental WHMIS principle of immediate worker access to hazard information.

12. C — The tape's hook contacts the workpiece at what should be the zero reference point. With the first 30 mm of blade bent back, the hook now reads a 30 mm offset on every measurement taken from the hook end — a systematic error affecting all measurements. This makes the tape unreliable for production use and it must be removed from service.

13. A — Welding heat locally reduces the yield strength of the base metal at the heated zone. On a pressurized system, the softened metal cannot support the internal pressure and can fail by plastic

yielding and explosive rupture at the heat application point. This hazard is present regardless of the weld quality — the pressurized stress plus localized softening is the mechanism of failure.

14. B — Working from an aerial work platform at 7 metres requires fall protection from a harness connected to an engineered anchor point when active work creates a risk of falling past the guardrail. A short energy-absorbing lanyard limits fall distance while the absorber manages peak arrest force. Tool lanyards prevent dropped tools but provide no fall arrest protection for the worker.

15. C — Confined space atmospheric testing for welding must address all three hazard categories: oxygen content (for breathability), flammable gas concentration (for explosion risk from the welding arc), and toxic gases including CO (for health risk from welding byproducts). An entry decision based on incomplete data can result in immediate incapacitation or death from a hazard that was not measured.

16. A — Acetylene is simultaneously a gas stored under pressure (compressed gas cylinder pictogram) and an extremely flammable gas (flame pictogram). Both hazards must appear on the WHMIS 2015 supplier label. The compressed gas pictogram communicates explosion risk from heating and projectile risk from valve damage — both independent hazards present in any full acetylene cylinder.

17. D — Hydrofluoric acid penetrates skin rapidly and releases fluoride ions that bind to calcium and magnesium in tissues and blood, causing systemic hypocalcemia that can produce cardiac dysrhythmia and death even from modest skin exposures. Copious irrigation dilutes and removes surface HF; calcium gluconate gel provides calcium to neutralize fluoride ions at the tissue level. Emergency medical care is mandatory due to the systemic toxicity mechanism.

18. C — WHMIS 2015 workplace labels require at minimum: the product identifier so workers know what they are handling, hazard information such as pictograms or hazard statements so workers know the dangers, and safe handling precautions relevant to workplace conditions so workers know how to protect themselves. Full supplier label reproduction is not required on workplace labels.

19. A — CSA W47.1 certification requires each certified company to designate a Welding Engineer or Welding Supervisor holding the technical knowledge and authority to review production welding for procedure compliance and to approve or reject production welds. This person holds technical accountability for welding quality within the certification and their designation is a mandatory requirement of the standard.

20. B — Higher amperage and the more intense arc characteristics of GMAW spray transfer produce proportionally greater ultraviolet, visible, and infrared radiation than lower-amperage SMAW. The lens shade must increase with increasing amperage and arc intensity. An inadequate shade causes arc eye (photokeratitis) from UV and potential retinal damage from intense visible and infrared output.

21. D — Revision triangles (delta symbols with numbers) on engineering drawings mark which specific dimensions changed at the indicated revision. A "3" beside a dimension means that value was modified at Revision 3 and was different on all prior revisions. The fabricator must confirm those dimensions match current Revision 4 values before fabricating.

22. C — In AWS A2.4 symbology, the weld-all-around circle and the field weld flag (solid triangle) are independent supplementary symbols that communicate separate requirements simultaneously at the same reference line junction. The circle specifies continuous deposition completely around the joint perimeter; the flag specifies the weld must be performed at the construction site rather than in the fabrication shop.

23. A — Penetrant enters defects during dwell via capillary action. When wet remover and developer are simultaneously present on the surface, the developer wicks the diluted mixture into the defect opening as the penetrant bleeds out, reducing bleedback dye concentration below the visible detection threshold. Legitimate defects produce no indication — the most dangerous possible inspection outcome.

24. B — Tack welds incorporated into the final joint become a permanent part of the weld cross-section and contribute directly to the mechanical properties of the completed weld. They are subject to the same WPS requirements — preheat, electrode classification, and mechanical performance — as any other weld pass. Stating they require no mechanical property compliance is factually incorrect and the most dangerous misconception about incorporated tack welds.

25. D — Slag on RT film appears as irregular, elongated dark zones because slag is less dense than weld metal and absorbs less X-ray radiation. Their consistent position at fusion line boundaries between passes and their irregular angular outline distinguishes them from the round profile of porosity, the fine linear character of cracks, and the bright (high-density) appearance of tungsten inclusions.

26. A — For a 45-degree pipe offset, the travel pipe length equals the offset distance divided by sin(45°): travel = 350 ÷ 0.707 = 495 mm. The diagonal pipe spanning the horizontal offset at 45 degrees must be longer than the offset itself to cover the angular routing distance.

27. C — Liquid penetrant testing operates by capillary action drawing penetrant into discontinuities open to the examination surface. Subsurface defects have no surface opening for penetrant to enter — they produce no bleedback and therefore no indication. This fundamental limitation applies to all materials and is independent of surface preparation, penetrant type, or dwell time.

