

# PRACTICE EXAM 5: POSS SIMULATION

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*Use scratch paper and pencil only. Do not consult notes, study materials, or the answer key during the exam. Answer every question — there is no penalty for wrong answers.*

## **SUBTEST 1 — MATHEMATICAL USAGE**

**46 questions | 17 minutes | No calculator**

1. What is  $105^2$ ?

- A. 11,025
- B. 10,250
- C. 11,225
- D. 12,025

2. A pump moves 540 gallons in 18 minutes. How many gallons does it move in 27 minutes at the same rate?

- A. 720 gallons
- B. 800 gallons
- C. 810 gallons
- D. 850 gallons

3. What is 85% of 160?

A. 120

B. 128

C. 132

D. 136

4. Solve for  $x$ :  $8x - 14 = 50$

A. 6

B. 8

C. 9

D. 10

5. Convert 4 hours and 30 minutes to total minutes.

A. 270 minutes

B. 250 minutes

C. 280 minutes

D. 290 minutes

6. A pipe is 132 inches long. How many feet is that?

A. 9 feet

B. 10 feet

C. 12 feet

D. 11 feet

7. What is  $\frac{5}{6} + \frac{3}{8}$  expressed as a fraction in simplest form?

- A.  $\frac{8}{14}$
- B.  $\frac{4}{3}$
- C.  $\frac{29}{24}$
- D.  $\frac{11}{12}$

8. A motor runs at 1,800 RPM. How many revolutions does it complete in 12 seconds?

- A. 360
- B. 400
- C. 420
- D. 480

9. If 8 workers complete a task in 18 hours, how many hours would 12 workers take to complete the same task?

- A. 9 hours
- B. 12 hours
- C. 14 hours
- D. 16 hours

10. What is  $1.25 \times 0.8$ ?

- A. 0.50
- B. 0.80
- C. 0.90

D. 1.00

11. A storage tank loses 17 gallons of water per hour. How many gallons does it lose in 9 hours?

A. 153 gallons

B. 145 gallons

C. 162 gallons

D. 170 gallons

12. Which fraction is equivalent to 0.4?

A.  $\frac{3}{7}$

B.  $\frac{1}{3}$

C.  $\frac{2}{5}$

D.  $\frac{5}{8}$

13. A worker is paid \$28 per hour. What are the gross earnings for 34 hours?

A. \$920

B. \$952

C. \$980

D. \$1,008

14. What is  $32 \times 25$ ?

A. 600

B. 700

C. 750

D. 800

15. A pressure gauge reads 75 PSI. How many feet of water column does this represent? (Use 1 PSI = 2.31 feet of water.)

A. 173.25 feet

B. 165 feet

C. 180 feet

D. 195 feet

16. Solve for n:  $6n + 7 = 4n + 25$

A. 7

B. 8

C. 9

D. 11

17. What is the average of 14, 22, 28, 36, and 50?

A. 26

B. 28

C. 32

D. 30

18. A pump's output is 110 gallons per minute. How many gallons does it produce in 1 hour and 18 minutes?

- A. 7,920 gallons
- B. 8,580 gallons
- C. 9,200 gallons
- D. 9,500 gallons

19. What is the square root of 196?

- A. 12
- B. 13
- C. 14
- D. 15

20. A truck travels at 75 miles per hour. How long does it take to travel 450 miles?

- A. 6 hours
- B. 5.5 hours
- C. 7 hours
- D. 8 hours

21. What is  $\frac{5}{8}$  of 80?

- A. 40
- B. 45
- C. 48

D. 50

22. A water tank is 60% full. If the tank holds 1,500 gallons total, how many gallons of water are in the tank?

A. 850 gallons

B. 880 gallons

C. 900 gallons

D. 950 gallons

23. Convert 56 fluid ounces to cups. (Use 1 cup = 8 fluid ounces.)

A. 6 cups

B. 7 cups

C. 8 cups

D. 9 cups

24. What is  $224 \div 16$ ?

A. 14

B. 15

C. 12

D. 18

25. A rectangular tank is 12 feet long, 8 feet wide, and 5 feet deep. What is its volume?

A. 360 cubic feet

- B. 400 cubic feet
- C. 440 cubic feet
- D. 480 cubic feet

26. If a number is decreased by 35% to give a result of 130, what is the original number?

- A. 200
- B. 220
- C. 230
- D. 250

27. What is the result of  $21.6 \div 0.4$ ?

- A. 48
- B. 50
- C. 54
- D. 60

28. A chemical mixing tank uses water and chemical in an 11:3 ratio. If 88 gallons of water are used, how many gallons of chemical are needed?

- A. 22 gallons
- B. 24 gallons
- C. 26 gallons
- D. 28 gallons

29. What is  $\frac{7}{10} - \frac{1}{5}$  expressed as a fraction in simplest form?

- A.  $\frac{3}{10}$
- B.  $\frac{2}{5}$
- C.  $\frac{3}{5}$
- D.  $\frac{1}{2}$

30. A motor's speed decreases by 18%. If the original speed was 2,000 RPM, what is the new speed?

- A. 1,640 RPM
- B. 1,720 RPM
- C. 1,800 RPM
- D. 1,850 RPM

31. Solve for  $y$ :  $3y - 9 = 2y + 6$

- A. 12
- B. 13
- C. 15
- D. 18

32. What is 22% of 350?

- A. 70
- B. 77
- C. 81
- D. 85

33. A pump operates 6 hours per day. How many minutes does it operate over an 8-day week?

- A. 2,400 minutes
- B. 2,640 minutes
- C. 2,800 minutes
- D. 2,880 minutes

34. What is the value of  $3^4$ ?

- A. 81
- B. 64
- C. 27
- D. 12

35. If 70 is 35% of a number, what is the number?

- A. 180
- B. 200
- C. 220
- D. 250

36. A fuel tank holds 2,000 gallons. After a 14-hour shift, the level has dropped to 1,440 gallons. What is the average consumption rate per hour?

- A. 32 gallons per hour
- B. 35 gallons per hour
- C. 38 gallons per hour

D. 40 gallons per hour

37. What is  $\frac{1}{2} \times \frac{3}{4}$  expressed as a fraction in simplest form?

A.  $\frac{1}{4}$

B.  $\frac{1}{2}$

C.  $\frac{3}{8}$

D.  $\frac{5}{8}$

38. A worker earns \$30 per hour for the first 40 hours and \$45 per hour for overtime. What are the total earnings for a 52-hour week?

A. \$1,740

B. \$1,800

C. \$1,860

D. \$1,920

39. What is the perimeter of a rectangle that is 22 feet long and 14 feet wide?

A. 60 feet

B. 65 feet

C. 70 feet

D. 72 feet

40. A pipe with a 12-inch diameter has a cross-sectional area of approximately how many square inches? (Use  $\pi \approx 3.14$ .)

A. 92.5 square inches

- B. 113.04 square inches
- C. 144.0 square inches
- D. 172.0 square inches

41. What is 0.25 expressed as a fraction in simplest form?

- A.  $\frac{1}{4}$
- B.  $\frac{2}{9}$
- C.  $\frac{3}{11}$
- D.  $\frac{5}{16}$

42. A boiler heats water from  $50^{\circ}\text{F}$  to  $175^{\circ}\text{F}$ . What is the temperature increase?

- A.  $105^{\circ}\text{F}$
- B.  $115^{\circ}\text{F}$
- C.  $120^{\circ}\text{F}$
- D.  $125^{\circ}\text{F}$

43. Two pumps work together to fill a tank. Pump A delivers 60 gallons per minute and Pump B delivers 90 gallons per minute. How long will it take both pumps together to fill a 3,000-gallon tank?

- A. 15 minutes
- B. 18 minutes
- C. 20 minutes
- D. 25 minutes

44. What is 6% of 800?

A. 48

B. 50

C. 54

D. 60

45. A 360-foot length of pipe is cut into sections that are each 9 feet long. How many full sections can be cut?

A. 32 sections

B. 36 sections

C. 38 sections

D. 40 sections

46. If  $x = 2$  and  $y = 5$ , what is the value of  $4x^3 + y^2 - 6$ ?

A. 38

B. 51

C. 64

D. 72

## SUBTEST 2 — MECHANICAL CONCEPTS

44 questions | 20 minutes | Pictorial questions

47. A first-class lever has a fulcrum 4 feet from a 320-pound load and 8 feet from the effort. What force is required to balance the load?

