

**Registration form**

**PUMPS 303 \$250.00**  
**48 HOUR RUSH ORDER PROCESSING FEE ADDITIONAL \$50.00**

**Start and Finish Dates:** \_\_\_\_\_  
*You will have 90 days from this date in order to complete this course*

**Name** \_\_\_\_\_ **Signature** \_\_\_\_\_  
*I have read and understood the disclaimer notice on page 2. Digitally sign XXX*

**Address** \_\_\_\_\_

**City** \_\_\_\_\_ **State** \_\_\_\_\_ **Zip** \_\_\_\_\_

**Email** \_\_\_\_\_ **Fax (\_\_\_\_\_)** \_\_\_\_\_

**Phone:**  
**Home (\_\_\_\_\_)** \_\_\_\_\_ **Work (\_\_\_\_\_)** \_\_\_\_\_

**Operator ID #** \_\_\_\_\_ **Exp. Date** \_\_\_\_\_

**Class/Grade** \_\_\_\_\_

**Please circle/check which certification you are applying the course CEU's.**  
Water Treatment \_\_\_ Water Distribution \_\_\_ Other \_\_\_\_\_

Collections \_\_\_ Wastewater Treatment \_\_\_ Onsite Installer \_\_\_\_\_

**Technical Learning College TLC PO Box 3060, Chino Valley, AZ 86323**  
**Toll Free (866) 557-1746 Fax (928) 272-0747 [info@tlch2o.com](mailto:info@tlch2o.com)**

**If you've paid on the Internet, please write your Customer#** \_\_\_\_\_

**Please invoice me, my PO#** \_\_\_\_\_

***We'll stop mailing the certificate of completion we need your e-mail address. We will e-mail the certificate to you, if no e-mail address; we will mail it to you.***

## **DISCLAIMER NOTICE**

I understand that it is my responsibility to ensure that this CEU course is either approved or accepted in my State for CEU credit. I understand State laws and rules change on a frequent basis and I believe this course is currently accepted in my State for CEU or contact hour credit, if it is not, I will not hold Technical Learning College responsible. I fully understand that this type of study program deals with dangerous, changing conditions and various laws and that I will not hold Technical Learning College, Technical Learning Consultants, Inc. (TLC) liable in any fashion for any errors, omissions, advice, suggestions or neglect contained in this CEU education training course or for any violation or injury, death, neglect, damage or loss of your license or certification caused in any fashion by this CEU education training or course material suggestion or error or my lack of submitting paperwork. It is my responsibility to call or contact TLC if I need help or assistance and double-check to ensure my registration page and assignment has been received and graded. It is my responsibility to ensure all information is correct and to abide with all rules and regulations.

**State Approval Listing Link**, check to see if your State accepts or has pre-approved this course. Not all States are listed. Not all courses are listed. If the course is not accepted for CEU credit, we will give you the course free if you ask your State to accept it for credit.

**Professional Engineers:** Most states will accept our courses for credit but we do not officially list the States or Agencies. Please check your State for approval.

## **State Approval Listing URL...**

<http://www.ABCTLC.com/downloads/PDF/CEU%20State%20Approvals.pdf>

*You can obtain a printed version of the course manual from TLC for an additional \$129.95 plus shipping charges.*

## **AFFIDAVIT OF EXAM COMPLETION**

I affirm that I personally completed the entire text of the course. I also affirm that I completed the exam without assistance from any outside source. I understand that it is my responsibility to file or maintain my certificate of completion as required by the state or by the designation organization.

## **Grading Information**

In order to maintain the integrity of our courses we do not distribute test scores, percentages or questions missed. Our exams are based upon pass/fail criteria with the benchmark for successful completion set at 70%. Once you pass the exam, your record will reflect a successful completion and a certificate will be issued to you.

For security purposes, please fax or e-mail a copy of your driver's license and always call us to confirm we've received your assignment and to confirm your identity.

No refunds.

**Pumps 303 Answer Key** Name \_\_\_\_\_

Phone \_\_\_\_\_

**You are solely responsible to ensure this course is accepted for credit by your State. Did you check with your State agency to ensure this course is accepted for credit?**

**Method of Course acceptance confirmation. Please fill this section  
No refunds**

Website \_\_ Telephone Call\_\_ Email\_\_ Spoke to \_\_\_\_\_

Did you receive the approval number, if applicable? \_\_\_\_\_

What is the course approval number, if applicable? \_\_\_\_\_

**You are responsible to ensure that TLC receives the Assignment and Registration Key. Please call us to ensure that we received it.**

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**Amount of Time for Course Completion – How many hours you spent on course?**

**Must match State Hour Requirement \_\_\_\_\_ (Hours)**

*I understand that I am 100 percent responsible to ensure that TLC receives the Assignment and Registration Key and that it is accepted for credit by my State or Providence. I understand that TLC has a zero tolerance towards not following their rules, cheating or hostility towards staff or instructors. I need to complete the entire assignment for credit. There is no credit for partial assignment completion. My exam was proctored. I will contact TLC if I do not hear back from them within 2 days of assignment submission. I will forfeit my purchase costs and will not receive credit or a refund if I do not abide with TLC's rules.*

**Please Sign that you understand and will abide with TLC's Rules.**

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**Signature**

***Please write down any questions you were not able to find the answers or that have errors.***





*Please e-mail or fax this survey along with your final exam*

**PUMPS 303 CEU COURSE  
CUSTOMER SERVICE RESPONSE CARD**

NAME: \_\_\_\_\_

E-MAIL \_\_\_\_\_ PHONE \_\_\_\_\_

**PLEASE COMPLETE THIS FORM BY CIRCLING THE NUMBER OF THE APPROPRIATE ANSWER IN THE AREA BELOW.**

1. Please rate the difficulty of your course.

Very Easy 0 1 2 3 4 5 Very Difficult

2. Please rate the difficulty of the testing process.

Very Easy 0 1 2 3 4 5 Very Difficult

3. Please rate the subject matter on the exam to your actual field or work.

Very Similar 0 1 2 3 4 5 Very Different

4. How did you hear about this Course? \_\_\_\_\_

5. What would you do to improve the Course?

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How about the price of the course?

Poor\_\_\_\_ Fair \_\_\_\_ Average \_\_\_\_ Good\_\_\_\_ Great\_\_\_\_

How was your customer service?

Poor\_\_ Fair \_\_\_\_ Average \_\_\_\_ Good \_\_\_\_ Great\_\_\_\_

Any other concerns or comments.

\_\_\_\_\_  
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Please fax the answer key to  
**TLC Western Campus**  
**Fax (928) 272-0747**

You are responsible to ensure that TLC receives the Assignment and Registration Key.

Always call us after faxing the paperwork to ensure that we've received it.

**Rush Grading Service**

If you need this assignment graded and the results mailed to you within a 48-hour period, prepare to pay an additional rush service handling fee of \$50.00.