28. B — In AWS A2.4 intermittent fillet weld notation: the first number before the weld symbol triangle = leg size (8 mm), the number directly after the symbol = segment length (50 mm), and the number after the dash = centre-to-centre pitch (150 mm). This defines an 8 mm fillet weld deposited in 50 mm segments spaced at 150 mm centre-to-centre — the standard intermittent fillet weld format.

29. D — Tacking diagonally opposite corners first (1 then 3, then 2 then 4) distributes shrinkage forces symmetrically across both axes of the frame simultaneously. Sequential corner tacking concentrates shrinkage on one side before the opposing side is secured, creating a diagonal pull that takes the assembly out of square before it can be held by the opposing tack.

30. A — CSA W59 specifies a minimum weld access hole depth to provide adequate electrode access and clearance for groove weld deposition. Equally critical, the perimeter must be smooth and free of re-entrant notches and sharp corners because these geometric stress concentrations act as fatigue crack initiation sites under cyclic loading in completed moment connections.

31. C — Standard orthographic cross-section conventions use hatching to indicate solid material in the cut plane and leave voids unhatched. A hollow pipe cross-section shows a hatched annular zone representing the pipe wall material surrounding an unhatched inner circle representing the hollow bore. The unhatched interior indicates the open space through which fluid or gas flows in service.

32. B — Excessive interpass temperature subjects the weld metal and HAZ to repeated thermal cycles above the austenite grain-coarsening threshold. Progressive grain growth in successive passes significantly reduces Charpy V-notch impact energy — a critical mechanical property for structural and pressure vessel applications where resistance to brittle fracture must be demonstrated by impact testing.

33. D — Under ASME Section IX QW-404, the filler metal F-number is an essential variable for SMAW procedures. The F-number groups electrodes by similar usability and deposition characteristics. Changing from E7018 (F-Number 4) to E6013 (F-Number 3) is a change in F-number classification that requires new PQR test welds to validate the revised procedure.

34. A — The back weld symbol (semicircle on the opposite side of the reference line from the groove weld symbol) specifies a separate weld pass deposited on the reverse face after the primary groove weld is completed from the arrow side. The complete sequence is: deposit groove weld from arrow side, back-gouge to sound metal from the other side, then deposit the back weld pass to complete the joint.

35. C — Tempilstik crayons are formulated to melt at their specific calibrated temperature. When the crayon mark transitions from a dry waxy streak to a melted liquid film, the plate surface at that location has reached at least the crayon's rated temperature. This confirms the minimum preheat requirement is satisfied at that measurement point before welding begins.

36. D — CSA W59 pre-qualified joint tolerances define specific maximum and minimum values for root face, groove angle, root opening, and other geometric variables. A root face 2 mm above the specified maximum falls outside the pre-qualified dimensional envelope — the joint configuration is no longer pre-qualified and PQR testing is required to demonstrate weld quality for the altered geometry.

37. C — The yoke generates a magnetic field parallel to the line connecting the two poles. To detect a crack, the field must cross the crack plane approximately perpendicularly. One yoke orientation parallel to the weld axis creates a field perpendicular to transverse cracks. A second orientation perpendicular to the weld axis creates a field perpendicular to longitudinal cracks. Both orientations together provide coverage of all crack directions.

38. B — The root pass establishes the foundational geometry for all subsequent fill passes. A 2.0 mm mismatch exceeding the code limit of 1.6 mm creates a step transition at the root that concentrates stress and exceeds the design basis assumption of aligned joint faces. Depositing fill passes over an out-of-tolerance root locks the non-conforming geometry permanently inside the finished weld.

39. A — CSA W59 specifies a maximum cap reinforcement height to prevent stress concentration at the weld toes caused by an abrupt geometric transition between the cap crown and the base metal surface. For 20 mm structural plate, 3 mm is the applicable maximum — excessive reinforcement creates a toe notch that initiates fatigue cracks under cyclic loading at the abrupt change in section.

40. D — A round-to-square transition involves a surface that is neither a simple cone (convergent) nor a cylinder (constant cross-section), so neither parallel line nor radial line development applies. Triangulation development divides the complex double-curvature surface into small triangular facets, develops the true length and shape of each triangle, and assembles the flat pattern from the triangular elements.

41. B — Magnetic particle testing functions by magnetizing ferromagnetic materials and detecting flux leakage at surface discontinuities. Aluminum is paramagnetic — it cannot support a magnetic flux pattern suitable for MT. Attempting to magnetize aluminum produces no usable field for defect detection. Liquid penetrant testing is the correct surface examination method for non-ferrous materials including aluminum.

42. A — Under AWS D1.1 Table 4.12, the overhead (4G) plate groove qualification covers all less demanding groove weld positions: flat (1G), horizontal (2G), vertical (3G), and overhead (4G). The logic is that a welder who can control the pool in the most gravity-opposed position can work in all less challenging orientations. This qualification coverage is one reason the 4G test is commonly selected for its broad coverage.

43. C — Drawing scale 1:20 means one unit on the drawing represents twenty units on the actual object — the drawing is one-twentieth actual size. Actual dimension = drawing measurement × scale factor = 32 mm × 20 = 640 mm. Fabrication dimensions should always be taken from the stated dimensions on the drawing, not measured directly from the paper.