- A. 100 pounds
- B. 120 pounds
- C. 160 pounds
- D. 200 pounds

48. Two meshing gears have 30 and 90 teeth. If the smaller gear rotates clockwise at 900 RPM, the larger gear rotates:

- A. Counterclockwise at 300 RPM
- B. Clockwise at 300 RPM
- C. Counterclockwise at 2,700 RPM
- D. Clockwise at 2,700 RPM

49. A hydraulic system has an input piston of 6 square inches and an output piston of 72 square inches. If 90 pounds of force is applied to the input, what force is produced at the output?

- A. 720 pounds
- B. 900 pounds
- C. 1,200 pounds
- D. 1,080 pounds

50. In a block-and-tackle system with 8 supporting rope segments, what force is required to lift a 2,400-pound load (ignoring friction)?

- A. 200 pounds
- B. 300 pounds
- C. 400 pounds
- D. 500 pounds

51. Water flows through a 24-square-inch pipe at 2 feet per second. The pipe narrows to 6 square inches. What is the new water velocity?

- A. 8 feet per second
- B. 12 feet per second
- C. 6 feet per second
- D. 16 feet per second

52. A wheel-and-axle system has a wheel radius of 21 inches and an axle radius of 3 inches. What mechanical advantage does it provide?

- A. 5
- B. 6
- C. 8
- D. 7

53. According to Pascal's law, pressure applied to an enclosed liquid is:

- A. Increased only at the point of application
- B. Reduced as it travels through the system

- C. Transmitted equally throughout the fluid
- D. Concentrated at the largest pipe diameter

54. A 6-inch driver pulley turns at 1,400 RPM and is connected by a belt to an 8-inch driven pulley. What is the speed of the driven pulley?

- A. 1,400 RPM
- B. 1,050 RPM
- C. 1,200 RPM
- D. 1,866 RPM

55. A wedge that is 18 inches long and 2 inches thick at the wide end has a mechanical advantage of:

- A. 9
- B. 6
- C. 4
- D. 12

56. A butterfly valve uses what type of internal element to control flow?

- A. A flat sliding gate perpendicular to flow
- B. A spherical ball with a perforation through it
- C. A movable disk pressed against a stationary seat
- D. A circular disk that rotates 90° on a central shaft

57. A pneumatic tank contains 45 cubic feet of air at 80 PSI. If the air is compressed to 15 cubic feet at constant temperature, what is the new pressure?

- A. 160 PSI
- B. 200 PSI
- C. 240 PSI
- D. 320 PSI

58. A loading ramp is 30 feet long and rises 5 feet. What is its mechanical advantage?

- A. 5
- B. 6
- C. 7
- D. 8

59. The primary advantage of a chain drive over a belt drive is that chains:

- A. Are quieter under all operating conditions
- B. Always cost less to install and maintain
- C. Operate without any contact between components
- D. Provide positive engagement and do not slip

60. The hydrostatic pressure at the base of a fluid column depends on:

- A. The height of the column and the fluid density
- B. The width of the container
- C. The shape of the container

D. The temperature of the fluid

61. As back pressure on a centrifugal pump approaches the shutoff head:

- A. Flow rate increases dramatically
- B. Flow rate remains constant at maximum
- C. Flow rate decreases toward zero
- D. Flow reverses direction through the pump

62. A second-class lever produces a mechanical advantage that is:

- A. Always less than 1
- B. Always greater than 1
- C. Always exactly equal to 1
- D. Variable depending on the effort applied

63. A vertical column of water 60 feet tall produces a pressure at its base of approximately:

- A. 26 PSI
- B. 32 PSI
- C. 38 PSI
- D. 45 PSI

64. According to Newton's second law of motion:

- A. An object at rest stays at rest unless acted on by a force
- B. Pressure transmits equally in all directions

- C. For every action there is an equal and opposite reaction
- D. Force equals mass times acceleration

65. A check valve installed at a pump discharge serves primarily to:

- A. Reduce friction loss in the discharge piping
- B. Throttle the flow to a precise rate
- C. Prevent reverse flow when the pump stops
- D. Provide overpressure protection for the pump

66. Two meshing gears: the driver has 80 teeth and the driven has 20 teeth. If the driver rotates at 150 RPM, the driven rotates at:

- A. 75 RPM
- B. 600 RPM
- C. 300 RPM
- D. 1,200 RPM

67. The conservation principle that applies to all simple machines is that:

- A. Work (force  $\times$  distance) is conserved across input and output
- B. Force is conserved without any cost in distance
- C. Distance is conserved without any cost in force
- D. Energy can be created if mechanical advantage is high enough

68. A worker pushes a 480-pound crate up a 20-foot ramp that rises 4 feet. The minimum theoretical force required is:

- A. 80 pounds
- B. 120 pounds
- C. 60 pounds
- D. 96 pounds

69. The relationship  $W = m \times g$  defines weight in terms of mass and:

- A. Volume of the object
- B. Density of the object
- C. Temperature of the object
- D. Acceleration due to gravity

70. A centrifugal pump operating against a fully closed discharge valve produces:

- A. Maximum flow with minimum pressure
- B. Maximum pressure but zero flow
- C. Stable normal flow and pressure
- D. No pressure and no flow simultaneously

71. The friction force between two surfaces:

- A. Decreases as the normal force increases
- B. Acts in the direction of motion
- C. Always opposes the direction of motion

D. Has no effect on plant equipment performance

72. The mechanical advantage of a single fixed pulley is:

- A. 1
- B. 2
- C. 3
- D. 4

73. When the driven gear has fewer teeth than the driver gear in a meshed pair:

- A. The driven gear rotates at the same speed as the driver
- B. The driven gear rotates slower than the driver
- C. No power is transmitted between the gears
- D. The driven gear rotates faster than the driver

74. When a long steel pipe carrying steam is heated significantly:

- A. Its diameter decreases noticeably
- B. It expands in length and requires expansion provisions
- C. It loses density
- D. Its mass changes substantially

75. The principle that an object in motion stays in motion at constant velocity unless acted on by an external force is part of:

- A. Newton's first law (inertia)

- B. Pascal's law
- C. Bernoulli's principle
- D. The continuity equation

76. A 50-pound force on a balanced lever produces a 350-pound output force. The mechanical advantage is:

- A. 5
- B. 6
- C. 7
- D. 8

77. The primary function of a lubricating oil system in a turbine is to:

- A. Generate electrical power directly from the oil flow
- B. Increase the rotational speed of the turbine
- C. Cool the steam entering the turbine
- D. Supply oil to bearings to reduce friction and remove heat

78. The reason hydraulic systems can transmit force across long distances with no time delay is that:

- A. Hydraulic fluid is electrically conductive
- B. Hydraulic fluid is essentially incompressible
- C. Hydraulic systems operate at extremely high temperatures
- D. Hydraulic systems use chemical reactions for force transmission

79. By the continuity equation, when fluid flows from a wider pipe section into a narrower section:

- A. The fluid stops entirely
- B. The fluid reverses direction
- C. The fluid speeds up
- D. The fluid pressure increases at the narrow section

80. A V-belt is preferred over a flat belt of the same width because:

- A. V-belts cost less to manufacture
- B. V-belts last forever and never require replacement
- C. The wedging action increases friction and grip on the pulleys
- D. V-belts can transmit electricity simultaneously with mechanical power

81. Heat transfer through the bulk movement of a fluid (such as warm air rising) is called:

- A. Convection
- B. Conduction
- C. Radiation
- D. Insulation

82. A 36-tooth driver sprocket connected by a chain to a 12-tooth driven sprocket. If the driver rotates at 100 RPM, the driven sprocket rotates at:

- A. 100 RPM
- B. 50 RPM
- C. 200 RPM

D. 300 RPM

83. The outward sensation experienced on a rotating object is best understood as the result of:

- A. Magnetic attraction toward the rotation axis
- B. The object's inertia attempting to maintain straight-line motion
- C. Air pressure differences along the rotating arm
- D. Gravitational forces acting on the rotating mass

84. A flexible coupling between two shafts is required when:

- A. The shafts must rotate in opposite directions
- B. The shafts will operate at significantly different speeds
- C. Some shaft misalignment is anticipated during operation
- D. No power transmission is needed between the shafts

85. The energy released when steam at 212°F condenses into water at 212°F (with no temperature change) is called the:

- A. Latent heat of vaporization
- B. Sensible heat
- C. Specific heat capacity
- D. Convective heat

86. A pressure relief valve that fails to open at the setpoint creates the immediate risk of:

- A. Reduced operating efficiency only

- B. Faster than expected component wear
- C. Lower than normal operating temperatures
- D. Catastrophic failure of the pressurized equipment

