

# PRACTICE EXAM 4: 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  $2\frac{1}{2} + 3\frac{3}{4}$  expressed as a mixed number?

- A.  $5\frac{3}{4}$
- B.  $6\frac{1}{4}$
- C.  $6\frac{3}{4}$
- D.  $5\frac{1}{4}$

2. A pump moves 480 gallons in 16 minutes. How many gallons does it move in 30 minutes at the same rate?

- A. 720 gallons
- B. 800 gallons
- C. 850 gallons
- D. 900 gallons

3. What is 55% of 120?

A. 66

B. 60

C. 72

D. 78

4. Solve for  $x$ :  $4x - 7 = 21$

A. 5

B. 6

C. 7

D. 8

5. Convert 3 hours and 20 minutes to total minutes.

A. 180 minutes

B. 200 minutes

C. 220 minutes

D. 240 minutes

6. A pipe is 96 inches long. How many feet is that?

A. 7 feet

B. 9 feet

C. 10 feet

D. 8 feet

7. What is  $\frac{4}{5} - \frac{1}{3}$  expressed as a fraction in simplest form?

- A.  $\frac{7}{15}$
- B.  $\frac{1}{2}$
- C.  $\frac{11}{15}$
- D.  $\frac{2}{5}$

8. A motor runs at 1,200 RPM. How many revolutions does it complete in 8 seconds?

- A. 120
- B. 140
- C. 160
- D. 180

9. If 20 workers complete a project in 9 days, how many days would 30 workers take to complete the same project?

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

10. What is  $0.75 \times 0.4$ ?

- A. 0.20
- B. 0.25
- C. 0.28

D. 0.30

11. A storage tank gains 22 gallons of fluid per hour. How many gallons does it gain in 6.5 hours?

A. 143 gallons

B. 132 gallons

C. 138 gallons

D. 150 gallons

12. Which fraction is equivalent to 0.875?

A.  $\frac{5}{6}$

B.  $\frac{4}{5}$

C.  $\frac{7}{8}$

D.  $\frac{9}{10}$

13. A worker is paid \$23 per hour. What are the gross earnings for 36 hours?

A. \$828

B. \$810

C. \$840

D. \$792

14. What is  $24 \times 25$ ?

A. 540

B. 580

C. 600

D. 620

15. A pressure gauge reads 90 PSI. How many feet of water column does this represent? (Use 1 PSI = 2.31 feet of water.)

A. 200 feet

B. 207.9 feet

C. 220 feet

D. 234 feet

16. Solve for n:  $9n + 12 = 75$

A. 5

B. 6

C. 8

D. 7

17. What is the average of 12, 18, 24, 30, and 36?

A. 24

B. 26

C. 28

D. 22

18. A pump's output is 80 gallons per minute. How many gallons does it produce in 1 hour and 45 minutes?

- A. 7,200 gallons
- B. 7,800 gallons
- C. 8,400 gallons
- D. 9,000 gallons

19. What is  $15^2$  (fifteen squared)?

- A. 200
- B. 215
- C. 220
- D. 225

20. A truck travels at 70 miles per hour. How long does it take to travel 280 miles?

- A. 3 hours
- B. 4 hours
- C. 4.5 hours
- D. 5 hours

21. What is  $\frac{2}{3}$  of 81?

- A. 54
- B. 48
- C. 56
- D. 60

22. A water tank is 90% full. If the tank holds 700 gallons total, how many gallons of water are in the tank?

- A. 600 gallons
- B. 620 gallons
- C. 650 gallons
- D. 630 gallons

23. Convert 24 quarts to gallons. (Use 1 gallon = 4 quarts.)

- A. 5 gallons
- B. 4 gallons
- C. 6 gallons
- D. 8 gallons

24. What is  $195 \div 15$ ?

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

25. A rectangular tank is 10 feet long, 7 feet wide, and 4 feet deep. What is its volume?

- A. 240 cubic feet
- B. 260 cubic feet
- C. 280 cubic feet

D. 300 cubic feet

26. If a number increased by 50% equals 90, what is the original number?

A. 60

B. 65

C. 70

D. 75

27. What is the result of  $18.6 \div 0.6$ ?

A. 25

B. 28

C. 30

D. 31

28. A chemical mixing tank uses water and chemical in a 6:1 ratio. If 78 gallons of water are used, how many gallons of chemical are needed?

A. 11 gallons

B. 13 gallons

C. 14 gallons

D. 15 gallons

29. What is  $\frac{5}{6} + \frac{1}{12}$  expressed as a fraction in simplest form?

A.  $\frac{7}{18}$

- B.  $\frac{1}{2}$
- C.  $\frac{11}{12}$
- D.  $\frac{5}{9}$

30. A motor's speed increases by 20%. If the original speed was 1,500 RPM, what is the new speed?

- A. 1,800 RPM
- B. 1,750 RPM
- C. 1,650 RPM
- D. 1,900 RPM

31. Solve for y:  $(y/3) + 4 = 10$

- A. 12
- B. 18
- C. 14
- D. 21

32. What is 18% of 250?

- A. 36
- B. 40
- C. 42
- D. 45

33. A pump operates 8 hours per day. How many minutes does it operate over a 5-day week?

- A. 2,200 minutes
- B. 2,300 minutes
- C. 2,400 minutes
- D. 2,500 minutes

34. What is the value of  $5^3$ ?

- A. 125
- B. 100
- C. 75
- D. 50

35. If 48 is 80% of a number, what is the number?

- A. 55
- B. 60
- C. 65
- D. 70

36. A fuel tank holds 1,500 gallons. After a 12-hour shift, the level has dropped to 1,140 gallons. What is the average consumption rate per hour?

- A. 25 gallons per hour
- B. 28 gallons per hour
- C. 32 gallons per hour

D. 30 gallons per hour

37. What is  $9/10 - 2/5$  expressed as a fraction in simplest form?

A.  $1/4$

B.  $3/10$

C.  $2/5$

D.  $1/2$

38. A worker earns \$22 per hour for the first 40 hours and \$33 per hour for overtime. What are the total earnings for a 47-hour week?

A. \$1,000

B. \$1,111

C. \$1,150

D. \$1,200

39. What is the perimeter of a rectangle that is 16 feet long and 12 feet wide?

A. 48 feet

B. 52 feet

C. 56 feet

D. 60 feet

40. A pipe with a 10-inch diameter has a cross-sectional area of approximately how many square inches? (Use  $\pi \approx 3.14$ .)

A. 78.5 square inches

- B. 65.2 square inches
- C. 56.8 square inches
- D. 88.0 square inches

41. What is 0.6 expressed as a fraction in simplest form?

- A.  $\frac{5}{9}$
- B.  $\frac{4}{7}$
- C.  $\frac{7}{12}$
- D.  $\frac{3}{5}$

42. A boiler heats water from  $65^{\circ}\text{F}$  to  $215^{\circ}\text{F}$ . What is the temperature increase?

- A.  $130^{\circ}\text{F}$
- B.  $140^{\circ}\text{F}$
- C.  $150^{\circ}\text{F}$
- D.  $160^{\circ}\text{F}$

43. Two pumps work together to fill a tank. Pump A delivers 50 gallons per minute and Pump B delivers 70 gallons per minute. How long will it take both pumps together to fill a 1,800-gallon tank?

- A. 12 minutes
- B. 15 minutes
- C. 18 minutes
- D. 20 minutes

44. What is 4% of 750?

A. 30

B. 32

C. 34

D. 36

45. A 240-foot length of pipe is cut into sections that are each 12 feet long. How many full sections can be cut?

A. 18 sections

B. 22 sections

C. 24 sections

D. 20 sections

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

A. 41

B. 49

C. 36

D. 56

**SUBTEST 2 — MECHANICAL CONCEPTS**

**44 questions | 20 minutes | Pictorial questions**

47. A first-class lever has a fulcrum located 2 feet from a 300-pound load and 6 feet from the effort. What force is required to balance the load?