## Pumps 303 CEU Training Course Assignment

The Pumps 303 CEU course assignment is available in Word on the Internet for your convenience, please visit [www.ABCTLIC.com](http://www.ABCTLIC.com) and download the assignment and e-mail it back to TLC.

You will have 90 days from receipt of this manual to complete it in order to receive your Professional Development Hours (PDHs) or Continuing Education Unit (CEU). A score of 70 % or better is necessary to pass this course. If you should need any assistance, please email or fax all concerns and the completed ANSWER KEY to [info@tlch2o.com](mailto:info@tlch2o.com).

Select one answer per question. Please utilize the answer key. If you see (s) in the answer, this means the answer could be singular or plural.

If you find any error or problem with the question or the answer, please write that concern down and notify us of this issue.

### Physical Science and Laws Section

- Which of the following states that every object in a state of uniform motion tends to remain in that state of motion unless an external force is applied to it?  
A. First law                      C. Law of Thermodynamics  
B. Physical Law                 D. None of the above
- Which of the following t can also be described intuitively as a push or a pull?  
A. Force                            C. Drag  
B. Pull                              D. None of the above
- Which of the following is both a property of a physical body and a measure of its resistance to acceleration when a net force is applied?  
A. Gravity                         C. Inertia  
B. Mass                             D. None of the above
- Which of the following is any interaction that, when unopposed, will change the motion of an object?  
A. Force                            C. Push  
B. Drag                              D. None of the above
- Which of the following is the force that attracts a body toward the center of the earth, or toward any other physical body having mass?  
A. Gravity                         C. Inertia  
B. Mass                             D. None of the above
- Which of the following is the resistance of any physical object to any change in its state of motion?  
A. Gravity                         C. Inertia  
B. Mass                             D. None of the above
- Which of the following represents an increase in the speed of a fluid occurs simultaneously with a decrease in pressure or a decrease in the fluid's potential energy?  
A. Pascal's Law                 C. Bernoulli's Principle  
B. Physical Law                 D. None of the above

8. Which of the following is a theoretical statement inferred from particular facts, applicable to a defined group or class of phenomena, and expressible by the statement that a particular phenomenon always occurs if certain conditions be present?

- A. Newton's Laws
- B. Physical Law
- C. Law of Thermodynamic
- D. None of the above

9. Which of the following is the tendency of objects to keep moving in a straight line at constant velocity?

- A. Force
- B. Inertia
- C. Friction
- D. None of the above

10. Which of the following can cause an object with mass to change its velocity to accelerate?

- A. Force
- B. Pull
- C. Push
- D. None of the above

11. Which of the following determines the strength of its mutual gravitational attraction to other bodies?

- A. Force
- B. Mass
- C. Weight
- D. None of the above

12. Which of the following are three physical laws that, together, laid the foundation for classical mechanics?

- A. Newton's Laws of motion
- B. Physical Laws
- C. Laws of Thermodynamics
- D. None of the above

13. Which of the following describe the relationship between a body and the forces acting upon it, and its motion in response to those forces.

- A. Newton's Laws of motion
- B. Bernoulli's Principle
- C. Laws of Thermodynamics
- D. None of the above

### Physical Science and Related Laws

14. Physical Law Description Physical laws are:

True, at least within their regime of validity. By definition, there have never been repeatable contradicting?

- A. Time
- B. Space and time
- C. Observations
- D. None of the above

15. Which of the following represents unchanged since first discovered although they may have been shown to be approximations of more accurate laws?

- A. Stable
- B. Absolute
- C. Space and time
- D. None of the above

16. Which of the following represents everything in the universe apparently must comply with them according to observations?

- A. Stable
- B. Universal
- C. Omnipotent
- D. None of the above

17. Which of the following represents that this appears to apply everywhere in the universe?

- A. Stable
- B. Universal
- C. Space and time
- D. None of the above



28. Which of the following terms is the resistance of any physical object to any change in its state of motion?

- A. Pressure
- B. Inertia
- C. Torque
- D. None of the above

29. Which of the following is both a property of a physical body and a measure of its resistance to acceleration when a net force is applied?

- A. Gravity
- B. Fundamental interactions
- C. Mass
- D. None of the above

30. There are four conventionally accepted fundamental interactions—gravitational, electromagnetic, strong nuclear, and weak nuclear.

- A. True
- B. False

### **Pascal's Law**

31. Pascal discovered that pressure in a fluid acts equally in some directions.

- A. True
- B. False

32. Pressure due to the \_\_\_\_\_, at any level, depends on the depth of the fluid from the surface.

- A. Weight of a liquid
- B. Liquid at a specific depth
- C. Height of a liquid
- D. None of the above

33. If the exposed face of the pressure gauges are moved closer to the surface of the liquid, the indicated?

- A. Pressure will be less
- B. Pressure of a liquid
- C. Is equal
- D. None of the above

34. The indicated pressure is doubled, when the?

- A. Depth is doubled
- B. Pressure of a liquid
- C. Column is tripled
- D. None of the above

35. The pressure at any depth in that the \_\_\_\_\_ of the column of liquid at that depth divided by the cross-sectional area of the column at that depth.

- A. Depth is doubled
- B. Pressure of a liquid
- C. Liquid is equal to the weight
- D. None of the above

36. Which of the following produces the pressure is referred to as the fluid head of the liquid?

- A. Depth is doubled
- B. Pressure of a liquid
- C. Volume of a liquid
- D. None of the above

37. Which of the following is due to its fluid head is also dependent on the density of the liquid?

- A. Pressure will be less
- B. Pressure of a liquid
- C. Is equal
- D. None of the above

### **Static Pressure**

38. Static pressure exists in addition to Gravity that may also be present at the same time.

- A. True
- B. False

39. Pascal's law states that a pressure set up in a fluid acts equally in all directions and at right angles to the containing surfaces.

- A. True      B. False

40. When velocity becomes a factor it must have a direction, the force related to the velocity must also have a direction, so that Pascal's law alone does not apply to the dynamic factors of?

- A. Pressure drop      C. Fluid power  
B. Volume of a liquid      D. None of the above

### **Volume and Velocity of Flow**

41. Which of the following is passing a point in a given time is known as its volume of flow or flow rate?

- A. Friction head      C. Volume of flow  
B. Volume of a liquid      D. None of the above

42. Which of the following is usually expressed in gallons per minute (gpm) and is associated with relative pressures of the liquid, such as 5 gpm at 40 psi?

- A. Velocity of flow      C. Volume of flow  
B. Volume of a liquid      D. None of the above

43. Which of the following flow terms is defined as the average speed at which the fluid moves past a given point. It is usually expressed in feet per second (fps) or feet per minute (fpm).

- A. Velocity of flow      C. Volume of flow  
B. Volume of a liquid      D. None of the above

44. Volume and friction head are often considered together, that is, with volume of input unchanged—the velocity of flow increases as the cross section or size of the pipe decreases.