44. D — Incomplete fusion at the groove sidewall results from the arc not being directed onto the fusion surface. The sidewall base metal receives only secondary heat from the pool rather than direct arc impingement, and never reaches the fusion temperature. The deposited pass solidifies against an unmelted sidewall, producing an unbonded planar defect at the fusion line that is detectable on RT as a linear indication.

45. B — HIC in sour service is stepwise cracking through base metal from atomic hydrogen trapping at MnS inclusion planes in wet H_2S service — it does not require hard martensite and is a base metal failure mechanism. HICC in welded joints requires the simultaneous presence of diffusible hydrogen, a susceptible microstructure (typically hard martensite in the HAZ), and sufficient residual or applied restraint stress.

46. A — Level readings are linearly proportional to height on the column. If 3 mm deviation is measured at 3 metres, the same plumb error at the base produces 6 mm of deviation at 6 metres by proportion: (3 mm ÷ 3 m) × 6 m = 6 mm. This proportional relationship allows total deviation at the top to be calculated from any accessible measurement elevation.

47. C — Overlap is defined as weld metal that has flowed beyond the toe onto the adjacent base metal surface without metallurgical bonding at the interface. The weld metal lays on an unmelted surface that

never reached fusion temperature — the contact is mechanical, not metallurgical. This creates a notch-like unbonded interface that concentrates stress and cannot carry design load across the toe line.

48. D — Under ASME Section IX QW-408, shielding gas composition is an essential variable for GTAW. Changing from 100% argon to argon-hydrogen blend changes the arc thermal properties, heat input, and pool chemistry in ways that affect the mechanical properties and microstructure of the deposit — particularly on stainless steel. New PQR testing is required to validate the revised procedure.

49. B — Acetylene gas is dissolved in acetone in the cylinder, and the maximum safe flow rate is one-seventh of the total cylinder gas volume per hour. Exceeding this rate draws acetone vapor with the gas, contaminating the flame and degrading cut quality. For high-volume thick-plate production work, this flow rate ceiling often makes acetylene impractical and requires propane, natural gas, or manifolded cylinders.

50. A — The cutting oxygen orifice diameter determines the width and volume of the cutting stream. A larger tip has a larger bore, producing a wider cutting oxygen column that removes material across a broader path through the plate. Kerf width is directly proportional to the cutting stream width — a larger orifice equals a wider stream, a wider kerf, and greater material loss per unit of cut length.

51. C — Acetylene is stored dissolved in acetone within the cylinder's porous media. When stored horizontally, acetone migrates toward the valve end under gravity. Drawing gas immediately after restoring the cylinder to vertical could co-vaporize acetone with the acetylene. One hour of upright standing allows the acetone to drain back to the cylinder base before gas is drawn, preventing acetone contamination of the cutting flame.

52. D — At a full-amperage pierce start, the arc initiates against solid plate at maximum energy, subjecting the electrode tip and nozzle orifice to peak thermal load from the very first arc. Starting at low current and ramping upward with a slow upslope allows the pierce to develop gradually with reduced thermal shock to the consumable surfaces. Eliminating this aggressive initiation is the single most effective way to extend electrode and nozzle service to rated life.

53. B — A backfire is a momentary flame extinction at the tip caused by a brief disturbance — most commonly the tip touching the work surface or a particle of slag momentarily blocking an orifice. The disturbance creates a back-pressure spike that extinguishes the preheat flame at the tip without propagating into the hose system. The flame re-ignites immediately as soon as the hot tip re-contacts flowing gas.

54. A — CAC-A carbon electrodes partially vaporize in the arc, depositing a carbon-enriched surface layer on the groove metal through diffusion. On stainless steel, this layer would be incorporated into the repair deposit and raise the local carbon content above the L-grade specification, promoting sensitization and potential hot cracking in the repair weld. Grinding 1 to 2 mm into the groove surface removes this layer and restores the low-carbon base metal before re-welding.

55. C — For 6 mm structural steel, the two-tooth-contact rule requires maximum tooth spacing of approximately 3 mm, corresponding to at least 8 TPI. An 18 TPI bi-metal blade ensures multiple teeth contact the 6 mm wall simultaneously, preventing the rocking tooth-catch that breaks lower-TPI blades. Bi-metal construction (HSS cutting teeth on a flexible backing) resists the heat generated on structural steel and extends blade life significantly over carbon steel blades.

56. D — Above 103 kPa (15 psi), acetylene can undergo an exothermic self-decomposition reaction — breaking down into carbon and hydrogen — without any ignition source. This decomposition is explosive in character. This pressure ceiling is an absolute physical property of acetylene's chemical stability and applies regardless of the desired cutting speed or plate thickness. It is not a regulatory guideline subject to engineering override.

57. A — Closing the fuel gas needle valve first prevents an oxygen-rich mixture from remaining in the cutting tip during shutdown. Closing the oxygen needle valve second removes any remaining gas pressure from the torch. Closing both cylinder valves isolates the supply, and bleeding the hoses through the torch removes all pressurized gas. Releasing the regulator adjusting screws last removes tension from the regulator springs and prevents spring fatigue.