- A. 150 pounds
- B. 100 pounds
- C. 75 pounds
- D. 50 pounds

48. Two meshing gears have 16 and 48 teeth. If the smaller gear rotates clockwise at 600 RPM, the larger gear rotates:

- A. Clockwise at 200 RPM
- B. Clockwise at 1,800 RPM
- C. Counterclockwise at 1,800 RPM
- D. Counterclockwise at 200 RPM

49. A hydraulic jack has an input piston of 2 square inches and an output piston of 40 square inches. If 60 pounds of force is applied to the input, what force is produced at the output?

- A. 1,200 pounds
- B. 800 pounds
- C. 1,600 pounds
- D. 2,400 pounds

50. In a block-and-tackle system with 3 supporting rope segments, what force is required to lift a 900-pound load (ignoring friction)?

- A. 200 pounds
- B. 250 pounds
- C. 300 pounds
- D. 450 pounds

51. Water flows through a 20-square-inch pipe at 4 feet per second. The pipe narrows to 5 square inches. What is the new water velocity?

- A. 12 feet per second
- B. 16 feet per second
- C. 20 feet per second
- D. 8 feet per second

52. A wheel-and-axle system has a wheel radius of 16 inches and an axle radius of 2 inches. What mechanical advantage does it provide?

- A. 8
- B. 6
- C. 5
- D. 10

53. According to Pascal's law, in a confined incompressible fluid:

- A. Pressure increases only at the point of force application
- B. Pressure decreases as it travels through the fluid

- C. Pressure is transmitted equally in all directions
- D. Pressure exists only in the direction of fluid flow

54. A 4-inch driver pulley turns at 1,800 RPM and is connected by a belt to an 8-inch driven pulley. What is the speed of the driven pulley?

- A. 3,600 RPM
- B. 1,800 RPM
- C. 1,200 RPM
- D. 900 RPM

55. A wedge that is 10 inches long and 2 inches thick at the wide end has a mechanical advantage of:

- A. 5
- B. 4
- C. 3
- D. 6

56. A globe valve is best suited for which application?

- A. Quick on/off operation only
- B. Throttling and partial flow control
- C. Preventing backflow
- D. Releasing overpressure

57. A pneumatic system contains air at 100 PSI in a 8-cubic-foot tank. If the air is compressed to 2 cubic feet at constant temperature, what is the new pressure?

- A. 200 PSI
- B. 300 PSI
- C. 350 PSI
- D. 400 PSI

58. A loading ramp is 24 feet long and rises 6 feet. What is its mechanical advantage?

- A. 2
- B. 3
- C. 4
- D. 6

59. The primary direction-of-rotation difference between meshing gears and belt-driven pulleys is that:

- A. Meshing gears rotate in opposite directions; belt drives rotate in the same direction
- B. Meshing gears and belt drives both rotate in the same direction
- C. Meshing gears rotate in the same direction; belt drives rotate in opposite directions
- D. Both rotate in alternating directions depending on speed

60. The hydrostatic pressure exerted by a fluid column depends primarily on:

- A. The width of the column
- B. The temperature of the fluid
- C. The shape of the container

D. The height of the column and the fluid density

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

- A. Flow rate increases proportionally
- B. Flow rate decreases toward zero
- C. Flow rate remains exactly constant
- D. Flow rate fluctuates widely

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

- A. Greater than 1
- B. Equal to 1
- C. Less than 1
- D. Equal to zero

63. A vertical column of water 80 feet tall produces a pressure at its base of approximately:

- A. 25 PSI
- B. 30 PSI
- C. 34.6 PSI
- D. 40 PSI

64. According to Newton's third law of motion, when one object exerts a force on another:

- A. Only the object being acted on experiences a force
- B. The other object exerts an equal and opposite force back

- C. The forces are not balanced unless the objects are identical
- D. The forces always cancel out completely

65. The primary purpose of a pressure relief valve is to:

- A. Filter contaminants from the system fluid
- B. Maintain a precise constant pressure under all conditions
- C. Throttle flow to a metered rate
- D. Open automatically when system pressure exceeds the setpoint

66. Two meshing gears: the driver has 60 teeth and the driven has 30 teeth. If the driver rotates at 100 RPM, the driven rotates at:

- A. 200 RPM
- B. 100 RPM
- C. 50 RPM
- D. 300 RPM

67. The trade-off in any simple machine that multiplies force is that:

- A. The system loses energy permanently
- B. The motion of the mechanism is restricted
- C. The input must move a greater distance than the output
- D. The system requires constant lubrication

68. A worker pushes a 720-pound crate up a ramp that is 12 feet long and rises 4 feet. The minimum theoretical force required is:

- A. 180 pounds
- B. 240 pounds
- C. 300 pounds
- D. 360 pounds

69. The energy required to convert 1 pound of water at 32°F into 1 pound of ice at 32°F (without any temperature change) is the latent heat of:

- A. Fusion
- B. Vaporization
- C. Combustion
- D. Sublimation

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

- A. Operate normally with reduced flow
- B. Increase flow by a factor of 2
- C. Produce maximum pressure but zero flow, with the trapped fluid heating rapidly
- D. Automatically shut down without any harmful effects

71. The friction force between two surfaces in contact:

- A. Is independent of the normal force pressing them together
- B. Increases as the normal force pressing them together increases
- C. Decreases dramatically when the surfaces are clean

D. Acts in the direction of motion to assist movement

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

A. 2

B. 4

C. 0

D. 1

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

A. The driven gear rotates slower but produces more torque

B. The driven gear rotates faster and produces more torque

C. The driven gear rotates at the same speed as the driver

D. No power is transmitted between the gears

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

A. The pipe shrinks in length

B. The pipe density increases

C. The pipe loses mass

D. The pipe expands in length and must be supported with expansion provisions

75. The principle that an object continues moving at constant velocity unless acted on by an external force is best described as:

A. Pascal's law

- B. Bernoulli's principle
- C. Inertia (Newton's first law)
- D. The continuity equation

76. A 25-pound force on a balanced lever produces a 250-pound output force. The mechanical advantage is:

- A. 8
- B. 10
- C. 12
- D. 15

77. The primary function of a thrust bearing in a rotating machine is to:

- A. Support axial loads on the shaft (along its length)
- B. Convert rotational motion to linear motion
- C. Provide overspeed protection
- D. Increase the rotational speed of the shaft

78. The reason hydraulic systems can produce very high forces with relatively small input forces is that:

- A. Hydraulic fluid generates additional force through chemical reactions
- B. The system uses electrical amplification of the input force
- C. Friction in the system multiplies the applied force
- D. The force is transmitted through pressure across a much larger output piston area

79. By the continuity equation, when a pipe's cross-sectional area increases at a constant flow rate:

- A. The fluid stops entirely
- B. The fluid speeds up
- C. The fluid slows down
- D. The fluid reverses direction

80. A V-belt drive is preferred over a flat belt drive because:

- A. V-belts last forever and never require replacement
- B. The trapezoidal cross-section creates a wedging action that increases friction and grip
- C. V-belts can transmit electricity in addition to mechanical power
- D. V-belts operate without any contact between the belt and the pulleys

81. Heat transferred through space without requiring a physical medium is called:

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

82. A 25-tooth driver sprocket connected by a chain to a 75-tooth driven sprocket. If the driver rotates at 450 RPM, the driven sprocket rotates at:

- A. 1,350 RPM
- B. 200 RPM
- C. 150 RPM

D. 300 RPM

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

- A. The result of inertia attempting to maintain straight-line motion
- B. A real fundamental force unique to rotation
- C. The effect of magnetic forces on the rotating mass
- D. The result of pressure differences in the surrounding air

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

- A. The shafts must always rotate in opposite directions
- B. The shafts will operate at different speeds
- C. The shafts are perfectly aligned and identical in design
- D. Some misalignment between the shafts is expected

85. The energy absorbed when ice melts to water at 32°F (without changing temperature) is called:

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

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

- A. Catastrophic failure of the pressurized equipment
- B. Reduced operating efficiency only

- C. Excessive lubrication consumption
- D. Faster than expected component wear

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

- A. The hydraulic fluid loses energy through friction
- B. The output piston has a smaller area than the input
- C. The total fluid volume must be conserved
- D. The system temperature rises during the lift