- A. True      B. False

### **Fluid Mechanics and Hydraulic Principles Section**

45. Which of the following definitions is often used to indicate gauge pressure?

- A. Head, Friction      C. Hydraulics  
B. Head      D. None of the above

46. Which of the following definitions is the pressure applied to a confined fluid at rest is transmitted with equal intensity throughout the fluid?

- A. Pressure      C. Pascal's Law  
B. Hydraulics      D. None of the above

47. Which of the following definitions is the force per unit area, usually expressed in pounds per square inch?

- A. Pressure      C. Pascal's Law  
B. Hydraulics      D. None of the above

48. Which of the following definitions is the pressure differential above or below ambient atmospheric pressure?

- A. Pressure, Atmospheric      C. Pressure, Gauge  
B. Pressure, Static      D. None of the above

49. Which of the following definitions is height of a column or body of fluid above a given point expressed in linear units?

- A. Head, Friction
- B. Head
- C. Hydraulics
- D. None of the above

50. Which of the following definitions is required to overcome the friction at the interior surface of a conductor and between fluid particles in motion?

- A. Head, Friction
- B. Head, static
- C. Hydraulics
- D. None of the above

51. Which of the following definitions varies with flow, size, type, and conditions of conductors and fittings, and the fluid characteristics?

- A. Head, Friction
- B. Head, static
- C. Hydraulics
- D. None of the above

52. Which of the following definitions is the pressure in a fluid at rest?

- A. Pressure, Atmospheric
- B. Pressure, Static
- C. Pressure, Gauge
- D. None of the above

53. Which of the following definitions is the height of a column or body of fluid above a given point?

- A. Head, Friction
- B. Head, static
- C. Hydraulics
- D. None of the above

54. Which of the following definitions is the pressure exported by the atmosphere at any specific location?

- A. Pressure, Atmospheric
- B. Pressure, Static
- C. Pressure, Gauge
- D. None of the above

55. Which of the following definitions is pressure above zero absolute, i.e. the sum of atmospheric and gauge pressure?

- A. Pressure, Absolute
- B. Pressure
- C. Pressure, Gauge
- D. None of the above

56. Sea level pressure is approximately 2.31 pounds per square inch absolute, 1 bar = .433psi.

- A. True
- B. False

### Hydraulics

57. Which of the following includes the behavior of all liquids, although it is primarily concerned with the motion of liquids?

- A. Fluids
- B. Hydrostatics
- C. Hydraulics
- D. None of the above

58. Hydrostatics is based on the Greek word for water, and originally covered the study of the physical behavior of water at rest and in motion.

- A. True
- B. False

59. Hydraulics is a branch of engineering concerned mainly with moving liquids.

- A. True
- B. False



60. Which of the following includes the consideration of liquids at rest, involves problems of buoyancy and flotation?
- A. Hydrokinetics                      C. Hydraulics  
 B. Hydrostatics                        D. None of the above
61. Hydraulics is applied commonly to the study of the \_\_\_\_\_, other liquids, and even gases when the effects of compressibility are small.
- A. Fluids                                C. Mechanical properties of water  
 B. Hydrokinetics                        D. None of the above
62. Hydraulics can be divided into two areas, \_\_\_\_\_ and hydrokinetics.
- A. Hydrokinetics                        C. Hydraulics  
 B. Hydrostatics                        D. None of the above
63. Which of the following includes the manner in which liquids act in tanks and pipes, deals with their properties, and explores ways to take advantage of these properties.
- A. Hydrokinetics                        C. Hydraulics  
 B. Hydrostatics                        D. None of the above
64. Which of the following terms includes the study of liquids in motion, is concerned with such matters as friction and turbulence generated in pipes by flowing liquids?
- A. Pressure                              C. Hydraulics  
 B. Hydrokinetics                        D. None of the above
65. Which of the following terms is about the pressures exerted by a fluid at rest?
- A. Pressure                              C. Hydraulics  
 B. Hydrostatics                        D. None of the above

**Properties of Fluids**

66. There are a few liquids, known as liquid crystals, in which the molecules are packed together in such a way as to make the properties of the medium locally anisotropic, but the vast majority of fluids - including air and water- are \_\_\_\_\_.
- A. Isotropic                              C. Composed of discrete molecules  
 B. Anisotropic                        D. None of the above
67. Fluids are \_\_\_\_\_ in the way that all the successors of Euler and Bernoulli have assumed, for fluids are composed of discrete molecules.
- A. Forces                                C. Not strictly continuous media  
 B. Its velocity                        D. None of the above

**Isotropic Fluid or Newtonian Fluid**

68. If the fluid is also \_\_\_\_\_, the viscosity tensor reduces to two real coefficients, describing the fluid's resistance to continuous shear deformation and continuous compression or expansion, respectively.
- A. Isotropic                              C. Composed of discrete molecules  
 B. Azeotropic                        D. None of the above

### Fluid Statics

69. Fluid statics or hydrostatics is the branch of fluid mechanics that studies \_\_\_\_\_. It embraces the study of the conditions under which fluids are at rest in stable equilibrium; and is contrasted with fluid dynamics, the study of fluids in motion.

- A. Forces
- B. Its velocity
- C. Fluids at rest
- D. None of the above

70. Hydrostatics is fundamental to hydraulics, the engineering of equipment for storing, transporting and using fluids. It is also relevant to some aspect of geophysics and astrophysics (i.e., in understanding plate tectonics and \_\_\_\_\_), to meteorology, to medicine (with the context of blood pressure), and many other fields.

- A. Forces
- B. Its velocity
- C. Anomalies in the Earth's gravitational field
- D. None of the above

### Fluid Dynamics

71. The solution to a fluid dynamics problem typically involves calculating various properties of the fluid, such as velocity, pressure, density, and temperature, as functions of space and time.

- A. True
- B. False

72. Fluid dynamics has several sub-disciplines itself, including aerodynamics (the study of air and other gases in motion) and hydrodynamics (the study of liquids in motion).

- A. True
- B. False

73. Fluid dynamics offers a systematic structure—which underlies these practical disciplines—that embraces empirical and semi-empirical laws derived from flow measurement and used to solve practical problems.

- A. True
- B. False

74. Fluid dynamics has a wide range of applications, including calculating forces and moments on aircraft, determining the mass flow rate of petroleum through pipelines, predicting evolving weather patterns, even understanding nebulae in interstellar space and modeling explosions.

- A. True
- B. False

### Gases and Liquids

75. A word is needed about the \_\_\_\_\_, though the difference is easier to perceive than to describe.

- A. Volume available
- B. Volume of a liquid
- C. Difference between gases and liquids
- D. None of the above

76. In gases, the molecules are sufficiently far apart to move almost independently of one another, and gases tend to expand to fill \_\_\_\_\_.