87. In a hydraulic jack, the small input piston moves a greater distance than the large output piston because:

- A. The hydraulic fluid expands during the lift
- B. Fluid volume must be conserved across the pistons
- C. The output piston has a smaller area than the input
- D. The hydraulic system loses energy to friction

88. A 4-inch motor pulley rotates at 1,750 RPM and is connected by a belt to a 7-inch fan pulley. The fan rotates at:

- A. 1,000 RPM
- B. 1,200 RPM
- C. 1,400 RPM
- D. 1,600 RPM

89. The boiling temperature of water:

- A. Is fixed at 212°F regardless of conditions
- B. Decreases as pressure above the water increases
- C. Depends on the pressure above the water surface
- D. Depends only on the volume of water present

90. Pressure loss in a long section of pipe carrying flowing fluid:

- A. Decreases with longer pipe length
- B. Is unaffected by pipe diameter or surface roughness
- C. Depends only on the temperature of the fluid
- D. Increases with longer length, smaller diameter, and rougher interior

### **SUBTEST 3 — READING COMPREHENSION**

**36 questions | 30 minutes | 5 passages**

#### **Passage 1**

*Battery banks in power plants provide the direct current power necessary to operate critical control systems, switchgear, emergency lighting, and other essential loads when the normal alternating current supply is unavailable. The battery bank is typically composed of multiple individual cells connected in series to produce the required system voltage, with common voltages of 125 volts or 250 volts direct current. Lead-acid batteries are the most common type used in plant battery banks because of their proven reliability, long service life, and ability to deliver high currents during emergency demands. The batteries are kept fully charged by a battery charger that draws power from the plant's normal alternating current system; when the alternating current supply fails, the battery bank immediately and automatically supplies power to the connected critical loads through the direct current distribution system. Battery bank performance must be monitored continuously, with key parameters including individual cell voltage, electrolyte specific gravity, electrolyte level, and overall bank discharge capacity. Periodic testing under load conditions verifies that the battery bank can deliver the required current and duration during an actual emergency. Failure of the battery bank during a real emergency could leave critical control systems without power, potentially making the plant difficult or impossible to safely shut down.*

91. According to the passage, the primary purpose of plant battery banks is to:

- A. Provide power for routine plant operations
- B. Replace the plant's normal alternating current supply
- C. Provide direct current power to critical control systems during emergencies

D. Generate alternating current for sale back to the grid

92. The passage states that lead-acid batteries are commonly used in plant battery banks because of:

A. Their proven reliability and ability to deliver high currents

B. Their low initial purchase price

C. Their compact size and light weight

D. Their compatibility with renewable energy sources

93. According to the passage, common voltages for plant battery banks are:

A. 12 volts and 24 volts

B. 48 volts and 96 volts

C. 480 volts and 600 volts

D. 125 volts and 250 volts

94. As used in the passage, the word "automatically" most nearly means:

A. Only when commanded by an operator

B. Without manual intervention

C. After significant time delay

D. Through a manual switching procedure

95. What can be inferred from the passage about battery bank failure during a real emergency?

A. It could leave critical control systems without power and complicate safe shutdown

B. It would have minimal impact on plant operations

- C. It would automatically be corrected by the plant's grid connection
- D. It would only affect non-essential lighting

96. The author's primary purpose in this passage is to:

- A. Argue for replacing lead-acid batteries with newer technology
- B. Compare battery prices across different manufacturers
- C. Describe the function and importance of plant battery banks
- D. Critique current battery testing practices

97. According to the passage, periodic testing of battery banks is performed to:

- A. Calibrate the battery charger output
- B. Identify cells that should be removed for recycling
- C. Determine the optimal battery temperature
- D. Verify that the bank can deliver required current and duration

## **Passage 2**

*Lubrication systems in large rotating equipment perform two essential functions: they reduce friction between moving surfaces and they remove heat generated by mechanical action. The lubricating oil flows continuously through bearings, gear cases, and other friction-prone interfaces, where it forms a thin protective film that prevents direct metal-to-metal contact while carrying away the heat produced by mechanical work. The oil is then cooled in dedicated heat exchangers and filtered to remove contaminants before being returned to the equipment. The oil supply pressure, temperature, flow rate, and chemistry are continuously monitored to ensure adequate lubrication is being delivered to all served components. Any significant deviation from the normal operating parameters can indicate a developing problem with the lubrication system itself or with the equipment it serves. Common problems include filter clogging, cooler degradation, oil contamination from coolant or process leaks, and pump failures. Some critical equipment uses redundant lubrication pumps to ensure that lubrication continues uninterrupted even during pump maintenance or failure. Loss of lubrication in operating rotating equipment can lead to rapid bearing damage, overheating, and potentially catastrophic equipment failure within minutes.*

98. According to the passage, the two essential functions of lubrication systems are:

- A. Power transmission and electrical insulation
- B. Friction reduction and heat removal
- C. Cleaning and rust prevention
- D. Sealing and structural support

99. The passage states that lubricating oil prevents metal-to-metal contact by:

- A. Forming a thin protective film between moving surfaces
- B. Cooling the metal surfaces below operating temperature
- C. Coating the surfaces with a permanent corrosion barrier
- D. Magnetically separating the moving surfaces

100. According to the passage, after passing through equipment, the oil is:

- A. Discharged to a drain and replaced with fresh oil
- B. Stored in a holding tank for later regeneration
- C. Distilled to remove impurities
- D. Cooled in heat exchangers and filtered before being returned

101. As used in the passage, the word "deviation" most nearly means:

- A. A scheduled maintenance activity
- B. A departure from the normal operating value
- C. A documented operational improvement
- D. A regulatory permit modification

102. What can be inferred from the passage about loss of lubrication in operating equipment?

- A. It typically resolves itself within a few hours
- B. It has minimal effect on equipment life
- C. It can lead to rapid damage and catastrophic failure
- D. It is a normal part of equipment operation

103. The author's tone in this passage is best described as:

- A. Informative and authoritative
- B. Argumentative and persuasive
- C. Casual and personal
- D. Critical and dismissive

104. According to the passage, redundant lubrication pumps are used in some critical equipment to:

- A. Reduce the pressure drop across the system
- B. Provide backup electrical power
- C. Increase the operating efficiency of the equipment
- D. Ensure continuous lubrication during pump maintenance or failure

### **Passage 3**

*Cooling water chemistry programs are essential for protecting condenser tubes and the cooling water circuit from corrosion, scaling, biological fouling, and erosion. The cooling water that circulates through the condenser absorbs heat from the steam and is then sent to the cooling tower for heat rejection, where evaporation cools the water before it returns to the condenser. As water evaporates from the cooling tower, dissolved minerals become more concentrated in the remaining water, which can lead to scale deposits inside the condenser tubes that reduce heat transfer efficiency. To control mineral concentration, a portion of the circulating water is continuously discharged from the system as blowdown, and an equivalent*

*volume of fresh makeup water is added. Chemical additives are injected into the cooling water to control corrosion of the condenser tubes and other system components, to inhibit scale formation, and to suppress biological growth such as algae, bacteria, and shellfish that could otherwise foul the system. Cooling water chemistry parameters are monitored continuously, including pH, conductivity, biocide residual, and corrosion inhibitor concentrations. Improper cooling water chemistry can lead to costly condenser tube replacement and significant losses in plant generating efficiency.*

105. According to the passage, the primary purpose of cooling water chemistry programs is to:

- A. Improve the visual clarity of the cooling water
- B. Protect condenser tubes and the cooling water circuit
- C. Generate electricity from temperature differentials
- D. Reduce the volume of water used by the plant

106. The passage states that scale deposits inside condenser tubes:

- A. Reduce heat transfer efficiency
- B. Improve the strength of the condenser tubes
- C. Have no effect on plant operation
- D. Provide protection against biological fouling

107. According to the passage, mineral concentration in the cooling water is controlled by:

- A. Heating the water to evaporate excess minerals
- B. Allowing minerals to settle out at the cooling tower basin
- C. Continuously discharging blowdown and adding makeup water
- D. Filtering the water through specialized resin beds

108. As used in the passage, the word "fouling" most nearly means:

- A. Heating to high temperatures
- B. Removing impurities through filtration
- C. Reducing pressure in the system
- D. Accumulation of unwanted material

109. What can be inferred from the passage about improper cooling water chemistry?

- A. It is corrected automatically by the chemical injection system
- B. It can lead to costly condenser tube replacement and efficiency losses
- C. It affects only the visual appearance of the water
- D. It improves long-term equipment reliability