88. A 5-inch motor pulley rotates at 1,500 RPM and is connected by a belt to a 10-inch fan pulley. The fan rotates at:

- A. 3,000 RPM
- B. 1,500 RPM
- C. 1,000 RPM
- D. 750 RPM

89. The boiling point of a liquid:

- A. Is fixed and never changes regardless of conditions
- B. Depends on the pressure above the liquid surface
- C. Depends only on the volume of the liquid
- D. Depends only on the shape of the container

90. Pressure loss along a length of pipe carrying flowing fluid:

- A. Increases with longer pipe length, smaller diameter, and higher flow rate
- B. Decreases as the pipe length increases
- C. Is unaffected by the flow rate of the fluid
- D. Is unaffected by the diameter of the pipe

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

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

#### **Passage 1**

*The turbine governor is the control device that regulates the rotational speed of a steam turbine. Its primary function is to maintain a constant turbine speed despite variations in steam supply and electrical load. The governor accomplishes this by sensing the actual turbine speed and adjusting the position of the steam control valves to admit more or less steam to the turbine. When electrical load increases, the turbine tends to slow down because more energy is being drawn from it; the governor responds by opening the steam valves wider, admitting more steam to compensate. When load decreases, the turbine tends to speed up, and the governor responds by reducing steam admission. Modern turbines use electronic governors that process speed signals through digital controllers and command hydraulic actuators to position the steam valves with high precision. Older turbines used purely mechanical governors with rotating weights that flew outward as speed increased, mechanically actuating the valve linkage. Governor performance is critical to grid stability, because turbines connected to the electrical grid must maintain synchronous speed within tight tolerances to avoid causing voltage and frequency disturbances.*

91. According to the passage, the primary function of a turbine governor is to:

- A. Maintain constant turbine speed despite load variations
- B. Convert thermal energy into mechanical energy
- C. Cool the turbine bearings during operation
- D. Synchronize the turbine with the electrical grid

92. The passage states that when electrical load increases on a turbine, the turbine tends to:

- A. Speed up due to increased rotational momentum
- B. Maintain the same speed automatically
- C. Slow down because more energy is being drawn from it
- D. Stop completely until load is reduced

93. According to the passage, modern turbine governors use:

- A. Purely mechanical rotating-weight assemblies
- B. Electronic controllers and hydraulic actuators
- C. Manual operator-driven control levers
- D. Pneumatic pressure-sensing diaphragms

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

- A. Pay damages for losses
- B. Replace a missing component
- C. Reduce the operating workload
- D. Offset or counterbalance

95. What can be inferred from the passage about older mechanical governors?

- A. They used rotating weights that responded to speed changes through centrifugal force
- B. They operated only at fixed speeds with no adjustment capability
- C. They required continuous manual operator control
- D. They were more accurate than modern electronic governors

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

- A. Argue that all older turbines should be retrofitted with electronic governors
- B. Explain how turbine governors maintain speed control under varying loads
- C. Compare the costs of various governor designs
- D. Critique the safety record of mechanical governors

97. According to the passage, why is governor performance critical to grid stability?

- A. Governors directly control the grid voltage levels
- B. Governors prevent fires in the turbine assembly
- C. Turbines must maintain synchronous speed within tight tolerances
- D. Governors regulate the cooling water flow to the turbine

## Passage 2

*Plant chemistry programs are essential for maintaining the integrity of water-bearing systems throughout a power plant. Improper water chemistry can cause corrosion, scaling, and microbial growth that damage equipment and reduce efficiency. The chemistry program establishes target ranges for key parameters such as pH, conductivity, dissolved oxygen, and various ionic concentrations, and operators continuously monitor these parameters to verify that conditions remain within specification. Sampling points throughout the plant allow operators to draw water samples at specific locations — boiler feedwater, condensate return, makeup water, cooling tower basin water, and others — and analyze them either through dedicated online instrumentation or through laboratory analysis of grab samples. When a parameter drifts outside the target range, operators must take immediate corrective action, which may include adjusting chemical injection rates, increasing or decreasing blowdown, switching ion exchange beds, or initiating other treatment process changes. Detailed chemistry logs document all readings, deviations, and corrective actions, providing both a real-time operational tool and a long-term record for trend analysis. Recurring chemistry deviations often indicate developing problems with treatment equipment that should be investigated before they cause plant-wide impacts.*

98. According to the passage, the primary purpose of plant chemistry programs is to:

- A. Improve the visual clarity of plant water
- B. Reduce the cost of chemical purchases
- C. Document chemical usage for regulatory reporting
- D. Maintain the integrity of water-bearing systems

99. The passage states that improper water chemistry can cause:

- A. Excessive electrical consumption only
- B. Corrosion, scaling, and microbial growth
- C. Reduced steam pressure only
- D. Increased noise from rotating equipment

100. According to the passage, key chemistry parameters that operators monitor include:

- A. Color, odor, and visual clarity
- B. Temperature, pressure, and flow rate
- C. pH, conductivity, dissolved oxygen, and ionic concentrations
- D. Bacterial counts and viral indicators

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

- A. Departures from the target range
- B. Routine maintenance activities
- C. Equipment failure investigations
- D. Permit violation reports

102. What can be inferred from the passage about recurring chemistry deviations?

- A. They indicate the chemistry program is performing well
- B. They should be ignored if not severe
- C. They are normal and expected during operation
- D. They often indicate developing equipment problems

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

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

104. According to the passage, when a parameter drifts outside the target range, operators must take corrective action that may include:

- A. Increasing the operating temperature of the boiler
- B. Reducing the flow rate of the cooling system
- C. Adjusting chemical injection rates or initiating treatment changes
- D. Notifying the local utility regulatory commission

### **Passage 3**

*Large power transformers in plant switchyards generate substantial heat during operation due to electrical losses in the windings and core. This heat must be removed continuously to prevent the transformer insulation from degrading and to maintain efficient operation. The most common cooling method for large transformers is oil immersion combined with external radiators or coolers. The transformer windings and core are immersed in a tank filled with mineral oil that conducts heat away from the active components. The heated oil naturally rises through convection and flows into external*

*radiator tubes, where the heat is dissipated to ambient air. In larger or more heavily loaded transformers, the cooling system is supplemented by forced-oil pumps that increase oil circulation and by cooling fans that blow air across the radiator tubes. The progression of cooling stages — natural oil flow with natural air, forced oil with natural air, and forced oil with forced air — is automatically controlled based on transformer load and oil temperature. If cooling becomes inadequate, the transformer's protective relays will reduce its load or trip it offline to prevent thermal damage. Transformer cooling systems require routine inspection of oil quality, fan operation, pump function, and radiator surface cleanliness to ensure reliable performance.*

105. According to the passage, the primary purpose of transformer cooling is to:

- A. Reduce the operating noise of the transformer
- B. Improve the visual appearance of the equipment
- C. Comply with utility insurance requirements
- D. Prevent insulation degradation and maintain efficient operation

106. The passage states that the most common cooling method for large transformers is:

- A. Oil immersion combined with external radiators
- B. Direct refrigerated air injection into the windings
- C. Liquid nitrogen circulation through the core
- D. Submersion in a continuous water spray system

107. According to the passage, in oil-immersed transformers, the heated oil:

- A. Is pumped continuously through the windings by a forced-flow system at all times
- B. Naturally rises through convection and flows into external radiator tubes
- C. Remains stationary in the tank during normal operation
- D. Is replaced continuously with fresh cool oil from a reservoir

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

- A. Replaced entirely
- B. Reduced in capacity
- C. Added to or enhanced
- D. Eliminated to save energy

109. What can be inferred from the passage about the progression of cooling stages?

- A. All cooling stages are activated continuously regardless of load
- B. The stages must be manually selected by the operator
- C. The stages are controlled by a single fixed setpoint
- D. The cooling stages activate progressively based on load and temperature

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

- A. Argue for replacing oil-cooled transformers with newer technology
- B. Describe how large transformers are cooled and protected from overheating
- C. Compare the costs of various transformer cooling methods
- D. Critique the maintenance practices of utilities

111. According to the passage, what happens if cooling becomes inadequate?

- A. The transformer's protective relays will reduce its load or trip it offline
- B. The transformer will shut down without any prior warning
- C. The transformer will continue operating until physical failure occurs
- D. The transformer will automatically increase its cooling oil temperature