- A. Volume available
- B. Any volume available to them
- C. Settle down into the ordered arrays
- D. None of the above

77. In liquids, the molecules are more or less in contact, and the \_\_\_\_\_ between them make them cohere; the molecules are moving too fast to settle down into the ordered arrays that are characteristic of solids, but not so fast that they can fly apart.

- A. Volume available
- B. Volume of a liquid
- C. Short-range attractive forces
- D. None of the above

78. Samples of liquid can exist as drops or as jets with free surfaces, or they can sit in beakers constrained only by \_\_\_\_\_, in a way that samples of gas cannot.
- A. Volume
  - B. Gravity
  - C. Ordered arrays
  - D. None of the above

### Solids

79. Solids can be stretched without breaking, and liquids, though not gases, can withstand stretching, too. Therefore, if the pressure is steadily reduced in a specimen of very pure water, bubbles will ultimately appear, but they may not do so until the pressure is negative and well below  $-10^7$  newton per square meter; this is 100 times greater in magnitude than the (positive) pressure exerted by the Earth's atmosphere.
- A. True
  - B. False

80. Water owes its strength is extremely reduced by anything that provides a nucleus at which the process known as cavitation can begin, and a liquid containing suspended \_\_\_\_\_ or dissolved gases is liable to cavitate quite easily.
- A. Surface tension
  - B. Liquid surface
  - C. Dust particles
  - D. None of the above

### Surface Tension

81. Work also must be done if a free liquid drop of spherical shape is to be drawn out into a long thin cylinder or deformed in any other way that increases its surface area. Here again work is needed to break \_\_\_\_\_.

- A. Intermolecular links
- B. Liquid surface
- C. Dissolved gases
- D. None of the above

82. The \_\_\_\_\_ behaves as if it were an elastic membrane under tension, except that the tension exerted by an elastic membrane increases when the membrane is stretched in a way that the tension exerted by a liquid surface does not.

- A. Surface tension
- B. Surface of a liquid
- C. Dissolved gases
- D. None of the above

83. Surface tension is what causes liquids to rise up capillary tubes, what supports hanging \_\_\_\_\_, what limits the formation of ripples on the surface of liquids, and so on.

- A. Surface tension
- B. Liquid surface
- C. Liquid drops
- D. None of the above

### Several Types of Friction

84. Which type of friction is a case of fluid friction where a lubricant fluid separates two solid surfaces?

- A. Dry
- B. Fluid
- C. Lubricated
- D. None of the above

85. Which type of friction is the force resisting motion between the elements making up a solid material while it undergoes deformation?

- A. Dry
- B. Fluid
- C. Internal
- D. None of the above

86. Which type of friction resists relative lateral motion of two solid surfaces in contact?

- A. Dry      C. Lubricated
- B. Fluid     D. None of the above

87. Which type of friction describes the friction between layers of a viscous fluid that are moving relative to each other?

- A. Dry      C. Lubricated
- B. Fluid     D. None of the above

**Water and Electrical Principles are Very Similar**

88. The electronic–hydraulic analogy is the most widely used analogy for "Hydraulic fluid" in a metal conductor.

- A. True      B. False

89. Electricity was understood to be a kind of energy, and the names of certain electric quantities are derived from heating equivalents.

- A. True      B. False

90. Since electric current is invisible and the processes at play in electronics are often difficult to demonstrate, the various electronic components are represented by?

- A. Volts                                      C. Hydraulic equivalents
- B. Hydraulic ohm analogy     D. None of the above

**Basic Ideas**

91. Flow and pressure variables can be calculated in fluid flow network with the use of the?

- A. Electron fluids      C. Hydraulic ohm analogy
- B. Pressures             D. None of the above

**Component Equivalents**

92. Connecting one end of a wire to a circuit is equivalent to forcibly un-capping one end of the pipe and attaching it to another pipe.

- A. True      B. False

93. When comparing to a piece of wire, a water pipe should be thought of as having semi-permanent caps on the ends.

- A. True      B. False

94. Memristor is a needle valve operated by a flow meter.

- A. True      B. False

95. A capacitor cannot "filter out" constant pressure differences frequency pressure differences.

- A. True      B. False

96. A resistor is considered a constriction in the bore of the pipe that requires less pressure to pass the same amount of water.

- A. True      B. False

97. Voltage is the difference in pressure between two points, usually measured in volts.

- A. True      B. False

98. A diode is equivalent to a two-way check valve with a tight valve seal.

- A. True      B. False

99. A wire with only one end attached to a circuit will do nothing; the pipe remains capped on the free end, and?

- A. Voltage in a capacitor      C. Adds nothing to the circuit  
B. Force of gravity      D. None of the above

## **Fluid/Hydraulic Forces & Pressures Section**

### **Atmospheric Pressure**

100. The atmosphere is the entire mass of air that surrounds the earth.

- A. True      B. False

101. Which of the following is the layer called that extends upward for about 500 miles, the section of primary interest is the portion that rests on the earth's surface and extends upward for about 7 1/2 miles.

- A. Troposphere      C. Atmospheric pressure  
B. Sea level      D. None of the above

102. If a column of air 1-inch square extending all the way to the "atmosphere", this column of air would weigh approximately 2.31 pounds at sea level.

- A. True      B. False

103. Pressures under water differ from those under air only because the weight of the water must be added to the?

- A. Pressure(s) of the air      C. Seal Level  
B. Height      D. None of the above

104. Which of the following can be measured by any of several methods, one method is the mercury column barometer?

- A. Pressure      C. Atmospheric pressure  
B. Gauge pressure      D. None of the above

105. Which of the following could be measured with the aneroid Barometer?

- A. Pressure      C. Atmospheric pressure  
B. Gauge pressure      D. None of the above

106. The atmospheric pressure does not vary uniformly with?

- A. Barometric pressure      C. Altitude  
B. Weight      D. None of the above

107. Atmospheric pressure is defined as the force per unit area exerted against a surface by the \_\_\_\_\_ of the air above that surface.

- A. Barometric pressure      C. Altitude  
B. Weight      D. None of the above

108. If you were to ascend, the atmospheric pressure increases by approximately 1.0 psi for every 2,343 feet.

- A. True      B. False

109. At sea level and at a temperature of 0° Celsius (C), the height of the mercury column is approximately 30 inches, or 76 centimeters. This represents a pressure of approximately 14.7 psi.

- A. True      B. False

### **Barometric Loop**

110. According to the text, the barometric loop, will provide protection against backsiphonage, is based upon the principle that a water column, at sea level pressure, will not rise above 33.9 feet. In general, barometric loops are locally fabricated, and are 35 feet high.

- A. True      B. False

111. Gauge pressure is simply the pressure read on the gauge. If there is no pressure on the gauge other than atmospheric, the gauge will read zero.

- A. True      B. False

112. Absolute pressure is equal to gauge pressure plus the atmospheric pressure.

- A. True      B. False

113. The barometric loop consists of a continuous section of supply piping that abruptly rises to a height of approximately 233 feet and then returns back down to the originating level.