110. The author's primary purpose in this passage is to:

- A. Explain the role of cooling water chemistry in protecting plant equipment
- B. Argue for replacing cooling towers with closed-loop systems
- C. Compare different cooling water chemical additive brands
- D. Critique current cooling water management practices

111. According to the passage, chemical additives in cooling water control:

- A. Only biological growth from algae and bacteria
- B. Only corrosion of condenser tubes
- C. Only scale formation from dissolved minerals
- D. Corrosion, scale formation, and biological growth

#### Passage 4

*Ion exchange demineralizers are water treatment devices that remove dissolved mineral ions from water, producing the high-purity water required for boiler feed and other critical plant uses. The demineralizer contains beds of ion exchange resin — small spherical beads that selectively attract and retain mineral ions from the water passing through them. Cation resin beds remove positively charged ions such as calcium, magnesium, and sodium, while anion resin beds remove negatively charged ions such as chloride, sulfate, and silica. As the resin beds operate, the active sites on the resin beads gradually become saturated with the captured ions and lose their ability to remove additional minerals. When this happens, the resin must be regenerated to restore its capacity. Regeneration is performed by passing concentrated chemical solutions through the resin beds — sulfuric acid for cation resins and sodium hydroxide for anion resins — which displace the captured ions and return the resin to its active form. After regeneration, the resin beds are rinsed thoroughly to remove residual chemicals before being returned to service. Operators monitor the conductivity of the water leaving the demineralizer to determine when regeneration is required, with rising conductivity indicating that the resin's capacity is becoming exhausted.*

112. According to the passage, ion exchange demineralizers produce high-purity water by:

- A. Boiling the water to evaporate impurities
- B. Removing dissolved mineral ions from the water
- C. Filtering out suspended solids and particles
- D. Adding chemicals that neutralize impurities

113. The passage states that cation resin beds remove which type of ions?

- A. Negatively charged ions only
- B. Suspended particles and solids
- C. Positively charged ions such as calcium, magnesium, and sodium
- D. Only ions associated with biological contamination

114. According to the passage, anion resin beds remove which type of ions?

- A. Negatively charged ions such as chloride, sulfate, and silica
- B. Only metallic positively charged ions
- C. All organic compounds dissolved in water
- D. Only radioactive isotopes

115. As used in the passage, the word "saturated" most nearly means:

- A. Heated to high temperatures
- B. Cooled below freezing
- C. Reduced in chemical activity
- D. Filled to capacity

116. What can be inferred from the passage about resin regeneration?

- A. It is performed only during scheduled annual maintenance
- B. It restores the resin's capacity to remove additional ions
- C. It permanently destroys the resin beads
- D. It is unnecessary if the resin is replaced frequently

117. The author's primary purpose in this passage is to:

- A. Argue for replacing ion exchange systems with newer technology
- B. Compare costs of different demineralizer designs
- C. Critique current water treatment practices
- D. Explain how ion exchange demineralizers function and are maintained

118. According to the passage, operators monitor what parameter to determine when regeneration is required?

- A. The conductivity of the water leaving the demineralizer
- B. The pH of the regenerant chemical solutions
- C. The temperature of the resin beads
- D. The pressure drop across the resin beds

### Passage 5

*Operator shift turnover is one of the most safety-critical activities in plant operations. When one shift relieves another, the outgoing operators must transfer complete and accurate information about the current plant status, ongoing activities, abnormal conditions, and any special requirements to the incoming operators. A standardized turnover format ensures that no critical information is missed during the handoff. Typical turnover topics include current plant load and operating mode, status of major equipment, ongoing maintenance work and equipment lockouts, system anomalies or unusual readings, pending operational tasks, weather conditions affecting operations, and any communications from grid dispatchers or plant management. The incoming operators are expected to actively engage during turnover, asking questions to clarify any ambiguous information and verifying that they understand the current plant condition before the outgoing operators leave the area. After the verbal turnover is complete, the incoming operators perform a walk-through of the plant or a comprehensive review of control room indications to confirm the information they received. Inadequate shift turnover has been identified as a contributing factor in many plant operational incidents, which is why most plants require formal documentation of the turnover and the participation of both outgoing and incoming operators throughout the entire turnover process.*

119. According to the passage, the primary purpose of operator shift turnover is to:

- A. Document operator performance for performance reviews
- B. Reduce operator overtime expenses
- C. Transfer complete and accurate information from one shift to the next
- D. Identify operators eligible for promotion

120. The passage states that a standardized turnover format ensures:

- A. Operators can complete the turnover quickly
- B. No critical information is missed during the handoff
- C. The same operators always work together as a team
- D. Plant management does not need to monitor turnovers

121. According to the passage, typical turnover topics include all of the following EXCEPT:

- A. Current plant load and operating mode
- B. Status of major equipment
- C. Ongoing maintenance work and equipment lockouts
- D. Operator vacation schedules and personal preferences

122. As used in the passage, the word "anomalies" most nearly means:

- A. Unusual conditions or irregularities
- B. Routine equipment failures
- C. Scheduled maintenance activities
- D. Standard operating conditions

123. What can be inferred from the passage about the role of incoming operators during turnover?

- A. They should listen passively without asking questions
- B. They should leave the area as soon as the verbal handoff begins
- C. They should actively engage and verify their understanding
- D. They should rely entirely on the outgoing operator's documentation

124. The author's tone in this passage is best described as:

- A. Casual and conversational
- B. Authoritative and instructive
- C. Critical and dismissive
- D. Argumentative and persuasive

125. According to the passage, after the verbal turnover is complete, incoming operators:

- A. Perform a walk-through of the plant or comprehensive control room review
- B. Begin their shift work immediately without further verification
- C. Wait for management approval before assuming control
- D. Review documentation from the previous week's shifts

126. The passage indicates that inadequate shift turnover has been identified as:

- A. A reason for increased operator wages
- B. A justification for shorter shifts
- C. A contributing factor in many plant operational incidents
- D. A topic for industry-wide research collaboration

**SUBTEST 4 — FIGURAL REASONING**

**20 questions | 10 minutes | Visual pattern recognition**

127. A sequence shows a triangle that rotates  $120^\circ$  clockwise per frame. Frame 1 shows the triangle pointing up. Frame 2 shows it rotated  $120^\circ$  (pointing lower-right). Frame 3 shows another  $120^\circ$  rotation (pointing lower-left). Frame 4 shows another  $120^\circ$  (back to pointing up). What should Frame 5 show?

- A. Pointing lower-left
- B. Pointing lower-right
- C. Pointing up
- D. Pointing right

128. A  $2 \times 2$  grid shows: top-left = small black circle, top-right = small white circle, bottom-left = large black circle, bottom-right = ? What should appear in the bottom-right?

- A. Small white circle
- B. Small black circle
- C. Large black circle
- D. Large white circle

129. A sequence shows a row of dots that triples in count each frame: 1, 3, 9, 27. How many dots should Frame 5 contain?

- A. 81 dots
- B. 54 dots
- C. 30 dots
- D. 100 dots

130. A  $3 \times 3$  grid shows numbers in each cell: top row = 1, 2, 3. Middle row = 4, 5, 6. Bottom row = 7, 8, ? What number belongs in the missing cell?

- A. 10
- B. 11
- C. 9
- D. 12

131. A sequence shows a square that is mirrored across its vertical axis in each frame. Frame 1 shows a small mark on the left edge. Frame 2 shows the mark on the right edge. Frame 3 shows it on the left again. Frame 4 shows it on the right. What should Frame 5 show?

- A. Mark in the center
- B. Mark on the left edge
- C. Mark on the right edge
- D. Mark on both edges

132. A  $2 \times 2$  grid shows: top-left = 1 dot, top-right = 4 dots, bottom-left = 1 line, bottom-right = ? What should appear in the bottom-right?

- A. 4 lines
- B. 2 lines
- C. 8 lines
- D. 16 lines

133. A sequence shows shapes that change from outline to filled in successive frames: outline circle, filled circle, outline circle, filled circle. What should Frame 5 show?

- A. A half-filled circle

- B. A striped circle
- C. An outline circle
- D. A square

134. A  $2 \times 2$  grid shows: top-left = arrow pointing northeast, top-right = arrow pointing southeast, bottom-left = arrow pointing northwest, bottom-right = ? What should appear in the bottom-right?

- A. Arrow pointing northeast
- B. Arrow pointing southwest
- C. Arrow pointing north
- D. Arrow pointing south

135. A sequence shows a clock where the hour hand advances  $45^\circ$  clockwise per frame. Frame 1 is at 12 ( $0^\circ$ ). Frame 2 at 1:30 ( $45^\circ$ ). Frame 3 at 3 ( $90^\circ$ ). Frame 4 at 4:30 ( $135^\circ$ ). What rotation should Frame 5 show?