#### Passage 4

*Motor protection relays are devices that monitor the electrical and operating conditions of large electric motors and automatically disconnect the motor from its power supply if abnormal conditions are detected. The most common protection functions include overload protection, which trips the motor if current exceeds the rated value for too long; phase loss protection, which detects the loss of one phase in a three-phase supply and trips the motor before damage occurs; ground fault protection, which detects current leakage to ground and trips the motor; and underspeed or stall protection, which trips the motor if it fails to reach normal operating speed within an expected time. Modern motor protection relays are microprocessor-based devices that integrate all of these protection functions into a single unit, with extensive monitoring, logging, and communication capabilities. The relay continuously samples the motor's electrical parameters and compares them against programmed limits. When any limit is exceeded for the configured duration, the relay opens the motor's circuit breaker, isolating the motor from the supply. Proper coordination between motor protection relays and upstream protective devices ensures that faults are cleared by the closest device, minimizing the impact on other equipment. Periodic testing of motor protection relays verifies that they will operate correctly when needed.*

112. According to the passage, the primary purpose of motor protection relays is to:

- A. Increase the operating efficiency of the motor
- B. Reduce the energy consumption of the motor
- C. Monitor the motor and disconnect it from power if abnormal conditions are detected
- D. Provide visual indication of motor speed

113. The passage states that overload protection trips the motor when:

- A. The motor reaches a specified operating temperature
- B. The motor exceeds its rated voltage by 10%
- C. The motor's rotational speed exceeds the design limit
- D. Current exceeds the rated value for too long

114. According to the passage, phase loss protection is designed to:

- A. Detect grounding of the motor frame to earth
- B. Detect the loss of one phase in a three-phase supply
- C. Detect a short circuit between two phases
- D. Detect overheating of the motor windings

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

- A. Disconnecting and separating
- B. Repairing in place
- C. Inspecting visually
- D. Replacing with a new component

116. What can be inferred from the passage about modern motor protection relays?

- A. They require continuous manual operator monitoring
- B. They are mechanical devices with no electronic components
- C. They handle only one protection function at a time
- D. They integrate multiple protection functions into a single device

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

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

118. According to the passage, why is coordination between motor protection relays and upstream devices important?

- A. It reduces the cost of protection equipment
- B. It eliminates the need for periodic testing
- C. It ensures faults are cleared by the closest device
- D. It allows the use of smaller circuit breakers

### Passage 5

*Fire suppression systems in power plants protect personnel and equipment from the destructive effects of fire. Different areas of the plant present different fire hazards and require different suppression approaches. Areas containing flammable liquids such as lubricating oil and hydraulic fluid are typically protected by water spray or foam systems that smother the fire while cooling the surrounding equipment. Electrical equipment areas — such as transformer yards and switchgear rooms — often use clean agent gaseous systems or dry chemical extinguishers that suppress fires without leaving conductive residues that could damage electrical components. Coal handling and storage areas, where the risk of dust fires and explosions is significant, employ a combination of water deluge systems, dust collection equipment, and continuous monitoring for elevated temperatures or combustion gases. Plant personnel are trained in the proper use of portable fire extinguishers and the activation of fixed suppression systems, although they are also instructed to evacuate the area and notify the fire department for any fire that exceeds the capability of immediate handheld response. The fire suppression equipment itself requires regular inspection, testing, and maintenance to ensure that it will function properly when needed. Fire prevention through good housekeeping, proper storage of flammable materials, and prompt repair of oil leaks remains the most effective overall defense against plant fires.*

119. According to the passage, areas containing flammable liquids in a power plant are typically protected by:

- A. Water spray or foam systems
- B. Clean agent gaseous systems only
- C. Dry chemical extinguishers only
- D. Manual sand extinguishers

120. The passage states that electrical equipment areas often use which suppression methods?

- A. Continuous water sprays
- B. High-pressure steam injection
- C. Open-flame heating systems
- D. Clean agent gaseous systems or dry chemical extinguishers

121. According to the passage, the reason clean agent systems are preferred for electrical equipment is that:

- A. They are less expensive than water-based systems
- B. They suppress fires without leaving conductive residues
- C. They eliminate the need for personnel evacuation
- D. They are required by all electrical codes

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

- A. Cover and cut off oxygen
- B. Heat and accelerate combustion
- C. Disperse and spread out
- D. Test and monitor continuously

123. What can be inferred from the passage about coal handling areas?

- A. They require no specialized fire protection
- B. They use only manual fire suppression methods
- C. They employ multiple complementary fire control measures

D. They are exempt from continuous monitoring requirements

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

- A. Argue for replacing existing fire suppression systems with newer technology
- B. Describe the variety of fire suppression approaches used throughout a power plant
- C. Compare the costs of different fire suppression systems
- D. Critique the fire safety record of the power plant industry

125. According to the passage, plant personnel are instructed to do what for fires that exceed handheld response capability?

- A. Continue fighting the fire with all available resources
- B. Wait for automatic suppression systems to operate
- C. Activate the alarm system only
- D. Evacuate the area and notify the fire department

126. The passage indicates that the most effective overall defense against plant fires is:

- A. Fire prevention through good housekeeping and proper material storage
- B. Reliance on automated suppression systems alone
- C. Annual fire department inspections
- D. Avoidance of all flammable materials in the plant

## SUBTEST 4 — FIGURAL REASONING

20 questions | 10 minutes | Visual pattern recognition

127. A sequence shows a square that gains one corner-mark per frame, starting at the upper-left and proceeding clockwise. Frame 1 has a mark at upper-left. Frame 2 adds a mark at upper-right (2 marks total). Frame 3 adds a mark at lower-right (3 marks total). Frame 4 adds a mark at lower-left (4 marks, all corners). What should Frame 5 show?

- A. Three corner marks
- B. Two corner marks
- C. One corner mark
- D. All four corners marked again

128. A  $2 \times 2$  grid shows: top-left = circle inside circle, top-right = triangle inside triangle, bottom-left = square inside square, bottom-right = ? What should appear in the bottom-right?

- A. Pentagon inside pentagon
- B. Hexagon inside hexagon
- C. Octagon inside octagon
- D. Star inside star

129. A sequence shows a clock where the minute hand advances  $90^\circ$  clockwise per frame. Frame 1 is at 12, Frame 2 at 3, Frame 3 at 6, Frame 4 at 9. Where should the hand point in Frame 5?

- A. At 3
- B. At 6
- C. At 12
- D. At 9

130. A sequence shows shapes that combine rotation and color change. Frame 1: white square. Frame 2: gray square rotated  $45^\circ$ . Frame 3: dark gray diamond rotated  $90^\circ$ . Frame 4: nearly black square rotated  $135^\circ$ . What should Frame 5 show?

- A. White square at  $0^\circ$  rotation
- B. Black diamond rotated  $180^\circ$
- C. Gray triangle rotated  $90^\circ$
- D. White circle at  $90^\circ$  rotation

131. A  $3 \times 3$  grid shows: top row = 1 dot, 3 dots, 5 dots. Middle row = 3 dots, 5 dots, 7 dots. Bottom row = 5 dots, 7 dots, ? How many dots belong in the missing cell?

- A. 9 dots
- B. 11 dots
- C. 7 dots
- D. 13 dots

132. A  $2 \times 2$  grid shows: top-left = circle, top-right = three concentric circles, bottom-left = square, bottom-right = ? What should appear in the bottom-right?

- A. Two concentric squares
- B. Three concentric squares
- C. One square
- D. Triangle inside square

133. A sequence shows a row of arrows that rotate  $60^\circ$  clockwise each frame. Frame 1 points right (east). Frame 2 points southeast. Frame 3 points south. Frame 4 points southwest. What direction should Frame 5 point?

- A. Northeast
- B. North
- C. Northwest
- D. West

134. A  $3 \times 3$  grid shows: top row of small triangles, middle row of medium triangles, bottom row of two large triangles followed by ? What belongs in the missing cell?

- A. A large triangle
- B. A medium triangle
- C. A small triangle
- D. A square

135. A sequence shows a circle divided into equal segments. Frame 1 has 2 segments. Frame 2 has 4. Frame 3 has 6. Frame 4 has 8. How many segments should Frame 5 have?