- A. True      B. False

114. The barometric loop is a loop in the piping system that effectively protects against backpressure.

- A. True      B. False

115. Absolute pressure and gauge pressure?

- A. Are the same      C. That effectively protects  
B. Are related      D. None of the above

116. Which of the following is the total pressure?

- A. Absolute pressure      C. Atmospheric pressure  
B. Gauge pressure      D. None of the above

117. Which of the following would be equal to 14.7 psi, which is the atmospheric pressure?

- A. Absolute pressure      C. Atmospheric pressure  
B. Gauge pressure      D. None of the above

### **Pressure**

118. Water is incompressible, while air is very compressible.

- A. True      B. False

119. A fluid is a substance that cannot exert any permanent forces tangential to a boundary and any force that it exerts on a boundary must be normal to the boundary.

- A. True      B. False

120. Both air and water are considered to be?

- A. Gases
- B. Fluid(s)
- C. Volume
- D. None of the above

121. Which of the following terms does water possess and air does not?

- A. Gases
- B. Fluid(s)
- C. Volume
- D. None of the above

122. The coefficient of viscosity is the ratio of \_\_\_\_\_ to the velocity gradient.

- A. Absolute pressure
- B. Shearing force
- C. Volume
- D. None of the above

123. Which of the following deals with permanent, time-independent states of fluids, so viscosity does not appear?

- A. Pascal's Principle
- B. Hydrostatics
- C. Permanent forces tangential
- D. None of the above

124. In permanent, time-independent states of fluids, the pressure will be the same throughout the fluid, and the same in any direction at a point?

- A. Pascal's Principle
- B. Acting on the body of the fluid
- C. Permanent forces tangential
- D. None of the above

125. Which of the following that if a certain volume of fluid were somehow made solid, the equilibrium of forces would not be disturbed?

- A. Axiom
- B. Pressure
- C. Displaced fluid
- D. None of the above

126. Which of the following is an example of a body force that disturbs the equality of pressure in a fluid?

- A. Gravitational body force
- B. Pressure
- C. Gravitation
- D. None of the above

127. We call this relation the barometric equation, for when this equation is integrated, we find the variation of pressure with?

- A. Height or depth
- B. Gravitation
- C. Displaced fluid
- D. None of the above

### **Free Surface Perpendicular to Gravity**

128. Archimedes' Principle says that the buoyant force is equal to the weight of the displaced fluid, and passes through the center of mass of?

- A. Gravitation
- B. Pressure
- C. Displaced fluid
- D. None of the above

### **Standard Atmospheric Pressure**

129. Which of the following is a practice that is convenient to measure pressure differences by measuring the height of liquid columns?

- A. Barometer measurement
- B. Manometer
- C. Partial vacuum measurement
- D. None of the above

130. Which of the following uses a partially evacuated chamber of thin metal that expands and contracts according to the external pressure?

- A. Aneroid barometer
- B. Capillarity tube
- C. Partial vacuum
- D. None of the above

**Vacuum**

131. The term vacuum indicates that the absolute pressure is less than the atmospheric pressure and that the \_\_\_\_\_ is negative.

- A. Pressure
- B. Gauge pressure
- C. Atmospheric pressure
- D. None of the above

132. Which of the following would mean a pressure of 0 psia or -14.7 psig?

- A. Static pressure
- B. Gauge pressure
- C. Total vacuum
- D. None of the above

133. Which of the following the pressure would range from slightly less than 14.7 psia to slightly greater than 0 psia?

- A. Pressure
- B. Gauge pressure
- C. Partial vacuum
- D. None of the above

**Water Pressure**

134. Which of the following are very frequently stated in terms of the height of a fluid.

- A. Weight
- B. Pressure(s)
- C. Depth
- D. None of the above

135. Water with a pressure head of 10 ft can provide the same \_\_\_\_\_ as an equal amount of water raised by 10 ft.

- A. Weight
- B. Pressure(s)
- C. Energy
- D. None of the above

136. Water flowing in a pipe is subject to head loss because of?

- A. Friction
- B. Pressure(s)
- C. Siphon
- D. None of the above

137. When a siphon goes below the free water levels, it is called an?

- A. Water bearer
- B. Siphon
- C. Inverted siphon
- D. None of the above

138. Which of the following can be made by filling the tube, closing the ends, and then putting the ends under the surface on both sides?

- A. Water bearer
- B. Siphon
- C. Inverted siphon
- D. None of the above

**Pressure and Force**

139. Which of the following is the force that pushes water through pipes?

- A. Pressure
- B. Fluid(s)
- C. Shearing force
- D. None of the above



140. Which of the following and force are used extensively in the study of fluid power?

- A. Pressure
- B. Fluid(s)
- C. Shearing force
- D. None of the above

141. Which of the following terms means a total push or pull. It is the push or pull exerted against the total area of a particular surface?

- A. Absolute pressure
- B. Force
- C. Volume
- D. None of the above

142. Which of the following means the amount of push or pull applied to each unit area of the surface?

- A. Absolute pressure
- B. Pressure
- C. Volume
- D. None of the above

143. Which of the following maybe exerted in one direction, in several directions, or in all directions?

- A. Absolute pressure
- B. Pressure
- C. Volume
- D. None of the above

### Computing Force, Pressure, and Area

144. A formula is used in computing force, volume, and area in fluid power systems. In this formula, P refers to pressure, F indicates volume, and A represents area.

- A. True
- B. False

## Experiments and Early Applications Section

145. Which of the following arises from our failure to accept, at first sight, the conclusion published by Blaise Pascal in 1663?

- A. Hydrostatic paradox
- B. Coriolis Force
- C. Specific gravity
- D. None of the above

146. Which of the following is a law of physics fundamental to fluid mechanics?

- A. Archimedes' principle
- B. Coriolis Force
- C. Downthrust
- D. None of the above

147. Which of the following is an effect whereby a mass moving in a rotating system experiences a force acting perpendicular to the direction of motion and to the axis of rotation.

- A. Hydrostatic paradox
- B. Coriolis Force
- C. Isobaric process
- D. None of the above

148. Which of the following is an upward force exerted by a fluid that opposes the weight of an immersed object?

- A. Archimedes' principle
- B. Coriolis Force
- C. Buoyancy or upthrust
- D. None of the above

149. \_\_\_\_\_ in a column of fluid, pressure increases with depth as a result of the weight of the overlying fluid. Thus, the pressure at the bottom of a column of fluid is greater than at the top of the column.

- A. Hydrostatic paradox
- B. Buoyancy
- C. Isobaric process
- D. None of the above

150. Which of the following indicates that the upward buoyant force that is exerted on a body immersed in a fluid, whether fully or partially submerged, is equal to the weight of the fluid.