- A.  $90^\circ$
- B.  $135^\circ$
- C.  $225^\circ$
- D.  $180^\circ$

136. A  $3 \times 3$  grid shows shapes that increase by one corner from left to right in each row. The bottom row begins with a triangle (3 corners) and a square (4 corners). What belongs in the missing third cell?

- A. A pentagon (5 corners)
- B. A hexagon (6 corners)
- C. A circle
- D. A heptagon (7 corners)

137. A sequence shows a circle that is divided into halves, quarters, eighths, and sixteenths in successive frames. How many divisions should Frame 5 contain?

- A. 24 divisions
- B. 30 divisions
- C. 32 divisions
- D. 36 divisions

138. A  $2 \times 2$  grid shows: top-left = empty box with no dots, top-right = box with one dot, bottom-left = empty oval with no dots, bottom-right = ? What should appear in the bottom-right?

- A. Box with one dot
- B. Oval with one dot
- C. Empty oval
- D. Empty box

139. A sequence shows a shape that gains one straight side per frame: triangle (3), square (4), pentagon (5), hexagon (6). What should Frame 5 show?

- A. An octagon (8 sides)
- B. A square
- C. A pentagon
- D. A heptagon (7 sides)

140. A  $2 \times 2$  grid shows: top-left = a single dot in the upper-left corner of the cell, top-right = a single dot in the upper-right corner, bottom-left = a single dot in the lower-left corner, bottom-right = ? What should appear in the bottom-right?

- A. A dot in the lower-right corner

- B. A dot in the center
- C. A dot in the upper-right corner
- D. No dot at all

141. A sequence shows a star that changes color in a fixed cycle: white, gray, black, white, gray. What color should Frame 6 be?

- A. White
- B. Gray
- C. Black
- D. Striped

142. A  $3 \times 3$  grid shows shapes whose color rotates by one position per row: top row = white, gray, black. Middle row = gray, black, white. Bottom row = black, white, ? What color belongs in the missing cell?

- A. Gray
- B. White
- C. Black
- D. Striped

143. A sequence shows a hexagon that gradually loses internal lines, going from 6 internal lines to 4 to 2 to 0. What should Frame 5 show?

- A. 2 internal lines
- B. 4 internal lines
- C. 6 internal lines again
- D. 0 internal lines (still empty)

144. A  $2 \times 2$  grid shows: top-left = upward-pointing triangle, top-right = downward-pointing triangle, bottom-left = leftward-pointing triangle, bottom-right = ? What should appear in the bottom-right?

- A. Upward-pointing triangle
- B. Downward-pointing triangle
- C. Rightward-pointing triangle
- D. Leftward-pointing triangle

145. A sequence shows a square divided into smaller squares of equal size. Frame 1 has 1 square (the original). Frame 2 has 4 squares. Frame 3 has 9 squares. Frame 4 has 16 squares. How many squares should Frame 5 contain?

- A. 20 squares
- B. 25 squares
- C. 30 squares
- D. 36 squares

146. A  $2 \times 2$  grid shows: top-left = a single horizontal line, top-right = a horizontal line and a vertical line forming a plus sign, bottom-left = a single circle, bottom-right = ? What should appear in the bottom-right?

- A. A circle and a square
- B. Two circles side by side
- C. A circle inside a circle
- D. A circle with a smaller circle inside it

# PRACTICE EXAM 5 — ANSWER KEY

## AND FULL EXPLANATIONS

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### SUBTEST 1 — MATHEMATICAL USAGE (Questions 1–46)

1. **A** — 11,025. Use the squaring shortcut for numbers ending in 5: take the leading digits (10), multiply by the next integer (11) to get 110, then append 25. Result: 11,025. This trick works for every number ending in 5.
2. **C** — 810 gallons. Set up the proportion:  $540/18 = x/27$ . Cross-multiply:  $18x = 14,580$ , so  $x = 810$  gallons. Direct proportional reasoning handles steady-rate flow problems reliably.
3. **D** — 136. Use the 10% anchor: 10% of 160 = 16, so 80% = 128 and 5% = 8. Add:  $128 + 8 = 136$ . The anchor method is the fastest mental approach for percentage calculations.
4. **B** — 8. Add 14 to both sides:  $8x = 64$ . Divide by 8:  $x = 8$ . The standard two-step pattern handles every linear equation: undo addition first, then undo multiplication.
5. **A** — 270 minutes. Convert 4 hours to 240 minutes, then add 30 minutes:  $240 + 30 = 270$  minutes. Mixed time-unit conversions must be handled by converting to a common unit first.
6. **D** — 11 feet. Divide 132 inches by 12 inches per foot = 11 feet. The conversion factor of 12 inches per foot should be at the level of automatic recall.
7. **C** —  $29/24$ . Find a common denominator of 24:  $5/6 = 20/24$  and  $3/8 = 9/24$ . Add:  $20/24 + 9/24 = 29/24$ . The fraction is improper and cannot be reduced further.
8. **A** — 360. Convert 1,800 RPM to revolutions per second:  $1,800 / 60 = 30$  revolutions per second. In 12 seconds:  $30 \times 12 = 360$  revolutions. Recognizing the unit conversion embedded in the problem is the key step.
9. **B** — 12 hours. This is an inverse proportion: workers  $\times$  hours = constant. So  $8 \times 18 = 12 \times x$ , giving  $144 = 12x$  and  $x = 12$  hours. More workers means less time, which is the inverse-proportion signature.
10. **D** — 1.00. Multiply  $1.25 \times 0.8 = 1.00$ . Use the shortcut:  $1.25 \times 0.8 = (5/4) \times (4/5) = 1$ . Recognizing reciprocal relationships speeds up decimal multiplication.
11. **A** — 153 gallons. Multiply 17 gallons per hour  $\times$  9 hours = 153 gallons. Use decomposition:  $17 \times 9 = 17 \times (10 - 1) = 170 - 17 = 153$ . The round-and-adjust method is fast for multiplication near round numbers.

12. **C** —  $2/5$ . The decimal 0.4 equals  $4/10$ , which simplifies to  $2/5$  by dividing both by 2. This is one of the common fraction-to-decimal equivalences used across Math Sprint problems.
13. **B** — \$952. Multiply  $\$28 \times 34$  hours = \$952. Use decomposition:  $28 \times 34 = 28 \times (30 + 4) = 840 + 112 = 952$ . Mental decomposition is faster than long multiplication.
14. **D** — 800. Use the  $\times 25$  shortcut: multiply by 100 and divide by 4. So  $32 \times 25 = 3,200 / 4 = 800$ . The  $\times 25$  mental math shortcut is one of the highest-leverage patterns to internalize.
15. **A** — 173.25 feet. Multiply 75 PSI  $\times$  2.31 feet of water per PSI = 173.25 feet. The pressure-to-water-column conversion factor is a core plant operations equivalence used frequently in hydrostatic calculations.
16. **C** — 9. Subtract  $4n$  from both sides:  $2n + 7 = 25$ . Subtract 7:  $2n = 18$ . Divide:  $n = 9$ . Equations with variables on both sides require collecting variables first before applying the standard pattern.
17. **D** — 30. Add the five numbers:  $14 + 22 + 28 + 36 + 50 = 150$ . Divide by 5 = 30. Average problems require summing all values and dividing by the count.
18. **B** — 8,580 gallons. Convert 1 hour 18 minutes to 78 minutes total. Multiply 110 gallons per minute  $\times$  78 minutes = 8,580 gallons. Always convert mixed time units before applying the rate.
19. **C** — 14. The square root of 196 is 14 because  $14 \times 14 = 196$ . Memorization of perfect squares from 1 to 15 enables instant recognition.
20. **A** — 6 hours. Use  $T = D / R = 450 / 75 = 6$  hours. The DRT formula handles every distance-rate-time problem reliably regardless of which variable is the unknown.
21. **D** — 50. Multiply  $5/8 \times 80 = (5 \times 80) / 8 = 400 / 8 = 50$ . Recognizing that  $80 / 8 = 10$ , the calculation simplifies to  $5 \times 10 = 50$ .
22. **C** — 900 gallons. Multiply  $0.60 \times 1,500 = 900$  gallons. Use the 10% anchor: 10% of 1,500 = 150, so 60% = 900. The "of" in percentage problems always signals multiplication.
23. **B** — 7 cups. Divide 56 fluid ounces by 8 fluid ounces per cup = 7 cups. The 8-fluid-ounces-per-cup conversion is a memorized volume equivalence used in many fluid calculations.
24. **A** — 14. Recognize that  $16 \times 14 = 224$ , so  $224 / 16 = 14$ . Memorization of multiplication tables allows for instant division recognition.
25. **D** — 480 cubic feet. Volume = length  $\times$  width  $\times$  height =  $12 \times 8 \times 5 = 480$  cubic feet. Compute by stages:  $12 \times 8 = 96$ , then  $96 \times 5 = 480$ .
26. **A** — 200. If  $x$  decreased by 35% equals 130, then  $0.65x = 130$ , so  $x = 130 / 0.65 = 200$ . Always identify the original quantity before applying the percentage decrease relationship.
27. **C** — 54. Move the decimal points:  $21.6 / 0.4 = 216 / 4 = 54$ . Decimal division is simplified by shifting decimal points equally to make the divisor a whole number.