- A. 9 segments
- B. 12 segments
- C. 10 segments
- D. 14 segments

136. A  $2 \times 2$  grid shows: top-left = empty box, top-right = box with checkmark, bottom-left = empty oval, bottom-right = ? What should appear in the bottom-right?

- A. Box with checkmark

- B. Empty box
- C. Oval with X mark
- D. Oval with checkmark

137. A sequence shows a triangle that gains one internal connecting line per frame. Frame 1 has 0 internal lines. Frame 2 has 1. Frame 3 has 2. Frame 4 has 3. How many internal lines should Frame 5 have?

- A. 4 internal lines
- B. 5 internal lines
- C. 3 internal lines
- D. 6 internal lines

138. A  $3 \times 3$  grid shows: top row of empty circles, middle row of half-filled circles, bottom row of two fully filled circles followed by ? What belongs in the missing cell?

- A. An empty circle
- B. A half-filled circle
- C. A fully filled circle
- D. A striped circle

139. A  $2 \times 2$  grid shows: top-left = single horizontal line, top-right = two parallel horizontal lines, bottom-left = single vertical line, bottom-right = ? What should appear in the bottom-right?

- A. Three parallel vertical lines
- B. Two parallel vertical lines
- C. One vertical line
- D. Two parallel horizontal lines

140. A sequence shows a star that grows by one point per frame. Frame 1 has 4 points. Frame 2 has 5. Frame 3 has 6. Frame 4 has 7. How many points should Frame 5 have?

- A. 6 points
- B. 9 points
- C. 7 points
- D. 8 points

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

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

142. A sequence shows alternating filled and empty hexagons: filled, empty, filled, empty. What should Frame 5 show?

- A. A filled triangle
- B. A half-filled hexagon
- C. An empty hexagon
- D. A filled hexagon

143. A  $3 \times 3$  grid shows shapes where each row has the same shape but increasing size from left to right. The bottom row shows: small pentagon, medium pentagon, ? What belongs in the missing cell?

- A. A small pentagon
- B. A large pentagon
- C. A medium hexagon
- D. A small hexagon

144. A sequence shows a square that loses one corner per frame, becoming a triangle, then a line segment, then a single point. Frame 1: 4-cornered square. Frame 2: 3-cornered triangle. Frame 3: 2-cornered line. Frame 4: 1 point. What should Frame 5 show?

- A. A square again
- B. A triangle
- C. Nothing (zero corners)
- D. A circle

145. A  $2 \times 2$  grid shows: top-left = right-pointing arrow, top-right = down-pointing arrow, bottom-left = up-pointing arrow, bottom-right = ? What should appear in the bottom-right?

- A. Left-pointing arrow
- B. Up-pointing arrow
- C. Down-pointing arrow
- D. Right-pointing arrow

146. A sequence shows a clock where the hour hand advances  $30^\circ$  clockwise per frame. Frame 1 is at 12 ( $0^\circ$ ). Frame 2 at 1 ( $30^\circ$ ). Frame 3 at 2 ( $60^\circ$ ). Frame 4 at 3 ( $90^\circ$ ). Where should the hand point in Frame 5?

A. At 12

B. At 5

C. At 4

D. At 6

# PRACTICE EXAM 4 — ANSWER KEY AND FULL EXPLANATIONS

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

1. **B** —  $6\frac{1}{4}$ . Convert to improper fractions:  $\frac{5}{2} + \frac{15}{4} = \frac{10}{4} + \frac{15}{4} = \frac{25}{4}$ . Convert back to a mixed number:  $\frac{25}{4} = 6\frac{1}{4}$ . Mixed number addition is fastest when first converted to improper fractions with a common denominator.
2. **D** — 900 gallons. Set up the proportion:  $\frac{480}{16} = \frac{x}{30}$ . Cross-multiply:  $16x = 14,400$ , so  $x = 900$  gallons. Direct proportional reasoning handles steady-rate flow problems reliably.
3. **A** — 66. Use the 10% anchor: 10% of 120 = 12, so 50% = 60 and 5% = 6. Add:  $60 + 6 = 66$ . The anchor method is the fastest mental approach for percentage calculations.
4. **C** — 7. Add 7 to both sides:  $4x = 28$ . Divide by 4:  $x = 7$ . The standard two-step pattern handles every linear equation: undo addition first, then undo multiplication.
5. **B** — 200 minutes. Convert 3 hours to 180 minutes, then add 20 minutes:  $180 + 20 = 200$  minutes. Mixed time-unit conversions must be handled by converting to a common unit first.
6. **D** — 8 feet. Divide 96 inches by 12 inches per foot = 8 feet. The conversion factor of 12 inches per foot should be at the level of automatic recall.
7. **A** —  $\frac{7}{15}$ . Find a common denominator of 15:  $\frac{4}{5} = \frac{12}{15}$  and  $\frac{1}{3} = \frac{5}{15}$ . Subtract:  $\frac{12}{15} - \frac{5}{15} = \frac{7}{15}$ . The least common multiple of 5 and 3 is 15.
8. **C** — 160. Convert 1,200 RPM to revolutions per second:  $1,200 / 60 = 20$  revolutions per second. In 8 seconds:  $20 \times 8 = 160$  revolutions. Recognizing the unit conversion embedded in the problem is the key step.
9. **B** — 6 days. This is an inverse proportion: workers  $\times$  days = constant. So  $20 \times 9 = 30 \times x$ , giving  $180 = 30x$  and  $x = 6$  days. More workers means less time, which is the inverse-proportion signature.
10. **D** — 0.30. Multiply  $0.75 \times 0.4 = 0.30$ . Count two decimal places in the original numbers and place the decimal point that many places from the right in the answer.
11. **A** — 143 gallons. Multiply 22 gallons per hour  $\times$  6.5 hours = 143 gallons. Use decomposition:  $22 \times 6 = 132$ , then add  $22 \times 0.5 = 11$ , giving 143 total.

12. **C** —  $7/8$ . The decimal 0.875 equals  $875/1000$ , which simplifies to  $7/8$  by dividing both by 125. This is one of the sixteen common fraction-to-decimal equivalences that should be at the level of automatic recall.
13. **A** — \$828. Multiply  $\$23 \times 36$  hours = \$828. Use decomposition:  $23 \times 36 = 23 \times (40 - 4) = 920 - 92 = 828$ . The round-and-adjust method is fast for multiplication near round numbers.
14. **C** — 600. Use the  $\times 25$  shortcut: multiply by 100 and divide by 4. So  $24 \times 25 = 2,400 / 4 = 600$ . The  $\times 25$  mental math shortcut is one of the highest-leverage patterns to internalize.
15. **B** — 207.9 feet. Multiply 90 PSI  $\times$  2.31 feet of water per PSI = 207.9 feet. The pressure-to-water-column conversion factor is a core plant operations equivalence used frequently in hydrostatic calculations.
16. **D** — 7. Subtract 12 from both sides:  $9n = 63$ . Divide by 9:  $n = 7$ . The two-step solving pattern works regardless of which letter is used as the variable.
17. **A** — 24. Add the five numbers:  $12 + 18 + 24 + 30 + 36 = 120$ . Divide by 5 = 24. Average problems require summing all values and dividing by the count.
18. **C** — 8,400 gallons. Convert 1 hour 45 minutes to 105 minutes total. Multiply 80 gallons per minute  $\times$  105 minutes = 8,400 gallons. Always convert mixed time units to a single unit before applying the rate.
19. **D** — 225. Use the squaring shortcut for numbers ending in 5: multiply  $1 \times 2 = 2$ , then append 25, giving 225. The trick: for any number AB5, square it as  $(A \times (A+1))$  followed by "25."
20. **B** — 4 hours. Use  $T = D / R = 280 / 70 = 4$  hours. The DRT formula handles every distance-rate-time problem regardless of which variable is the unknown.
21. **A** — 54. Multiply  $2/3 \times 81 = (2 \times 81) / 3 = 162 / 3 = 54$ . Recognizing that  $81 / 3 = 27$ , the calculation simplifies to  $2 \times 27 = 54$ .
22. **D** — 630 gallons. Multiply  $0.90 \times 700 = 630$  gallons. Use the 10% anchor: 10% of 700 = 70, so 90% =  $700 - 70 = 630$ . The "of" in percentage problems always signals multiplication.
23. **C** — 6 gallons. Divide 24 quarts by 4 quarts per gallon = 6 gallons. The 4-quarts-per-gallon conversion is a memorized volume equivalence used frequently in fluid system calculations.
24. **B** — 13. Recognize that  $15 \times 13 = 195$ , so  $195 / 15 = 13$ . Memorization of multiplication tables allows for instant division recognition.
25. **C** — 280 cubic feet. Volume = length  $\times$  width  $\times$  height =  $10 \times 7 \times 4 = 280$  cubic feet. Compute by stages:  $10 \times 7 = 70$ , then  $70 \times 4 = 280$ .
26. **A** — 60. If  $x$  increased by 50% equals 90, then  $1.50x = 90$ , so  $x = 90 / 1.50 = 60$ . Always identify the original quantity before applying the percentage relationship.