- A. Hydrostatic paradox
- B. Archimedes' principle
- C. Isobaric process
- D. None of the above

151. Which of the following is the pressure at a certain level in a fluid is proportional to the vertical distance to the surface of the liquid?

- A. Hydrostatic paradox
- B. Coriolis Force
- C. Isobaric process
- D. None of the above

152. Which of the following is the ratio of the density of a substance to the density of a reference substance; equivalently, it is the ratio of the mass of a substance to the mass of a reference substance for the same given volume?

- A. Hydrostatic paradox
- B. Coriolis Force
- C. Specific gravity
- D. None of the above

153. Which of the following is the ratio of the weight of a volume of the substance to the weight of an equal volume of the reference substance?

- A. Hydrostatic paradox
- B. Coriolis Force
- C. Specific gravity
- D. None of the above

154. Which of the following is of great importance in meteorology, since it determines the winds?

- A. Stratosphere
- B. Atmosphere
- C. Atmospheric pressure
- D. None of the above

155. Certain typical weather patterns are associated with relatively high and relatively low \_\_\_\_\_, and how they vary with time.

- A. Forces
- B. Physics
- C. Pressures
- D. None of the above

### Experiments and Early Applications Key Terms

156. Which of the following to be made effective for practical applications, it was necessary to have a piston that "fit exactly?"

- A. Pascal's law
- B. Archimedes' law
- C. Aristotle' law
- D. None of the above

157. Valves, pumps, actuating cylinders, and motors have been developed and refined to make hydraulics one of the leading methods of transmitting power.

- A. True
- B. False

158. One characteristic of a liquid is the tendency to keep its free surface level.

- A. True
- B. False

159. Which of the following states that increase in pressure on the surface of a confined fluid is transmitted undiminished throughout the confining vessel or system?

- A. Pascal's law
- B. Blaise Pascal
- C. Aristotle' law
- D. None of the above

### Measurement of Specific Gravity

160. Which of the following is the ratio of the mass (or weight) of a certain sample of it to the mass or weight of an equal volume of water, the conventional reference material?

- A. Water
- B. Density
- C. Specific gravity of a material
- D. None of the above

161. Which of the following has the dimensions' g/cc, while specific gravity is a dimensionless ratio?

- A. Water
- B. Density
- C. Specific gravity of a material
- D. None of the above

### Variations in Specific Gravity

162. Which of the following of the density may have to be taken into consideration in accurate work?

- A. Water
- B. Temperature dependence
- C. Specific gravity of a material
- D. None of the above

163. Which of the following has a density 13.5955 at 0°C, and 13.5461 at 20°C?

- A. Water
- B. Air
- C. Mercury
- D. None of the above

### Hydrometer

164. An instrument for the \_\_\_\_\_ is the hydrometer, which consists of a weighted float and a calibrated stem that protrudes from the liquid when the float is entirely immersed.

- A. Higher specific gravity
- B. Specific gravities
- C. Measurement of specific gravity
- D. None of the above

165. \_\_\_\_\_ will result in a greater length of the stem above the surface, while a lower specific gravity will cause the hydrometer to float lower.

- A. Higher specific gravity
- B. Specific gravities
- C. Measurement of specific gravity
- D. None of the above

166. In most cases, the graduations or "degrees" are arbitrary and reference is made to a table to determine the \_\_\_\_\_.

- A. Higher specific gravity
- B. Specific gravities
- C. Measurement of specific gravity
- D. None of the above

## Pumps and Pumping Water Section

### Common Types of Water Pumps

167. The most common type of water pumps used for municipal and domestic water supplies are variable displacement pumps another term for \_\_\_\_\_.

- A. Dynamic pump(s)
- B. Turbine pump(s)
- C. Variable displacement pump(s)
- D. None of the above

168. Which of the following will produce at different rates relative to the amount of pressure or lift the pump is working against?

- A. Dynamic pump(s)
- B. Turbine pump(s)
- C. Variable displacement pump(s)
- D. None of the above

169. Which of the following are variable displacement pumps that are by far used the most? The water production well industry almost exclusively uses Turbine pumps, which are a type of centrifugal pump.

- A. Dynamic pump(s)
- B. Centrifugal pumps
- C. Variable displacement pump(s)
- D. None of the above

170. Which of the following utilizes impellers enclosed in single or multiple bowls or stages to lift water by centrifugal force? The impellers may be of either a semi-open or closed type.

- A. Dynamic pump(s)
- B. Turbine pump(s)
- C. Variable displacement pump(s)
- D. None of the above

171. Impellers are rotated by the \_\_\_\_\_, which provides the horsepower needed to overcome the pumping head.

- A. Pump motor
- B. Pumping rate
- C. Shaft rotated by a motor
- D. None of the above

172. The size and number of stages, horsepower of the motor and \_\_\_\_\_ are the key components relating to the pump's lifting capacity.

- A. Impeller(s)
- B. Pumping rate
- C. Pumping head
- D. None of the above

173. Which of the following pumps are commonly used in groundwater wells but also in many other applications?

- A. Dynamic
- B. Vertical turbine
- C. Variable displacement
- D. None of the above

174. Vertical turbine pumps are driven by a shaft rotated by a motor that is usually found on the surface. The shaft turns the \_\_\_\_\_ within the pump housing while the water moves up the column.

- A. Impeller(s)
- B. Pumping rate
- C. Shaft rotated by a motor
- D. None of the above

175. The rotating shaft in a \_\_\_\_\_ is actually housed within the column pipe that delivers the water to the surface.

- A. Line shaft turbine
- B. Shaft pump(s)
- C. Variable displacement pump(s)
- D. None of the above

176. The size of the column, impeller, and bowls are selected based on which desired requirements?

- A. Pumping head
- B. Pumping rate
- C. Pumping rate and lift
- D. None of the above

177. Column pipe sections can be threaded or coupled together while the drive shaft is coupled and suspended within the column by \_\_\_\_\_.

- A. Oil bearings
- B. Spider bearings
- C. Column bearings
- D. None of the above

178. The spider bearings provide both a seal at the \_\_\_\_\_ and keep the shaft aligned within the column. The water passing through the column pipe serves as the lubricant for the bearings.

- A. Check valve
- B. Strainer
- C. Column pipe joints
- D. None of the above

179. Some vertical turbines are lubricated by hydraulic fluid rather than water, these pumps are essentially the same as non-lubricated units; only the drive shaft is enclosed within the transmission.

- A. True      B. False

180. Careful operation of oil lubricated turbines is needed to ensure that the pumping levels do not drop enough to allow oil to enter the pump, both water and oil lubricated turbine pump units can be driven by electric or fuel powered motors.

- A. True      B. False

181. Where electricity is not readily available, fuel powered engines may be connected to the drive shaft by a \_\_\_\_\_.

- A. Drive shaft      C. Right angle drive gear  
B. Key and nut      D. None of the above

182. Both oil and water lubricated systems will have a strainer attached to the intake to prevent \_\_\_\_\_ from entering the pump.