58. B — The pilot arc generates a low-current ionized gas path between the electrode and the recessed nozzle without any physical contact with the workpiece. This ionized column allows the main transferred cutting arc to initiate at any standoff distance without touching the plate, eliminating the physical impact and orifice erosion that occurs during contact starts. The result is significantly extended electrode and nozzle service life in production operations.

59. C — Cold saws use large-diameter circular blades running at very low RPM, producing a chip-cutting action rather than a grinding action. The extremely slow cutting speed generates minimal heat, eliminates any heat-affected zone in the cut material, and produces a geometrically flat, square, and burr-free cut face directly suitable for mechanical test and inspection specimens without any additional machining.

60. B — Drag lines that are nearly vertical near the cut entry point but progressively curve backward through the lower plate depth indicate the cutting reaction at greater depth is falling further behind the

torch position. This progressive lag with increasing depth is the defining diagnostic signature of excessive travel speed for the plate thickness — the reaction rate cannot maintain vertical propagation through the full 50 mm at the current speed.

61. D — A backfire produces a single sharp pop at the torch tip with immediate self-re-ignition and no involvement of the torch body — caused by brief tip disturbance. A flashback produces sustained hissing and squealing from inside the torch body with smoke from the hose connections — the flame has propagated backward into the torch internals. Flashback requires immediate complete shutdown of both gases and torch inspection before any further use.

62. C — In dual-circuit PAC torches, the plasma gas is the primary arc medium carrying the cutting current. The shielding gas flows concentrically around the nozzle body outside the plasma column. Its specific functions are cooling the nozzle orifice (extending nozzle service life), constricting and squaring the plasma column profile (improving cut-edge squareness), and shielding the cutting zone from atmospheric oxygen that would otherwise oxidize the kerf faces.

63. A — CAC-A relies on compressed air velocity to physically expel molten metal continuously as the arc generates it. When pressure drops below the minimum operating range of 550-690 kPa, the air jet no longer has sufficient velocity or volume to remove molten metal faster than it is produced. The metal accumulates in the groove, re-solidifies, and fuses back to the base metal — creating a contaminated, irregular groove that requires additional gouging.

64. B — Zinc heated to burning temperature during OFC generates zinc oxide fumes classified as a respiratory hazard that causes metal fume fever. Confirming that a functioning local exhaust ventilation system is capturing fume at the cutting source is the critical safety requirement before beginning galvanized steel cutting. This is not an optional precaution — zinc oxide fume exposure from cutting galvanized steel without ventilation is a documented occupational health risk.

65. D — Low-speed dross forms when the plasma arc dwells too long at any given point due to insufficient travel speed. The excess heat melts material faster than the plasma jet can expel it, and some re-solidifies on the bottom edge from residual heat without high-velocity plasma impingement to drive it clear. The dross is soft and brushable because it re-solidified in place without being welded back to the parent metal with significant bonding energy.

66. C — The rounded, melted top edge results from an oversized preheat flame heating a larger area to a higher temperature than needed before the cutting oxygen is applied. A properly sized neutral preheat flame heats the steel to the iron ignition temperature at a localized point without melting the surrounding

material. An oversized flame over-heats the top entry zone and rounds and melts the upper edge of the plate before the cutting reaction starts.

67. D — Mechanized PAC eliminates operator variability entirely — the machine maintains precisely constant standoff distance, travel speed, and torch angle through every cut on every part in the production run. Manual operators cannot achieve this repeatability regardless of skill level. This mechanical consistency is the fundamental advantage that makes mechanized PAC the only practical choice when tight dimensional tolerances must be held across large production quantities.

68. B — Carbon from the CAC-A electrode vaporizes in the arc and diffuses into the groove surface, creating a darker, harder carbon-enriched layer. This layer must be removed by wire brushing before MT examination because residual carbon deposits create conductive surface films that can produce false indications or mask real ones during the MT process. Wire brushing mechanically removes the contaminated layer and exposes clean base metal for accurate inspection.

69. C — Check valves in OFC hose assemblies prevent reverse gas flow — specifically preventing oxygen from migrating into the fuel gas hose or fuel gas from entering the oxygen hose during pressure disturbances at the torch. A cross-contaminated hose contains an explosive mixture throughout its length. Without functional check valves, a backfire or improper operating sequence can create a detonatable mixture inside the hose circuit.

70. A — Tip cleaners are purpose-designed tapered steel tools precisely sized for each orifice diameter. They push soft slag deposits clear without enlarging the precision orifice geometry. Using a drill bit enlarges the orifice, permanently changing the gas flow and flame characteristics and making the tip unusable. After clearing with the tip cleaner, a brief flow of low-pressure air or oxygen confirms the orifice is open before the flame pattern is verified and cutting resumes.

71. D — Kerf width is simultaneously influenced by all three parameters: amperage determines the native plasma column diameter and energy density; standoff distance determines how much the column expands before reaching the plate surface; travel speed determines lateral heat dose per unit length of travel. All three must be controlled together to maintain consistent kerf geometry across a production run.

72. B — The 6G designation specifies a pipe joint with the pipe axis inclined at 45 degrees from horizontal and fixed in place. The welder must travel around the full circumference, working through flat, horizontal, vertical, and overhead positions in sequence. This comprehensive positional challenge

makes the 6G qualification the most demanding and broadly recognized pipe weld qualification available.