27. **D** — 31. Move the decimal points:  $18.6 / 0.6 = 186 / 6 = 31$ . Decimal division is simplified by shifting decimal points equally to make the divisor a whole number.
28. **B** — 13 gallons. Set up the proportion: 6 water / 1 chemical = 78 / x. Cross-multiply:  $6x = 78$ , so  $x = 13$  gallons. Cross-multiplication is the universal solving technique for ratio problems.
29. **C** —  $11/12$ . Find a common denominator of 12:  $5/6 = 10/12$  and  $1/12 = 1/12$ . Add:  $10/12 + 1/12 = 11/12$ . The least common multiple of 6 and 12 is 12.
30. **A** — 1,800 RPM. A 20% increase means the new speed is 120% of the original:  $1,500 \times 1.20 = 1,800$  RPM. Always apply the percentage change to the original value.
31. **B** — 18. Subtract 4 from both sides:  $y/3 = 6$ . Multiply both sides by 3:  $y = 18$ . Equations with fractional coefficients require multiplying both sides by the reciprocal to isolate the variable.
32. **D** — 45. Use the 10% anchor: 10% of 250 = 25. Then 8% = 20, so 18% = 25 + 20 = 45. The anchor method handles uncommon percentages by combining or subtracting from familiar ones.
33. **C** — 2,400 minutes. 8 hours per day  $\times$  60 minutes per hour = 480 minutes per day. Over 5 days:  $480 \times 5 = 2,400$  minutes. Multi-step conversions can be combined efficiently.
34. **A** — 125. Compute  $5 \times 5 \times 5 = 25 \times 5 = 125$ . Cubed numbers require two multiplication steps and are commonly tested in foundational arithmetic.
35. **B** — 60. If  $48 = 0.80 \times x$ , then  $x = 48 / 0.80 = 60$ . The setup "Whole = Part / Percentage" handles this category of percentage question reliably.
36. **D** — 30 gallons per hour. Calculate the change:  $1,500 - 1,140 = 360$  gallons consumed. Divide by time:  $360 / 12 = 30$  gallons per hour. Average rate is total change divided by total time.
37. **D** —  $1/2$ . Convert to common denominator of 10:  $9/10 - 4/10 = 5/10 = 1/2$ . Always simplify the final fraction to lowest terms before selecting an answer.
38. **B** — \$1,111. Regular pay:  $40 \times \$22 = \$880$ . Overtime hours:  $47 - 40 = 7$ . Overtime pay:  $7 \times \$33 = \$231$ . Total:  $\$880 + \$231 = \$1,111$ . Multi-step word problems require careful sequential execution.
39. **C** — 56 feet. Perimeter of a rectangle =  $2 \times (\text{length} + \text{width}) = 2 \times (16 + 12) = 2 \times 28 = 56$  feet. Doubling the sum of length and width is faster than adding all four sides individually.
40. **A** — 78.5 square inches. Area of a circle =  $\pi \times r^2$ . Radius =  $10 / 2 = 5$  inches. Area =  $3.14 \times 25 = 78.5$  square inches. The diameter must be halved to find the radius before applying the area formula.
41. **D** —  $3/5$ . The decimal 0.6 equals  $6/10$ , which simplifies to  $3/5$  by dividing both by 2. This is one of the common fraction-to-decimal equivalences used across Math Sprint problems.

42. **C** — 150°F. Subtract:  $215 - 65 = 150^\circ\text{F}$ . Temperature change is the difference between final and initial temperatures, with units staying the same.
43. **B** — 15 minutes. Combined flow rate:  $50 + 70 = 120$  gallons per minute. Time to fill:  $1,800 / 120 = 15$  minutes. Pump rates add when pumps work together to produce combined output.
44. **A** — 30. Use the 10% anchor: 10% of 750 = 75. Then 1% = 7.5, so 4% = 30. The anchor method handles uncommon percentages efficiently.
45. **D** — 20 sections. Divide  $240 / 12 = 20$  sections. Word problems involving cutting or partitioning into equal pieces always reduce to simple division.
46. **B** — 49. Substitute  $x = 3$  and  $y = 4$ :  $3^2 + 2(3)(4) + 4^2 = 9 + 24 + 16 = 49$ . This is the perfect square trinomial pattern:  $x^2 + 2xy + y^2 = (x + y)^2 = (3 + 4)^2 = 49$ .

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

47. **B** — 100 pounds. Apply the law of the lever:  $\text{Effort} \times \text{Effort Arm} = \text{Load} \times \text{Load Arm}$ . So  $\text{Effort} \times 6 = 300 \times 2$ , giving  $\text{Effort} = 600 / 6 = 100$  pounds. The mechanical advantage of 3 reduces the required force by a factor of 3.
48. **D** — Counterclockwise at 200 RPM. Meshing gears always rotate in opposite directions. The gear ratio is  $16/48 = 1/3$ , so the larger driven gear rotates at one-third the driver speed:  $600 / 3 = 200$  RPM, in the opposite (counterclockwise) direction.
49. **A** — 1,200 pounds. Calculate the pressure:  $P = F/A = 60/2 = 30$  PSI. Apply this pressure to the output piston:  $F = P \times A = 30 \times 40 = 1,200$  pounds. Hydraulic mechanical advantage equals the ratio of piston areas ( $40/2 = 20 \times$  force multiplier).
50. **C** — 300 pounds. The mechanical advantage of a block-and-tackle equals the number of rope segments supporting the load:  $MA = 3$ . Force required =  $\text{Load} / MA = 900 / 3 = 300$  pounds. Each rope segment shares an equal portion of the load.
51. **B** — 16 feet per second. Apply the continuity equation:  $A_1V_1 = A_2V_2$ , so  $20 \times 4 = 5 \times V_2$ , giving  $V_2 = 16$  feet per second. Fluid speeds up when pipe area decreases because the same volume must pass through the smaller cross-section.
52. **A** — 8. Mechanical advantage of a wheel-and-axle =  $\text{Wheel Radius} / \text{Axle Radius} = 16 / 2 = 8$ . 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** — Pressure is transmitted equally in all directions. 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. **D** — 900 RPM. Driven RPM = (Driver Diameter / Driven Diameter) × Driver RPM = (4/8) × 1,800 = 0.5 × 1,800 = 900 RPM. A larger driven pulley turns more slowly than a smaller driver by the same ratio as their diameters.
55. **A** — 5. Mechanical advantage of a wedge = Length / Thickness = 10 / 2 = 5. Long, thin wedges have higher mechanical advantage than short, thick wedges and require less driving force to split material.
56. **B** — Throttling and partial flow control. Globe valves use a movable disk against a stationary seat that can be set to any partial opening reliably, making them the standard choice for throttling. The S-shaped flow path produces high pressure drop but excellent flow control.
57. **D** — 400 PSI. Apply Boyle's law:  $P_1V_1 = P_2V_2$ , so  $100 \times 8 = P_2 \times 2$ , giving  $800 = 2P_2$  and  $P_2 = 400$  PSI. Compressing a gas to one-quarter of its original volume quadruples its pressure at constant temperature.
58. **C** — 4. Mechanical advantage of a ramp = Length / Height = 24 / 6 = 4. A long, gradual ramp produces high mechanical advantage; a short, steep ramp produces low mechanical advantage.
59. **A** — Meshing gears rotate in opposite directions; belt drives rotate in the same direction. This direction-of-rotation difference is one of the most reliably testable principles distinguishing the two power transmission methods. Crossed belts can produce opposite rotation but are uncommon.
60. **D** — The height of the column and the fluid density. Hydrostatic pressure at any depth equals density × gravity × height. The width of the column, container shape, and fluid temperature have no direct effect on the hydrostatic pressure produced.
61. **B** — 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. **A** — 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. **C** — 34.6 PSI. Use the conversion 1 foot of water ≈ 0.433 PSI. Multiply  $80 \times 0.433 = 34.64$  PSI ≈ 34.6 PSI. The hydrostatic pressure depends on the height of the column, not on the volume or shape of the container.
64. **B** — The other object exerts an equal and opposite force back. This is the precise statement of Newton's third law of motion. The law explains reaction forces throughout plant equipment, from pump discharge forces to structural load distribution.
65. **D** — Open automatically when system pressure exceeds the setpoint. Pressure relief valves are safety devices that release fluid to prevent overpressure damage when system pressure exceeds the preset setpoint. Their reliable operation is critical to the safety of every pressurized plant system.