28. **B** — 24 gallons. Set up the proportion: 11 water / 3 chemical = 88 / x. Cross-multiply:  $11x = 264$ , so  $x = 24$  gallons. Cross-multiplication is the universal solving technique for ratio problems.
29. **D** —  $1/2$ . Find a common denominator of 10:  $7/10 - 2/10 = 5/10 = 1/2$ . Always simplify the final fraction to its lowest terms.
30. **A** — 1,640 RPM. An 18% decrease means the new speed is 82% of the original:  $2,000 \times 0.82 = 1,640$  RPM. Always apply the percentage change to the original value.
31. **C** — 15. Subtract  $2y$  from both sides:  $y - 9 = 6$ . Add 9:  $y = 15$ . Equations with variables on both sides require collecting variables before applying the standard pattern.
32. **B** — 77. Use the 10% anchor: 10% of 350 = 35. Then 2% = 7, so 22% =  $70 + 7 = 77$ . The anchor method handles uncommon percentages by combining or subtracting from familiar ones.
33. **D** — 2,880 minutes. 6 hours per day  $\times$  60 minutes per hour = 360 minutes per day. Over 8 days:  $360 \times 8 = 2,880$  minutes. Multi-step conversions can be combined efficiently.
34. **A** — 81. Compute  $3 \times 3 \times 3 \times 3 = 9 \times 9 = 81$ . The fourth power requires three multiplication steps and is commonly tested in foundational arithmetic.
35. **B** — 200. If  $70 = 0.35 \times x$ , then  $x = 70 / 0.35 = 200$ . The setup "Whole = Part / Percentage" handles this category of percentage question reliably.
36. **D** — 40 gallons per hour. Calculate the change:  $2,000 - 1,440 = 560$  gallons consumed. Divide by time:  $560 / 14 = 40$  gallons per hour. Average rate is total change divided by total time.
37. **C** —  $3/8$ . Multiply numerators and denominators:  $(1 \times 3) / (2 \times 4) = 3/8$ . Fraction multiplication does not require a common denominator — multiply straight across, then simplify.
38. **A** — \$1,740. Regular pay:  $40 \times \$30 = \$1,200$ . Overtime hours:  $52 - 40 = 12$ . Overtime pay:  $12 \times \$45 = \$540$ . Total:  $\$1,200 + \$540 = \$1,740$ . Multi-step word problems require careful sequential execution.
39. **D** — 72 feet. Perimeter of a rectangle =  $2 \times (\text{length} + \text{width}) = 2 \times (22 + 14) = 2 \times 36 = 72$  feet. Doubling the sum of length and width is faster than adding all four sides individually.
40. **B** — 113.04 square inches. Area of a circle =  $\pi \times r^2$ . Radius =  $12 / 2 = 6$  inches. Area =  $3.14 \times 36 = 113.04$  square inches. The diameter must be halved to find the radius before applying the area formula.
41. **A** —  $1/4$ . The decimal 0.25 equals  $25/100$ , which simplifies to  $1/4$  by dividing both by 25. This is one of the most common fraction-to-decimal equivalences and should be recognized instantly.
42. **D** —  $125^\circ\text{F}$ . Subtract:  $175 - 50 = 125^\circ\text{F}$ . Temperature change is the difference between final and initial temperatures, with units staying the same.

43. **C** — 20 minutes. Combined flow rate:  $60 + 90 = 150$  gallons per minute. Time to fill:  $3,000 / 150 = 20$  minutes. Pump rates add when pumps work together to produce combined output.
44. **A** — 48. Use the 10% anchor: 10% of 800 = 80. Then 1% = 8, so 6% = 48. The anchor method handles uncommon percentages efficiently.
45. **D** — 40 sections. Divide  $360 / 9 = 40$  sections. Word problems involving cutting or partitioning into equal pieces always reduce to simple division.
46. **B** — 51. Substitute  $x = 2$  and  $y = 5$ :  $4(8) + 25 - 6 = 32 + 25 - 6 = 51$ . Apply the order of operations strictly — exponents first, then multiplication, then addition and subtraction.

**SUBTEST 2 — MECHANICAL CONCEPTS (Questions 47–90)**

47. **C** — 160 pounds. Apply the law of the lever:  $\text{Effort} \times \text{Effort Arm} = \text{Load} \times \text{Load Arm}$ . So  $\text{Effort} \times 8 = 320 \times 4$ , giving  $\text{Effort} = 1,280 / 8 = 160$  pounds. The mechanical advantage of 2 reduces the required force by a factor of 2.
48. **A** — Counterclockwise at 300 RPM. Meshing gears always rotate in opposite directions. The gear ratio is  $30/90 = 1/3$ , so the larger gear rotates at one-third the driver speed:  $900 / 3 = 300$  RPM, in the counterclockwise direction.
49. **D** — 1,080 pounds. Calculate the pressure:  $P = F/A = 90/6 = 15$  PSI. Apply this pressure to the output piston:  $F = P \times A = 15 \times 72 = 1,080$  pounds. Hydraulic mechanical advantage equals the ratio of piston areas ( $72/6 = 12 \times$  force multiplier).
50. **B** — 300 pounds. The mechanical advantage of a block-and-tackle equals the number of rope segments supporting the load:  $MA = 8$ . Force required =  $\text{Load} / MA = 2,400 / 8 = 300$  pounds. Each rope segment shares an equal portion of the load.
51. **A** — 8 feet per second. Apply the continuity equation:  $A_1V_1 = A_2V_2$ , so  $24 \times 2 = 6 \times V_2$ , giving  $V_2 = 8$  feet per second. Fluid speeds up when pipe area decreases because the same volume must pass through the smaller cross-section.
52. **D** — 7. Mechanical advantage of a wheel-and-axle =  $\text{Wheel Radius} / \text{Axle Radius} = 21 / 3 = 7$ . A force applied at the rim of the larger wheel is multiplied at the rim of the smaller axle by the radius ratio.
53. **C** — Transmitted equally throughout the fluid. This is Pascal's law, the foundational principle of all hydraulic systems. Pressure exists at every point in the connected fluid simultaneously, regardless of distance or path direction.
54. **B** — 1,050 RPM. Driven RPM =  $(\text{Driver Diameter} / \text{Driven Diameter}) \times \text{Driver RPM} = (6/8) \times 1,400 = 0.75 \times 1,400 = 1,050$  RPM. A larger driven pulley turns more slowly than a smaller driver by the same ratio as the diameters.