73. A — AWS D1.1 Table 4.7 limits atmospheric exposure of E7018 low-hydrogen electrodes to a maximum of 4 hours after removal from a holding oven at 120-150°C. Desiccant containers are not an approved code substitute because they cannot maintain the elevated temperature that prevents moisture absorption from ambient air. After 4+ hours at 65% shop humidity, the low-hydrogen designation cannot be reliably maintained regardless of desiccant packaging.

74. C — Transverse shrinkage from the root and hot passes permanently reduces the root opening available for subsequent passes. The narrowed groove restricts electrode access and manipulation, increases the probability that slag will bridge the tighter gap between passes rather than floating clear to the surface, and reduces the working space needed for the electrode to direct the arc at both fusion surfaces — all increasing defect risk.

75. D — For overhead SMAW groove welding, a drag travel angle positions the electrode body backward against the travel direction. A steeper drag angle directs the arc force upward and into the joint cavity, helping counteract the tendency of the pool to sag downward under gravity. Combined with a work angle perpendicular to the joint plane, this technique positions the electrode to physically support the overhead pool while maintaining the directional arc force needed for fusion.

76. B — At the 3 o'clock (side) position in 5G pipe welding, gravity acts laterally on the pool, potentially causing asymmetric keyhole formation and inconsistent back-side reinforcement at that clock position. A brief pause combined with a back-and-forth oscillating motion directs additional heat and weld metal specifically to that location, compensating for the lateral gravity effect and building the root reinforcement that is deficient at the side positions.

77. C — The "M" suffix in AWS A5.5 designates electrodes meeting Military Specification MIL-E-22200 requirements. M-classified electrodes undergo Charpy V-notch impact testing at multiple temperatures and must meet more stringent minimum toughness thresholds than the base classification requires. This multi-temperature toughness verification is the specific performance confirmation the "M" suffix communicates for critical structural applications.

78. A — E7024 incorporates a heavy iron-powder loading (typically over 50% by weight) in its titania coating. The iron powder melts with the electrode and deposits directly into the weld metal, dramatically increasing deposition rate over standard rutile electrodes in the flat and horizontal positions where the fluid slag system performs correctly. This same high-deposition, fluid-slag design prevents its use in

vertical or overhead positions where gravity would cause the slag to run ahead of and trap beneath the deposit.

79. D — For E7018 basic electrodes, an excessively long arc shifts the voltage-current balance — voltage increases while current decreases — disrupting the stable droplet formation and transfer cycle. Large, irregularly formed drops develop at the electrode tip without the directed arc force needed to transfer cleanly into the joint. They detach erratically and land as large-diameter, firmly adhered globular spatter that is characteristic of excessive arc length with basic electrode chemistry.

80. B — Arc blow intensity varies with the magnetic field asymmetry around the arc. As welding heat progresses along a long joint, it thermally reduces residual magnetism in the progressively heated base metal, making the field more uniform and reducing the asymmetric deflecting force. With reduced residual magnetism and the arc positioned in the thermally conditioned middle zone of the weld, arc blow is at a minimum compared to arc start conditions.

81. A — Under ASME Section IX P-number groupings, CSA G40.21 Grade 350W and ASTM A516 Grade 70 are both classified as P-Number 1, Group 1 carbon steel base metals with essentially equivalent chemistry and weldability for procedure qualification purposes. A WPS qualified on either material is supported by a PQR on the other without additional testing requirements within this P-number group.

82. C — Austenitic stainless steel weld metal has a coefficient of thermal expansion approximately 50% higher than ferritic carbon steel base metal (17.2×10^{-6}/°C vs. 11.7×10^{-6}/°C). In a highly restrained stud weld with minimal joint length and high constraint, the differential contraction stress during cooling from welding temperature can exceed the ductility capacity of the weld interface zone, producing transverse cracks at the highest-stress location adjacent to the carbon steel plate.

83. D — For overhead SMAW fillet welds showing sagging, using a shorter arc length concentrates the arc force and directs it against the joint surfaces to support the pool. Reducing travel speed allows deliberate incremental building of the bead — each small addition is given time to partially solidify before more metal is added, preventing the pool mass from accumulating to the point where it can no longer be held against the overhead surface by surface tension.

84. B — CWB welder qualification certificates are issued for specific combinations of process, joint type, position, material group, and filler metal group. Fillet weld and groove weld tests evaluate different skills and technique requirements — groove welds demand penetration management, joint

tracking, and multi-pass sequencing skills not fully assessed by fillet weld qualification. A fillet weld certificate does not extend to groove weld production under CWB certification requirements.

85. A — AWS D1.1 Table 4.7 restricts E7018 low-hydrogen electrode atmospheric exposure to a maximum of 4 hours after removal from the holding oven at 120-150°C, beyond which reconditioning at 260-430°C for a minimum of 1 hour is required. Electrodes removed at 8:00 AM must be reconditioned or discarded by 12:00 PM — the 4-hour limit reflects the critical moisture absorption rate of basic flux coatings at standard shop humidity levels.