- A. Hydraulic fluid      C. Neither oil nor air  
B. Sediment      D. None of the above

183. When the line shaft turbine is turned off, \_\_\_\_\_ will flow back down the column, turning the impellers in a reverse direction. A pump and shaft can easily be broken if the motor were to turn on during this process.

- A. Hydraulic fluid      C. Water  
B. Sediment      D. None of the above

### Three Main Types of Diaphragm Pumps

184. In the first type, the diaphragm is sealed with one side in the fluid to be pumped, and the other in \_\_\_\_\_.

- A. Hydraulic fluid      C. Air or hydraulic fluid  
B. Sediment      D. None of the above

185. The diaphragm is flexed, causing the volume of the pump chamber to increase and decrease. A pair of non-return check valves prevents reverse flow of the \_\_\_\_\_.

- A. Fluid      C. Air  
B. Sediment      D. None of the above

186. The second type of diaphragm pump works with volumetric positive displacement, but differs in that the prime mover of the diaphragm is \_\_\_\_\_; but is electro-mechanical, working through a crank or geared motor drive. This method flexes the diaphragm through simple mechanical action, and one side of the diaphragm is open to air.

- A. Hydraulic fluid      C. Neither oil nor air  
B. Sediment      D. None of the above

187. When the volume of a chamber of either type of pump is increased (the diaphragm moving up), the pressure decreases, and fluid is drawn into the chamber. When the chamber pressure later increases from decreased volume (the diaphragm moving down), the \_\_\_\_\_ previously drawn in is forced out.

- A. Fluid      C. Vapor pressure  
B. Volume      D. None of the above

188. Finally, the diaphragm moving up once again draws \_\_\_\_\_ into the chamber, completing the cycle. This action is similar to that of the cylinder in an internal combustion engine.
- A. Fluid
  - B. Volume
  - C. Vapor pressure
  - D. None of the above

### **Cavitation**

189. Cavitation is defined as the phenomenon of formation of \_\_\_\_\_ of a flowing liquid in a region where the pressure of the liquid falls below its vapor pressure.
- A. Fluid
  - B. Vapor bubbles
  - C. Vapor pressure
  - D. None of the above

190. Non-inertial cavitation is the process in which a bubble in a fluid is forced to oscillate in size or shape due to some form of energy input, such as \_\_\_\_\_.
- A. An acoustic field
  - B. Volume
  - C. Vapor pressure
  - D. None of the above

191. When the cavitation bubbles collapse, they force \_\_\_\_\_ into very small volumes, thereby creating spots of high temperature and emitting shock waves, the latter of which are the source of rattling noise.
- A. Liquid energy
  - B. Volume
  - C. Vapor pressure
  - D. None of the above

192. Cavitation is, in many cases, an acceptable occurrence.
- A. True
  - B. False

193. In devices such as propellers and pumps, cavitation causes a great deal of noise, damage to components, vibrations, and a loss of efficiency.
- A. True
  - B. False

194. Although the collapse of a cavity is a relatively low-energy event, highly localized collapses can erode metals, such as steel, over time. The pitting caused by the collapse of cavities produces great wear on components and can dramatically shorten a propeller's or pump's lifetime.
- A. True
  - B. False

195. Cavitation is usually divided into three classes of behavior: collisional, transcendental and non-transcendental.
- A. True
  - B. False

196. Non-inertial cavitation is the process where a void or bubble in a liquid rapidly collapses, producing a shock wave.
- A. True
  - B. False

### **Complicated Pump Section - Types of Pumps**

197. The family of pumps comprises a large number of types based on application and capabilities. The two major groups of pumps are dynamic and positive displacement.
- A. True
  - B. False

### Dynamic Pumps (Centrifugal Pump)

**Centrifugal pumps are classified into three general categories:**

198. Which of the following is a centrifugal pump in which the pressure is developed partly by centrifugal force and partly by the lift of the vanes of the impeller on the liquid?

- A. Mixed flow
- B. Axial flow
- C. Radial flow
- D. None of the above

199. Which of the following is a centrifugal pump in which the pressure is developed by the propelling or lifting action of the vanes of the impeller on the liquid?

- A. Mixed flow
- B. Axial flow
- C. Radial flow
- D. None of the above

200. Which of the following is a centrifugal pump in which the pressure is developed wholly by centrifugal force?

- A. Mixed flow
- B. Axial flow
- C. Radial flow
- D. None of the above

### Plunger Pump

201. The plunger pump is a positive displacement pump that uses a plunger or piston to force \_\_\_\_\_ from the suction side to the discharge side of the pump. It is used for heavy sludge.

- A. Solids
- B. Pressure
- C. Liquid
- D. None of the above

### Diaphragm Pumps

202. In this type of pump, a diaphragm provides the mechanical action used to force \_\_\_\_\_ from the suction to the discharge side of the pump. The advantage the diaphragm has over the plunger is that the diaphragm pump does not come in contact with moving metal. This can be important when pumping abrasive or corrosive materials.

- A. Metal
- B. Pressure
- C. Liquid
- D. None of the above

### Complicated Pumps - Introduction

203. The force pump has two check valves in the cylinder, one for supply and the other for delivery. The supply valve opens when the cylinder volume \_\_\_\_\_, the delivery valve when the cylinder volume decreases.

- A. Enters
- B. Increases
- C. Reverses flow
- D. None of the above

204. The lift pump has a supply valve and a valve in the piston that allows the liquid to pass around it when the volume of the cylinder is reduced. The delivery in this case is from the upper part of the cylinder, which the \_\_\_\_\_ does not enter.

- A. Cylinder
- B. Piston
- C. Discharged fluid
- D. None of the above

205. Diaphragm pumps are force pumps in which the oscillating diaphragm takes the place of the piston. The diaphragm may be moved mechanically, or by the pressure of the fluid on \_\_\_\_\_.

- A. One side of the diaphragm
- B. Free surface
- C. Reverse flow
- D. None of the above

206. The force and lift pumps are typically used for \_\_\_\_\_.

- A. Solids
- B. Pressure
- C. Water
- D. None of the above

207. The force pump has two valves in the cylinder, while the lift pump has one valve in the \_\_\_\_\_ and one in the piston.

- A. Cylinder
- B. Tank
- C. Discharged fluid
- D. None of the above

208. The maximum lift, or "suction," is determined by the \_\_\_\_\_, and either cylinder must be within this height of the free surface.

- A. Atmospheric pressure
- B. Pressure
- C. Discharged fluid
- D. None of the above

209. The force pump can give an arbitrarily large pressure to the \_\_\_\_\_, as in the case of a diesel engine injector.

- A. Solids
- B. Pressure
- C. Discharged fluid
- D. None of the above

### Fluid Properties

210. The properties of the fluids being pumped can significantly affect the choice of pump.

- A. True
- B. False

### Key considerations include:

211. When pumping abrasive liquids such as industrial slurries, selecting a pump that will not clog or fail prematurely depends on particle size, hardness, and the volumetric percentage of solids.