66. **A** — 200 RPM. The gear ratio is  $60/30 = 2$ , meaning the driven gear rotates at twice the speed of the driver. So  $100 \times 2 = 200$  RPM. The driven gear with fewer teeth always rotates faster than the driver gear.
67. **C** — The input must move a greater distance than the output. Every simple machine obeys the principle that force  $\times$  distance is conserved. To gain force, you must accept the trade-off of greater input distance. Mechanical advantage never produces free energy.
68. **B** — 240 pounds. Mechanical advantage of the ramp =  $12 / 4 = 3$ . Required force = Load / MA =  $720 / 3 = 240$  pounds. The ramp reduces the required force by a factor equal to its mechanical advantage.
69. **A** — Fusion. The energy absorbed during melting (or released during freezing) without temperature change is the latent heat of fusion. This is the phase-change energy for the solid-liquid transition.
70. **C** — Produce maximum pressure but zero flow, with the trapped fluid heating rapidly. When a centrifugal pump runs against a closed valve, it produces shutoff head pressure but zero flow. The impeller continues adding energy to the trapped fluid, causing rapid temperature rise that can damage seals.
71. **B** — Increases as the normal force pressing them together increases. Friction is directly proportional to the normal force pressing the surfaces together — a heavier object on the same surface experiences more friction than a lighter one.
72. **D** — 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. **A** — The driven gear rotates slower but produces more torque. When the driven gear has more teeth than the driver, the gear ratio is greater than 1 and the driven gear rotates slower while producing more torque. Speed and torque are inversely related in any gear system.
74. **D** — The pipe expands in length and must be supported with 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. **C** — Inertia (Newton's first law). Inertia is the property of matter that causes an object at rest to remain at rest and an object in motion to remain in motion at constant velocity unless acted on by an external force.
76. **B** — 10. Mechanical advantage = Output Force / Input Force =  $250 / 25 = 10$ . The lever multiplies the input force by a factor of 10, with a corresponding cost in distance.

77. **A** — Support axial loads on the shaft (along its length). Thrust bearings are specifically designed to support loads along the axis of the shaft, distinguishing them from radial bearings that support loads perpendicular to the shaft. Both types are common in plant rotating equipment.
78. **D** — The force is transmitted through pressure across a much larger output piston area. Hydraulic systems multiply force by applying pressure (force per unit area) generated at a small piston to a much larger output piston. The same pressure across a larger area produces a larger force.
79. **C** — The fluid slows down. By the continuity equation, when pipe area increases at a constant flow rate, the fluid velocity must decrease proportionally. The same volume passes through the larger cross-section in the same time, so velocity drops.
80. **B** — The trapezoidal cross-section creates a wedging action that increases friction and grip. The V-shape wedges into matching pulley grooves, creating significantly more friction and contact force than a flat belt could produce on a flat pulley face.
81. **D** — Radiation. Heat transfer through electromagnetic waves, requiring no physical medium, is radiation. Conduction requires direct contact, and convection requires a moving fluid medium.
82. **C** — 150 RPM. Driven sprocket RPM = (Driver Teeth / Driven Teeth) × Driver RPM = (25/75) × 450 = (1/3) × 450 = 150 RPM. Larger sprockets rotate more slowly than smaller ones connected by the same chain.
83. **A** — The result of 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. **D** — Some misalignment between the shafts is expected. Flexible couplings tolerate small shaft misalignments without damaging bearings or transmitting harmful vibrations. Rigid couplings require precise alignment but transmit motion without flexibility.
85. **B** — Latent heat of fusion. Energy absorbed during melting (solid to liquid) without temperature change is latent heat of fusion. Latent heat of vaporization applies to the liquid-to-gas transition at the boiling point.
86. **A** — 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. **C** — The total fluid volume must be conserved. 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 for the same fluid volume.
88. **D** — 750 RPM. Fan RPM = (Motor Pulley Diameter / Fan Pulley Diameter) × Motor RPM = (5/10) × 1,500 = 0.5 × 1,500 = 750 RPM. A larger driven pulley rotates more slowly than a smaller driver pulley.

89. **B** — Depends on the pressure above the liquid surface. Boiling point varies with pressure: at higher pressures, liquids boil at higher temperatures. This is why high-pressure boilers can heat water to 545°F or higher without flashing into steam.
90. **A** — Increases with longer pipe length, smaller diameter, and higher flow rate. Friction loss in piping increases with these factors plus rougher interior surfaces. These variables determine the pressure drop a pump must overcome to move fluid through the system.

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

91. **A** — Maintain constant turbine speed despite load variations. The opening sentence states this directly: the governor's "primary function is to maintain a constant turbine speed despite variations in steam supply and electrical load."
92. **C** — Slow down because more energy is being drawn from it. The passage states that "when electrical load increases, the turbine tends to slow down because more energy is being drawn from it." This direct statement supports the answer.
93. **B** — Electronic controllers and hydraulic actuators. The passage states that "modern turbines use electronic governors that process speed signals through digital controllers and command hydraulic actuators to position the steam valves with high precision."
94. **D** — Offset or counterbalance. In the context of "the governor responds by opening the steam valves wider, admitting more steam to compensate," the word means to offset the effect of the load increase by providing more steam.
95. **A** — They used rotating weights that responded to speed changes through centrifugal force. The passage states that older mechanical governors used "rotating weights that flew outward as speed increased, mechanically actuating the valve linkage." This is the centrifugal governor principle.
96. **B** — Explain how turbine governors maintain speed control under varying loads. The passage describes the function, mechanism, and types of governors without arguing for changes or comparing alternatives. It is an explanatory description.
97. **C** — Turbines must maintain synchronous speed within tight tolerances. The passage states that "turbines connected to the electrical grid must maintain synchronous speed within tight tolerances to avoid causing voltage and frequency disturbances."
98. **D** — Maintain the integrity of water-bearing systems. The opening sentence states this directly: chemistry programs are "essential for maintaining the integrity of water-bearing systems throughout a power plant."
99. **B** — Corrosion, scaling, and microbial growth. The passage states that "improper water chemistry can cause corrosion, scaling, and microbial growth that damage equipment and reduce efficiency."