86. C — On a CV GMAW machine, increasing arc voltage directly lengthens the arc, spreading the concentrated arc heat delivery zone over a wider area of the base metal surface. This flatter, wider heat distribution prevents heat concentration at the bead crown, allowing the pool to spread laterally before solidifying and directing arc energy toward the weld toes. Both effects reduce crown height and improve toe fusion simultaneously.

87. B — Excessive convexity in vertical-up FCAW fillet welds results from depositing more metal volume than the pool can spread into a flat profile. Reducing the WFS lowers the amperage, producing a smaller pool with proportionally less fluid volume at the toes. The reduced pool mass has a more favorable surface tension-to-volume ratio, allowing it to spread to a flatter profile at the toes without overbuilding the bead crown.

88. D — E70T-1 uses a rutile slag system with CO2 or Ar/CO2 shielding at DCEP, producing self-releasing slag and a smooth bead suited to general structural applications. E70T-5 uses a basic (lime-based) slag chemistry at DCEP with CO2, analogous to the low-hydrogen E7018 SMAW electrode family — the basic chemistry produces significantly lower diffusible hydrogen in the deposit. E70T-5 is specified when cold cracking risk from high restraint or thick sections must be controlled.

89. A — E71T-1M wire's titania slag system is engineered to self-release through differential thermal contraction between the slag and underlying steel. When voltage is at the lower end of the operating range, the cooler, lower-energy arc and pool do not develop the slag fluidity required for clean separation — the slag bonds to the bead surface during cooling rather than contracting away. Operating at the upper end of the recommended voltage range restores proper slag fluidity and self-release behavior.

90. C — Increasing CTWD from 19 mm to 32 mm extends the wire end beyond the effective laminar shielding coverage zone produced by the gun nozzle. Standard gas flow rates provide adequate shielding to approximately 20-25 mm from the nozzle exit. Beyond this range, atmospheric air entrainment into

the arc zone disrupts the shielding atmosphere, causing arc instability that can transition the transfer mode from stable spray to irregular globular.

91. D — In GMAW, the push travel angle directs the arc forward ahead of the pool, impacting the base metal at the leading edge before the pool has spread laterally. This forward arc force accumulates weld metal at the leading edge of the deposit, building a slightly higher crown profile compared to the drag angle, where the arc is directed into the established pool and the metal is more evenly distributed into a wider, flatter bead.

92. A — When welding austenitic stainless steel with 98/2 Ar/O2 shielding in spray transfer, arc stability is critical for consistent bead quality. If 2% O2 does not provide sufficient ionization stability at the operating parameters, increasing the oxidant component toward 5% improves arc ionization and stabilizes the spray transfer mode — though this adjustment must be balanced against the increased chromium oxidation potential at higher O2 content.

93. C — For E71T-8 self-shielded FCAW, the flux core compounds must be resistively preheated by current flow through the wire stub between the contact tip and the arc before reaching the arc zone. When stick-out is shorter than specification, the compounds receive insufficient preheating time, their decomposition and shielding atmosphere generation at the arc is incomplete, and atmospheric nitrogen and oxygen can enter the pool to cause porosity even when all other parameters are correct.

94. B — FCAW-G achieves 2 to 4 times the deposition rate of SMAW by eliminating stub losses inherent in SMAW (discarded electrode ends), maintaining near-continuous arc time through uninterrupted wire feeding (versus frequent electrode change stops), and operating at amperages that are not practical with individual SMAW electrodes. These combined factors produce a major productivity advantage on long, accessible structural fillet welds.

95. D — AWS D1.1 and ASME Section IX classify filler metals by product form as well as composition. E70C-6M (metal-cored wire, AWS A5.18 "C" designation) and ER70S-6 (solid wire, AWS A5.18 "ER" designation) are classified as different filler metal types. This product form difference constitutes an essential variable requiring new PQR qualification even when both produce 70 ksi nominal mechanical properties from similar base chemistries.

96. A — For DCEN GTAW, the torch is connected to the negative terminal — concentrating approximately 70% of arc energy at the workpiece (anode). When accidentally connected to the positive terminal (DCEP), the torch electrode becomes the anode. The 70% energy concentration at the small

tungsten tip immediately overheats and melts it into a ball, produces an unstable arc from the irregular balled surface, and deposits tungsten particles as rejectable inclusions in the pool.

97. C — Cerium oxide (CeO_2) in EWCe-2 and thorium oxide (ThO_2) in EWTh-2 function through similar thermionic emission mechanisms, producing equivalent DCEN arc starting and stability performance on stainless steel. Modern industrial practice increasingly favors EWCe-2 specifically because cerium oxide is non-radioactive — this eliminates radiation exposure concerns for operators, specialized waste disposal requirements, and regulatory handling protocols associated with thorium-containing electrode materials.

98. B — Back purge quality on stainless steel root passes is assessed by bead surface color: silver = excellent, no significant chromium oxidation. Light straw = trace oxidation, generally acceptable for most applications. Gold = moderate, marginally acceptable. Blue or black = unacceptable. A silver to light straw color on the 316L root bead confirms the purge atmosphere maintained sufficient oxygen exclusion during welding to prevent meaningful chromium depletion at the root surface.