55. **A** — 9. Mechanical advantage of a wedge = Length / Thickness =  $18 / 2 = 9$ . Long, thin wedges have high mechanical advantage and require less driving force to split material.
56. **D** — A circular disk that rotates  $90^\circ$  on a central shaft. Butterfly valves use a circular disk mounted on a shaft that rotates  $90^\circ$  between fully open (parallel to flow) and fully closed (perpendicular to flow). They are compact and well-suited for large pipe sizes.
57. **C** — 240 PSI. Apply Boyle's law:  $P_1V_1 = P_2V_2$ , so  $80 \times 45 = P_2 \times 15$ , giving  $3,600 = 15P_2$  and  $P_2 = 240$  PSI. Compressing a gas to one-third of its original volume triples its pressure at constant temperature.
58. **B** — 6. Mechanical advantage of a ramp = Length / Height =  $30 / 5 = 6$ . A long, gradual ramp produces high mechanical advantage; a short, steep ramp produces low mechanical advantage.
59. **D** — Provide positive engagement and do not slip. Chain drives use mechanical engagement between sprocket teeth and chain links, eliminating the slippage that can occur with belt drives. This makes chains preferred for high-load and positive-motion applications.
60. **A** — The height of the column and the fluid density. Hydrostatic pressure at any depth equals density  $\times$  gravity  $\times$  height. The width of the column, container shape, and fluid temperature have no direct effect on the hydrostatic pressure produced.
61. **C** — Flow rate decreases toward zero. The pump curve of a centrifugal pump shows an inverse relationship between pressure and flow. As back pressure rises toward the shutoff head, the flow rate drops progressively toward zero.
62. **B** — Always greater than 1. Second-class levers (load between fulcrum and effort) always produce mechanical advantage greater than 1, meaning they multiply the input force. A wheelbarrow is the classic example.
63. **A** — 26 PSI. Use the conversion 1 foot of water  $\approx 0.433$  PSI. Multiply  $60 \times 0.433 = 25.98$  PSI  $\approx 26$  PSI. The hydrostatic pressure depends on the height of the column, not on the volume or shape of the container.
64. **D** — Force equals mass times acceleration. Newton's second law states  $F = m \times a$ . The same force produces less acceleration on a more massive object than on a less massive one.
65. **C** — Prevent reverse flow when the pump stops. Check valves allow fluid to flow in only one direction and close automatically when flow reverses. Without a check valve, fluid would flow backward through a stopped pump and could damage the impeller and drive system.
66. **B** — 600 RPM. The gear ratio is  $80/20 = 4$ , meaning the driven gear rotates at four times the speed of the driver. So  $150 \times 4 = 600$  RPM. The driven gear with fewer teeth always rotates faster than the driver gear.

67. **A** — Work (force  $\times$  distance) is conserved across input and output. Every simple machine obeys this conservation principle. Mechanical advantage trades force for distance — you can multiply force, or you can multiply distance, but never both simultaneously.
68. **D** — 96 pounds. Mechanical advantage of the ramp =  $20 / 4 = 5$ . Required force = Load / MA =  $480 / 5 = 96$  pounds. The ramp reduces the required force by a factor equal to its mechanical advantage.
69. **D** — Acceleration due to gravity. In the formula  $W = m \times g$ , the variable  $g$  represents the acceleration due to gravity, approximately  $9.8 \text{ m/s}^2$  or  $32.2 \text{ ft/s}^2$  on Earth's surface. Weight equals mass multiplied by gravitational acceleration.
70. **B** — Maximum pressure but zero flow. When a centrifugal pump runs against a closed valve, it produces its maximum pressure (called shutoff head) but zero flow. This is the leftmost extreme of the pump curve.
71. **C** — Always opposes the direction of motion. Friction acts in the opposite direction of attempted or actual movement, regardless of the type of motion or the surfaces involved. This is a defining characteristic of friction in every plant equipment scenario.
72. **A** — 1. A single fixed pulley changes the direction of force but does not multiply it — the input and output forces are equal. The mechanical advantage of 1 means you must pull with the same force as the load weight.
73. **D** — The driven gear rotates faster than the driver. When the driven gear has fewer teeth than the driver, the gear ratio is less than 1 and the driven gear rotates faster while producing less torque. Speed and torque are inversely related in any gear system.
74. **B** — It expands in length and requires expansion provisions. Most materials, including steel, expand when heated. Plant piping systems incorporate expansion loops, expansion joints, and slip fittings to safely accommodate this thermal expansion without buckling or rupturing.
75. **A** — Newton's first law (inertia). Newton's first law states that an object at rest stays at rest and an object in motion stays in motion at constant velocity unless acted on by an external force. This is the principle of inertia.
76. **C** — 7. Mechanical advantage = Output Force / Input Force =  $350 / 50 = 7$ . The lever multiplies the input force by a factor of 7, with a corresponding cost in distance.
77. **D** — Supply oil to bearings to reduce friction and remove heat. Lubrication systems perform two functions: reducing friction at moving interfaces and carrying away heat generated by mechanical work. Both functions are essential for reliable operation of rotating equipment.
78. **B** — Hydraulic fluid is essentially incompressible. Liquids barely change volume when pressure is applied, allowing pressure to transmit instantaneously throughout the fluid. Gases would compress and absorb energy, producing sluggish response.

79. **C** — The fluid speeds up. By the continuity equation, when pipe area decreases at a constant flow rate, the fluid velocity must increase proportionally. The same volume must pass through the smaller cross-section in the same time.
80. **C** — The wedging action increases friction and grip on the pulleys. The trapezoidal cross-section of a V-belt wedges into matching V-shaped pulley grooves, creating significantly more friction and contact force than a flat belt could produce.
81. **A** — Convection. Heat transfer through the bulk movement of a fluid is convection. Conduction requires direct contact through solid materials, and radiation involves electromagnetic waves through space.
82. **D** — 300 RPM. Driven sprocket RPM = (Driver Teeth / Driven Teeth) × Driver RPM = (36/12) × 100 = 3 × 100 = 300 RPM. A smaller driven sprocket rotates faster than a larger driver sprocket connected by the same chain.
83. **B** — The object's inertia attempting to maintain straight-line motion. The apparent outward force on a rotating object is the result of inertia — the object's natural tendency to travel in a straight line is constrained by the centripetal force pulling it toward the center.
84. **C** — Some shaft misalignment is anticipated during operation. Flexible couplings tolerate small shaft misalignments without damaging bearings or transmitting harmful vibrations. Rigid couplings require precise alignment but transmit motion without flexibility.
85. **A** — Latent heat of vaporization. Energy released when steam condenses to water (or absorbed when water vaporizes to steam) without temperature change is the latent heat of vaporization. The condensation phase change releases the same energy that vaporization absorbs.
86. **D** — Catastrophic failure of the pressurized equipment. A failed relief valve allows pressure to continue rising past the safety setpoint, potentially causing rupture, explosion, or other catastrophic equipment failure. This is why relief valves are required on every pressurized system.
87. **B** — Fluid volume must be conserved across the pistons. The fluid is incompressible, so the volume displaced from the small piston must equal the volume filling the large piston. Since the large piston has more area, the small piston must move farther.
88. **A** — 1,000 RPM. Fan RPM = (Motor Pulley Diameter / Fan Pulley Diameter) × Motor RPM = (4/7) × 1,750 = 1,000 RPM. A larger driven pulley rotates more slowly than a smaller driver pulley.
89. **C** — Depends on the pressure above the water surface. Water boils at 212°F at sea-level atmospheric pressure, but at higher pressures the boiling point rises significantly. Power plant boilers exploit this principle to heat water to 545°F or higher without flashing into vapor.
90. **D** — Increases with longer length, smaller diameter, and rougher interior. Friction loss in piping increases with these factors plus higher flow rates. These variables determine the pressure drop a pump must overcome to move fluid through the system.

### SUBTEST 3 — READING COMPREHENSION (Questions 91–126)

91. **C** — Provide direct current power to critical control systems during emergencies. The opening sentence states this directly: battery banks "provide the direct current power necessary to operate critical control systems, switchgear, emergency lighting, and other essential loads when the normal alternating current supply is unavailable."
92. **A** — Their proven reliability and ability to deliver high currents. The passage states that lead-acid batteries are common "because of their proven reliability, long service life, and ability to deliver high currents during emergency demands."
93. **D** — 125 volts and 250 volts. The passage states explicitly that common voltages are "125 volts or 250 volts direct current." This is a direct factual statement that supports the answer.
94. **B** — Without manual intervention. In the context of "the battery bank immediately and automatically supplies power," the word means without manual operator action — the transition happens by itself.
95. **A** — It could leave critical control systems without power and complicate safe shutdown. The passage states that "failure of the battery bank during a real emergency could leave critical control systems without power, potentially making the plant difficult or impossible to safely shut down."
96. **C** — Describe the function and importance of plant battery banks. The passage describes battery bank function, components, and monitoring without arguing for changes or comparing prices. It is a descriptive overview.
97. **D** — Verify that the bank can deliver required current and duration. The passage states that "periodic testing under load conditions verifies that the battery bank can deliver the required current and duration during an actual emergency."
98. **B** — Friction reduction and heat removal. The opening sentence states the two functions directly: lubrication systems "reduce friction between moving surfaces and they remove heat generated by mechanical action."
99. **A** — Forming a thin protective film between moving surfaces. The passage states that the oil "forms a thin protective film that prevents direct metal-to-metal contact." This protective film is what eliminates the destructive contact.
100. **D** — Cooled in heat exchangers and filtered before being returned. The passage states that "the oil is then cooled in dedicated heat exchangers and filtered to remove contaminants before being returned to the equipment."
101. **B** — A departure from the normal operating value. In the operational context of "any significant deviation from the normal operating parameters," the word means a departure from the established normal range.