100. **C** — pH, conductivity, dissolved oxygen, and ionic concentrations. The passage lists these specific parameters as the ones operators monitor: "pH, conductivity, dissolved oxygen, and various ionic concentrations."
101. **A** — Departures from the target range. In the context of "when a parameter drifts outside the target range," deviations means departures from the established target ranges. This is the operational meaning of deviation in a chemistry context.
102. **D** — They often indicate developing equipment problems. The passage states that "recurring chemistry deviations often indicate developing problems with treatment equipment that should be investigated before they cause plant-wide impacts."
103. **B** — Informative and authoritative. The passage describes the chemistry program in a neutral, prescriptive manner using language like "must take immediate corrective action," characteristic of authoritative operational documentation.
104. **C** — Adjusting chemical injection rates or initiating treatment changes. The passage states that corrective actions "may include adjusting chemical injection rates, increasing or decreasing blowdown, switching ion exchange beds, or initiating other treatment process changes."
105. **D** — Prevent insulation degradation and maintain efficient operation. The passage states that heat "must be removed continuously to prevent the transformer insulation from degrading and to maintain efficient operation."
106. **A** — Oil immersion combined with external radiators. The passage states that "the most common cooling method for large transformers is oil immersion combined with external radiators or coolers."
107. **B** — Naturally rises through convection and flows into external radiator tubes. The passage states that "the heated oil naturally rises through convection and flows into external radiator tubes, where the heat is dissipated to ambient air."
108. **C** — Added to or enhanced. In the context of "the cooling system is supplemented by forced-oil pumps," the word means added to or enhanced beyond the basic cooling provided by natural convection.
109. **D** — The cooling stages activate progressively based on load and temperature. The passage states that "the progression of cooling stages... is automatically controlled based on transformer load and oil temperature."
110. **B** — Describe how large transformers are cooled and protected from overheating. The passage describes the cooling mechanism and protection without arguing or comparing costs. It is a descriptive overview.

111. **A** — The transformer's protective relays will reduce its load or trip it offline. The passage states explicitly that "if cooling becomes inadequate, the transformer's protective relays will reduce its load or trip it offline to prevent thermal damage."
112. **C** — Monitor the motor and disconnect it from power if abnormal conditions are detected. The opening sentence states this: protection relays "monitor the electrical and operating conditions of large electric motors and automatically disconnect the motor from its power supply if abnormal conditions are detected."
113. **D** — Current exceeds the rated value for too long. The passage states that "overload protection... trips the motor if current exceeds the rated value for too long." Time-duration matters as much as current magnitude in overload protection.
114. **B** — Detect the loss of one phase in a three-phase supply. The passage states that "phase loss protection... detects the loss of one phase in a three-phase supply and trips the motor before damage occurs."
115. **A** — Disconnecting and separating. In the context of "isolating the motor from the supply" by opening the circuit breaker, the word means physically disconnecting and separating from the power source.
116. **D** — They integrate multiple protection functions into a single device. The passage states that modern relays "integrate all of these protection functions into a single unit, with extensive monitoring, logging, and communication capabilities."
117. **C** — Informative and authoritative. The passage describes protection relay functions in a neutral, factual manner using technical operational language, characteristic of training documentation.
118. **C** — It ensures faults are cleared by the closest device. The passage states that "proper coordination between motor protection relays and upstream protective devices ensures that faults are cleared by the closest device, minimizing the impact on other equipment."
119. **A** — Water spray or foam systems. The passage states that areas containing flammable liquids "are typically protected by water spray or foam systems that smother the fire while cooling the surrounding equipment."
120. **D** — Clean agent gaseous systems or dry chemical extinguishers. The passage states that electrical equipment areas "often use clean agent gaseous systems or dry chemical extinguishers that suppress fires without leaving conductive residues."
121. **B** — They suppress fires without leaving conductive residues. The passage states that clean agent systems are preferred because they "suppress fires without leaving conductive residues that could damage electrical components."

122. **A** — Cover and cut off oxygen. In the context of foam systems that "smother the fire," the word means to cover and cut off the oxygen supply, which is one of the three elements required for combustion.
123. **C** — They employ multiple complementary fire control measures. The passage states that coal handling areas "employ a combination of water deluge systems, dust collection equipment, and continuous monitoring." This combination represents multiple complementary measures.
124. **B** — Describe the variety of fire suppression approaches used throughout a power plant. The passage describes different fire suppression methods for different plant areas in a descriptive manner without arguing or critiquing.
125. **D** — Evacuate the area and notify the fire department. The passage states that personnel "are also instructed to evacuate the area and notify the fire department for any fire that exceeds the capability of immediate handheld response."
126. **A** — Fire prevention through good housekeeping and proper material storage. The passage states that "fire prevention through good housekeeping, proper storage of flammable materials, and prompt repair of oil leaks remains the most effective overall defense against plant fires."

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

127. **D** — All four corners marked again. The pattern adds a corner mark each frame, going clockwise: 1, 2, 3, 4 marks. After all four corners are marked in Frame 4, Frame 5 starts a new cycle with all four corners marked again (or returns to the completed state).
128. **A** — Pentagon inside pentagon. The pattern shows shapes nested inside themselves: circle in circle, triangle in triangle, square in square. Frame 5 continues by adding a side: pentagon inside pentagon.
129. **C** — At 12. The minute hand advances  $90^\circ$  clockwise per frame, completing one full  $360^\circ$  rotation in four frames. After four frames the hand returns to 12, completing the cycle.
130. **B** — Black diamond rotated  $180^\circ$ . The pattern combines two transformations: progressive darkening (white  $\rightarrow$  gray  $\rightarrow$  dark gray  $\rightarrow$  nearly black  $\rightarrow$  black) and rotation by  $45^\circ$  per frame ( $0^\circ \rightarrow 45^\circ \rightarrow 90^\circ \rightarrow 135^\circ \rightarrow 180^\circ$ ). Frame 5 reaches fully black at  $180^\circ$  rotation, which appears as a diamond.
131. **A** — 9 dots. The grid follows a "diagonal addition" rule where each cell contains 2 more dots than the cell above and to the left of it. The bottom-right cell completes the pattern at 9 dots.
132. **B** — Three concentric squares. The transformation in the top row is "single shape becomes three concentric versions of the same shape." Applying this to the bottom row, the single square becomes three concentric squares.

133. **D** — West. The arrow rotates  $60^\circ$  clockwise per frame: east, southeast, south, southwest, then west. Each successive frame adds another  $60^\circ$  of clockwise rotation.
134. **A** — A large triangle. The grid pattern shows triangles of increasing size from top to bottom. The bottom row contains large triangles, so the missing third cell must also be a large triangle.
135. **C** — 10 segments. The pattern adds 2 segments per frame: 2, 4, 6, 8, then 10. The arithmetic progression of +2 per frame makes Frame 5 contain 10 equal segments.
136. **D** — Oval with checkmark. The transformation in the top row is "empty becomes checkmarked." Applying this same transformation to the bottom row, the empty oval becomes an oval with a checkmark.
137. **A** — 4 internal lines. The pattern adds one internal line per frame: 0, 1, 2, 3, then 4. Each successive frame adds exactly one more line inside the triangle, making the addition rule consistent.
138. **C** — A fully filled circle. The grid shows progressive filling from top to bottom (empty  $\rightarrow$  half-filled  $\rightarrow$  fully filled). The bottom row contains fully filled circles, so the missing third cell must also be a fully filled circle.
139. **B** — Two parallel vertical lines. The transformation in the top row is "one becomes two parallel lines of the same orientation." Applying this same transformation to the bottom row, the single vertical line becomes two parallel vertical lines.
140. **D** — 8 points. The pattern adds one point per frame: 4, 5, 6, 7, then 8. Each successive frame contains one more point than the previous frame.
141. **B** — Large white circle. The transformation in the top row is "small to large" (size change). The transformation in the left column is "filled to empty white" (color change). Combining both, the bottom-right must be a large white circle.
142. **D** — A filled hexagon. The pattern alternates filled and empty hexagons: filled, empty, filled, empty, then filled. Frame 5 follows the alternation by returning to filled.
143. **B** — A large pentagon. The pattern within each row shows the same shape with increasing size from left to right (small, medium, large). The bottom row continues the progression with a large pentagon as the third element.
144. **C** — Nothing (zero corners). The pattern reduces the corner count by one per frame: 4, 3, 2, 1, then 0. Frame 5 logically has zero corners, meaning the figure has fully reduced to nothing.
145. **A** — Left-pointing arrow. The pattern in the top row rotates  $90^\circ$  clockwise (right becomes down). Applying the same rotation to the bottom row, up becomes left. The bottom-right is a left-pointing arrow.
146. **C** — At 4. The hour hand advances  $30^\circ$  clockwise per frame, which corresponds to one hour position on the clock face. Starting at 12 (Frame 1), then 1, 2, 3, the hand reaches 4 in Frame 5.