99. D — Duplex stainless steels are susceptible to sigma phase formation in the ferrite component when held above approximately 600°C for extended time during or after welding. Sigma phase and related intermetallic compounds dramatically reduce both Charpy impact toughness and pitting corrosion resistance — the two critical design properties of duplex alloys. Heat input per pass must be controlled to limit time-at-temperature in this formation range.

100. A — Immediately lifting the torch after arc extinction exposes the weld surface and adjacent HAZ to atmospheric oxygen while still at elevated temperature. For stainless steel, this produces rapid chromium oxide formation — a discoloration ranging from straw to blue to black depending on peak temperature reached. This chromium oxide layer represents a depletion of the passive surface layer that must be addressed by chemical passivation treatment.

101. C — In AC GTAW of aluminum, the alternating current operates by cycling between electrode-negative and electrode-positive half-cycles. The AC waveform distributes the arc energy between the workpiece and electrode on an alternating basis rather than maintaining the full concentration of DC. This alternating energy distribution changes the effective arc temperature profile relative to DCEN, allowing a different balance of heat input to be achieved in the aluminum welding zone.

102. D — The cathodic cleaning band width reflects the effective coverage of the electrode-positive (EP) half-cycle, which provides the cathodic bombardment that breaks up and removes the aluminum oxide layer adjacent to the weld. An AC balance set heavily toward electrode-negative (EN) reduces the

EP fraction of each cycle, providing less total cathodic cleaning energy per pass and producing a proportionally narrower oxide removal zone around the weld deposit.

103. D — At the 6 o'clock overhead position in a 6G GTAW root pass, the argon post-flow timer operates independently of the welding arc parameters. Reducing the post-flow timer eliminates the extended shielding gas cooling that occurs after each arc stop at that position — this removes the rapid localized pool solidification caused by the directed argon stream, which can prematurely freeze the pool before adequate root penetration is achieved.

104. A — When 75% He/25% Ar replaces 100% argon for GTAW of thick stainless steel, helium's higher thermal conductivity increases arc energy transfer to the base metal. This improved heat transfer to the base metal means similar penetration and fusion can be achieved with somewhat lower amperage compared to pure argon, reducing the total heat input per pass — an important advantage for maintaining the 175°C maximum interpass temperature limit on the thick section.

105. C — In orbital GTAW with constant amperage, the flat position at 12 o'clock builds excessive crown because gravity supports the pool and allows metal accumulation, while the overhead position at 6 o'clock produces undercut because the pool hangs and pulls away from the toes. Reducing the programmed amperage at 12 o'clock limits the pool size to control crown, and reducing at 6 o'clock tightens the overhead pool so surface tension can hold it at the toes without dripping.

106. D — Under ASME Section IX QW-408, shielding gas composition is an essential variable for GTAW — changing from pure argon to argon-hydrogen blend requires new PQR testing. Under QW-404, filler metal classification (ER308L vs. ER316L are different AWS classifications) is also an essential variable. Both changes independently require separate PQR qualification, making each individually an essential variable change.

107. B — When multiple tube welds are completed sequentially through a heated bundle, thermal distortion and small leaks can develop progressively in the purge seals. The most critical element for maintaining consistent root quality through successive welds is verifying the oxygen concentration at the weld zone remains below the required threshold before each individual tube weld, since purge quality may degrade as the bundle temperature increases from accumulated heat.

108. A — In SAW, a deep, narrow bead geometry with a high depth-to-width ratio increases the proportion of flux that contacts and reacts with the weld pool at depth relative to the total metal volume. This elevated flux-to-metal contact ratio at the bead bottom introduces proportionally more flux

chemistry into the deposit, which can alter the weld metal composition in ways that reduce the Charpy impact toughness of the finished deposit.

109. C — In AWS A5.17 submerged arc welding flux-wire classification, the alphanumeric suffix following the minimum tensile strength designation encodes the mechanical property testing condition and requirements of the composite deposit. The "A4" suffix confirms that the deposited weld metal meets the required Charpy V-notch impact performance under the as-welded testing condition at the temperature and energy threshold specified by the classification standard.

110. B — To reduce a heat input that is running at 4.8 kJ/mm against a 3.5 kJ/mm qualified maximum, a single-variable adjustment focused on travel speed provides the most straightforward parameter change. Since heat input is determined by voltage, amperage, and travel speed together, adjusting travel speed alone — holding other variables constant — allows isolated reduction of the heat input variable to bring the procedure back within the qualified range.

111. D — Bonded SAW flux is manufactured with organic or hydraulic binders that make the flux granules somewhat porous and moisture-susceptible. Three weeks of open-drum storage at shop conditions will result in measurable moisture absorption. Before returning stored bonded flux to production use, drying at the manufacturer's specified temperature and duration restores the moisture-free state required for consistent flux chemistry and mechanical property performance.

112. C — In tandem SAW systems where DC leads and AC trails operate simultaneously, the frequency relationship between the two power systems can create harmonic interactions between their respective arc characteristics. If the AC power source's frequency or phase characteristics are not properly coordinated with the overall system, the resulting electrical interference can disrupt the AC trail arc's re-ignition timing on each half-cycle, producing the wander and inconsistent penetration observed.