102. **C** — It can lead to rapid damage and catastrophic failure. The passage states that "loss of lubrication in operating rotating equipment can lead to rapid bearing damage, overheating, and potentially catastrophic equipment failure within minutes."
103. **A** — Informative and authoritative. The passage describes the lubrication system in a neutral, factual manner using prescriptive operational language, characteristic of training documentation.
104. **D** — Ensure continuous lubrication during pump maintenance or failure. The passage states that "some critical equipment uses redundant lubrication pumps to ensure that lubrication continues uninterrupted even during pump maintenance or failure."
105. **B** — Protect condenser tubes and the cooling water circuit. The opening sentence states this: cooling water chemistry programs are "essential for protecting condenser tubes and the cooling water circuit from corrosion, scaling, biological fouling, and erosion."
106. **A** — Reduce heat transfer efficiency. The passage states that "scale deposits inside the condenser tubes that reduce heat transfer efficiency." Scale acts as an insulating layer that prevents efficient heat exchange.
107. **C** — Continuously discharging blowdown and adding makeup water. The passage states that "a portion of the circulating water is continuously discharged from the system as blowdown, and an equivalent volume of fresh makeup water is added."
108. **D** — Accumulation of unwanted material. In the context of "biological fouling" and "shellfish that could otherwise foul the system," the word refers to accumulation of unwanted organic or inorganic material on equipment surfaces.
109. **B** — It can lead to costly condenser tube replacement and efficiency losses. The passage states that "improper cooling water chemistry can lead to costly condenser tube replacement and significant losses in plant generating efficiency."
110. **A** — Explain the role of cooling water chemistry in protecting plant equipment. The passage describes chemistry program functions and effects without arguing for changes or critiquing alternatives. It is a descriptive overview.
111. **D** — Corrosion, scale formation, and biological growth. The passage states that chemical additives are injected "to control corrosion of the condenser tubes and other system components, to inhibit scale formation, and to suppress biological growth."
112. **B** — Removing dissolved mineral ions from the water. The opening sentence states this directly: ion exchange demineralizers "remove dissolved mineral ions from water, producing the high-purity water required for boiler feed and other critical plant uses."
113. **C** — Positively charged ions such as calcium, magnesium, and sodium. The passage states that "cation resin beds remove positively charged ions such as calcium, magnesium, and sodium." Cations are positively charged ions by definition.

114. **A** — Negatively charged ions such as chloride, sulfate, and silica. The passage states that "anion resin beds remove negatively charged ions such as chloride, sulfate, and silica." Anions are negatively charged ions by definition.
115. **D** — Filled to capacity. In the context of "the active sites on the resin beads gradually become saturated with the captured ions," the word means filled to capacity — no more ions can be captured.
116. **B** — It restores the resin's capacity to remove additional ions. The passage states that "regeneration is performed by passing concentrated chemical solutions... which displace the captured ions and return the resin to its active form."
117. **D** — Explain how ion exchange demineralizers function and are maintained. The passage describes the demineralizer mechanism, regeneration process, and monitoring without arguing or critiquing. It is a descriptive overview.
118. **A** — The conductivity of the water leaving the demineralizer. The passage states that "operators monitor the conductivity of the water leaving the demineralizer to determine when regeneration is required, with rising conductivity indicating that the resin's capacity is becoming exhausted."
119. **C** — Transfer complete and accurate information from one shift to the next. The opening sentence describes the purpose: "the outgoing operators must transfer complete and accurate information about the current plant status, ongoing activities, abnormal conditions, and any special requirements to the incoming operators."
120. **B** — No critical information is missed during the handoff. The passage states that "a standardized turnover format ensures that no critical information is missed during the handoff."
121. **D** — Operator vacation schedules and personal preferences. The passage lists plant load, equipment status, maintenance work, anomalies, pending tasks, weather, and grid communications — but never mentions personal preferences or vacation schedules. EXCEPT questions require careful elimination.
122. **A** — Unusual conditions or irregularities. In the context of "system anomalies or unusual readings," the word means irregularities or unusual conditions that depart from normal operations.
123. **C** — They should actively engage and verify their understanding. The passage states that incoming operators "are expected to actively engage during turnover, asking questions to clarify any ambiguous information and verifying that they understand the current plant condition."
124. **B** — Authoritative and instructive. The passage uses prescriptive language and detailed procedural requirements characteristic of authoritative training documentation rather than casual or argumentative writing.

125. **A** — Perform a walk-through of the plant or comprehensive control room review. The passage states that "after the verbal turnover is complete, the incoming operators perform a walk-through of the plant or a comprehensive review of control room indications."
126. **C** — A contributing factor in many plant operational incidents. The passage states that "inadequate shift turnover has been identified as a contributing factor in many plant operational incidents."

**SUBTEST 4 — FIGURAL REASONING (Questions 127–146)**

127. **B** — Pointing lower-right. The triangle rotates  $120^\circ$  clockwise per frame, completing one full  $360^\circ$  rotation in three frames. After the cycle restarts in Frame 4 (pointing up), Frame 5 returns to pointing lower-right (the second position in the cycle).
128. **D** — Large white circle. The transformation in the top row is "black to white" (color change). The transformation in the left column is "small to large" (size change). Combining both, the bottom-right must be a large white circle.
129. **A** — 81 dots. The pattern triples the count each frame: 1, 3, 9, 27, then 81. Each successive frame multiplies the previous frame's count by 3, making the geometric progression predictable.
130. **C** — 9. The grid contains consecutive integers from 1 to 9 reading left-to-right, top-to-bottom. The bottom-right cell completes the sequence at 9.
131. **B** — Mark on the left edge. The pattern alternates between left and right edges: left, right, left, right, then left. Frame 5 follows the alternation by returning to the left edge.
132. **A** — 4 lines. The transformation in the top row is "1 becomes 4" (quadrupling). Applying this same transformation to the bottom row, 1 line becomes 4 lines.
133. **C** — An outline circle. The pattern alternates outline and filled: outline, filled, outline, filled, then outline. Frame 5 follows the alternation by returning to outline.
134. **B** — Arrow pointing southwest. The transformation in the top row is "northeast to southeast" (vertical flip from up to down on the right side). Applying the same vertical flip to the bottom row, northwest becomes southwest.
135. **D** —  $180^\circ$ . The hour hand advances  $45^\circ$  clockwise per frame:  $0^\circ$ ,  $45^\circ$ ,  $90^\circ$ ,  $135^\circ$ , then  $180^\circ$ . Each successive frame adds  $45^\circ$  to the cumulative rotation.
136. **A** — A pentagon (5 corners). The pattern within each row adds one corner: triangle (3), square (4), then pentagon (5). The bottom row continues this progression.
137. **C** — 32 divisions. The pattern doubles divisions per frame: 2, 4, 8, 16, then 32. Each successive frame doubles the previous frame's divisions, following the pattern of half/quarter/eighth/sixteenth/thirty-second divisions.

138. **B** — Oval with one dot. The transformation in the top row is "empty becomes one dot." Applying this same transformation to the bottom row, the empty oval becomes an oval with one dot.
139. **D** — A heptagon (7 sides). The pattern adds one side per frame: triangle (3), square (4), pentagon (5), hexagon (6), then heptagon (7). Each successive shape gains one side.
140. **A** — A dot in the lower-right corner. The pattern places the dot in the corner that completes the diagonal mirror pattern. The top row uses upper corners, and the bottom row uses lower corners — the missing cell continues this pattern with a lower-right corner dot.
141. **C** — Black. The cycle is white, gray, black, white, gray, then black. Frame 6 completes the second cycle by returning to black.
142. **A** — Gray. The pattern shifts colors leftward by one position in each row: top row (white, gray, black), middle row (gray, black, white), bottom row (black, white, gray). The missing cell continues the shift with gray.
143. **D** — 0 internal lines (still empty). The pattern subtracts 2 internal lines per frame: 6, 4, 2, 0, then 0 (already at minimum, cannot go lower). Frame 5 stays at 0 because there are no more lines to remove.
144. **C** — Rightward-pointing triangle. The transformation in the top row is "rotate 180°" (up becomes down). Applying this same rotation to the bottom row, leftward becomes rightward.
145. **B** — 25 squares. The pattern follows perfect squares:  $1^2$ ,  $2^2$ ,  $3^2$ ,  $4^2$ , then  $5^2 = 25$ . Each frame's count is the square of the frame number.
146. **D** — A circle with a smaller circle inside it. The transformation in the top row is "single shape becomes a combination shape" (line + line forming a plus sign). Applying the same "combination" transformation to the bottom row, a single circle becomes a combination of circles — specifically, one circle inside another.