113. A — If the plate temperature has fallen to 75°C before the next pass on a joint with a 125°C minimum preheat, but the temperature remains significantly above ambient, the residual heat distributed throughout the joint zone may retain sufficient capacity to prevent the critically fast HAZ cooling rate that triggers cold cracking. For lower CE steels, limited temperature variations within a reasonable range of the minimum may not produce a practical cold cracking risk.

114. B — For A514 quenched-and-tempered steel, exceeding the maximum interpass temperature of 230°C accelerates atomic hydrogen diffusion throughout the weld metal and HAZ. The elevated temperature promotes redistribution of hydrogen to high-stress sites at the weld interface. This sets the

conditions for delayed cold cracking that may not manifest until hours or days after welding is complete — a concern that cannot be detected by visual inspection of the weld surface at the time of welding.

115. D — PWHT at 600°C performs two critical functions for the offshore structural joint. Primarily, it thermally relaxes the residual tensile stresses that were locked into the weld metal and HAZ during rapid cooling from welding temperature. Simultaneously, it tempers any martensite or hard bainite that formed during post-weld cooling in the HAZ, reducing hardness and improving toughness — both important for offshore service environments involving fatigue and potential hydrogen exposure.

116. C — When the back purge supply is interrupted mid-pass with 60% of the root already completed with excellent color, the argon post-flow from the torch can be utilized as a localized atmospheric barrier by holding the torch very close to the weld surface during the remaining circuit. The post-flow stream, directed at the root of the ongoing weld, can partially substitute for back purge shielding for the limited duration needed to complete the remaining 40% of the circumference.

117. B — For DCEN GTAW, the tungsten tip is ground to a sharp taper ending in a point to concentrate the arc precisely at the electrode tip and produce a stable, directed arc column. Grinding marks must run longitudinally along the taper because transversely ground marks create circumferential surface discontinuities that can cause the arc to initiate at a groove mark on the electrode surface rather than at the intended tip point, resulting in arc wander and instability.

118. D — When ER4043 is considered as a substitute for ER5356 on 5083 aluminum, the higher silicon content of 4043 (4.5-6% Si) produces a more fluid pool behavior compared to the magnesium-alloyed 5356 wire. This difference in pool fluidity and heat input can be managed by reducing the welding amperage by approximately 20% from the 5356-qualified parameters to maintain comparable pool control and prevent overheating the 5083 base metal during the substitution.

119. A — While the technical basis for nitrogen additions to duplex stainless steel back purge gas includes metallurgical considerations, the practical benefit of nitrogen-containing purge gases for production operations includes cost-effectiveness relative to pure argon. In facilities performing high volumes of duplex stainless welding, the lower per-volume cost of nitrogen compared to argon provides a measurable reduction in consumable cost per metre of root pass completed.

120. C — The blue-to-dark blue discoloration zone 5-8 mm from the weld edge represents chromium oxide forming on the HAZ surface at temperatures above approximately 400°C during welding. Although lighter than a failed back purge, this zone indicates that the hot stainless surface was exposed to atmospheric oxygen during welding due to insufficient shielding gas coverage of the HAZ. This

chromium oxide layer depletes the passive surface layer and requires chemical passivation treatment to restore corrosion resistance.

121. D — Active bonded fluxes contain higher concentrations of reactive compounds than fused fluxes, and their reaction with the weld pool and electrode generates proportionally greater fume emissions during welding. Switching from fused flux to active flux in a production SAW welding environment requires evaluation of the new fume generation rate against occupational exposure limits for manganese, silicon compounds, and other flux-derived airborne constituents before implementing the change.

122. B — The heat input formula is HI = (V × A × 60) ÷ (speed mm/min × 1,000). PQR parameters: (32 × 500 × 60) ÷ (450 × 1,000) = 960,000 ÷ 450,000 = 2.13 kJ/mm. Production parameters: (34 × 525 × 60) ÷ (480 × 1,000) = 1,071,000 ÷ 480,000 = 2.23 kJ/mm. Both values are within the typical code tolerance for heat input, confirming production parameters remain in the qualified range.

123. A — In radiographic film interpretation of SAW weld metal, a transverse solidification crack at mid-thickness running perpendicular to the weld axis would appear as a linear indication in that orientation. Hot cracks form along grain boundaries in the last-to-solidify weld metal centreline. Their position, linear form, and orientation perpendicular to the weld axis — combined with the SAW process context — are consistent with centreline solidification cracking classification.

124. C — For 50 mm thick pressure vessel shell seams, SAW achieves substantially higher deposition rates (typically 15-30+ kg/hr) compared to FCAW-G (typically 3-8 kg/hr), with fewer total passes required to fill the deep groove. This advantage translates directly to reduced total arc time, fewer interpass temperature management cycles, and lower overall production cost per metre of completed pressure vessel seam weld.

125. B — In the AWS SAW flux-wire deposit classification system, the numerical suffix in the classification communicates specific preparation requirements for the flux before production use. The number "6" in the F7A6 classification specifies that the bonded flux must be dried for a minimum of 6 hours at 350°C prior to use, ensuring the flux granules are fully conditioned to produce the deposit mechanical properties that form the basis of the classification test results.