The properties of the fluids being pumped can significantly affect the choice of pump.

- A. True
- B. False

212. The fluid specific gravity is the ratio of the \_\_\_\_\_ to that of water under specified conditions.

- A. Fluid specific gravity
- B. Fluid's vapor pressure
- C. Fluid density
- D. None of the above

213. Which of the following normally varies directly with temperature, the pumping system designer must know the viscosity of the fluid at the lowest anticipated pumping temperature?

- A. Fluid specific gravity
- B. Kinematic viscosity
- C. High viscosity fluids
- D. None of the above

214. Which of the following is the force per unit area that a fluid exerts in an effort to change phase from a liquid to a vapor, and depends on the fluid's chemical and physical properties?

- A. Fluid specific gravity
- B. Fluid's vapor pressure
- C. Viscosity of a fluid
- D. None of the above



215. Proper consideration of the \_\_\_\_\_ will help to minimize the risk of cavitation.  
A. Fluid specific gravity      C. Viscosity of a fluid  
B. Fluid's vapor pressure      D. None of the above

216. Which of the following is a measure of its resistance to motion?  
A. Fluid specific gravity      C. Viscosity of a fluid  
B. Fluid's vapor pressure      D. None of the above

217. Which of the following result in reduced centrifugal pump performance and increased power requirements?  
A. Fluid specific gravity      C. High viscosity fluids  
B. Fluid's vapor pressure      D. None of the above

### Positive Displacement Pump Sub-Section

218. A positive displacement pump has an expanding cavity on \_\_\_\_\_ and a decreasing cavity on the discharge side.

A. The discharge line      C. The suction side of the pump  
B. A closed valve      D. None of the above

219. Liquid is allowed to flow into the pump as the cavity on the suction side expands and the liquid is forced out of the discharge as \_\_\_\_\_. This principle applies to all types of positive displacement pumps whether the pump is a rotary lobe, gear within a gear, piston, diaphragm, screw, progressing cavity, etc.

A. The cavity collapses      C. An expanding cavity  
B. A closed valve      D. None of the above

220. A positive displacement pump, unlike a centrifugal pump, will produce the same flow at a given RPM no matter what \_\_\_\_\_.

A. The discharge line      C. An expanding cavity  
B. The discharge pressure is      D. None of the above

221. A positive displacement pump cannot be operated against a closed valve on the discharge side of the pump, i.e. it does not have \_\_\_\_\_ like a centrifugal pump does.

A. A shut-off head      C. An expanding cavity  
B. A closed valve      D. None of the above

### Centrifugal Pump Sub-Section

222. By definition, a centrifugal pump is a simple machine. Specifically, a pump is a machine that imparts energy to a fluid. This energy infusion can cause a liquid to flow, rise to a higher level, or both.

A. True      B. False

223. The impellers used on centrifugal pumps may be classified as single suction or double suction.

A. True      B. False

224. In the operation of a centrifugal pump, the pump "slings" liquid out of the impeller via \_\_\_\_\_.

A. Centrifugal force      C. Resistance to flow  
B. The amount of resistance to flow      D. None of the above

225. A pump does not create pressure; it only provides flow. Pressure is just an indication of the amount of \_\_\_\_\_.
- A. Centrifugal force                      C. Resistance to flow  
B. Pressure                                  D. None of the above
226. A single-stage pump has only one impeller. A multi-stage pump has two or more impellers housed together in \_\_\_\_\_.
- A. Stage                                      C. The eye  
B. One casing                              D. None of the above
227. As a standard, each impeller acts separately, discharging to the suction of the next stage impeller. This arrangement is called \_\_\_\_\_.
- A. Centrifugal force                      C. Series staging  
B. The amount of resistance to flow      D. None of the above
228. Centrifugal pumps are also classified as Horizontal or Vertical, depending upon the position of the \_\_\_\_\_.
- A. Pump shaft                              C. Eye  
B. Casing                                      D. None of the above
229. The single-suction impeller allows liquid to enter the eye from one side only. The double-suction impeller allows liquid to enter \_\_\_\_\_ from two directions.
- A. Pump shaft                              C. The eye  
B. One casing                              D. None of the above
230. Recirculation lines are installed on some centrifugal pumps to prevent the pumps from overheating and becoming vapor bound, in case \_\_\_\_\_ or the flow of fluid is stopped for extended periods.
- A. Centrifugal force                      C. The discharge is entirely shut off  
B. The amount of resistance to flow      D. None of the above
231. Which of the following is inserted between the rings of the packing in the stuffing box?
- A. Water flinger rings                      C. A lantern ring spacer  
B. Seal piping                                D. None of the above
232. Which of the following may be fitted on the shaft between the packing gland and the pump bearing housing.
- A. Water flinger rings                      C. A lantern ring spacer  
B. Seal piping                                D. None of the above
233. Which of the following prevent water in the stuffing box from flowing along the shaft and entering the bearing housing?
- A. Water flinger rings                      C. A lantern ring spacer  
B. Seal piping                                D. None of the above

### Generation of Centrifugal Force

234. When the impeller rotates, it spins the liquid sitting in the cavities between the vanes outward and provides \_\_\_\_\_.

- A. Centrifugal force
- B. Centrifugal acceleration
- C. System pressure or head
- D. None of the above

235. As liquid leaves the eye of the impeller a \_\_\_\_\_ area is created causing more liquid to flow toward the inlet.

- A. Centrifugal force
- B. Low-pressure
- C. System pressure or head
- D. None of the above

236. Because the impeller blades are curved, the fluid is pushed in a \_\_\_\_\_ direction by the centrifugal force. This force acting inside the pump is the same one that keeps water inside a bucket that is rotating at the end of a string.

- A. Centrifugal force
- B. Centrifugal acceleration
- C. Tangential and radial
- D. None of the above

### Flow Rate and Pressure Head

237. The two types of pumps behave very differently regarding pressure head and flow rate: The centrifugal pump has varying flow depending on the \_\_\_\_\_.

- A. Centrifugal force
- B. Centrifugal acceleration
- C. System pressure or head
- D. None of the above

238. The positive displacement pump has \_\_\_\_\_ regardless of the system pressure or head.

- A. Centrifugal force
- B. Centrifugal acceleration
- C. More or less a constant flow
- D. None of the above

239. Positive Displacement pumps generally gives more \_\_\_\_\_ than centrifugal pumps.

- A. Centrifugal force
- B. Centrifugal acceleration
- C. Pressure
- D. None of the above

240. Which of the following indicates the losses due to friction are factored into the performance. The following terms are usually used when referring to lift or head?

- A. Dynamic
- B. Static
- C. Suction
- D. None of the above

241. Which of the following indicates the vertical distance from the water line to the centerline of the impeller?

- A. Dynamic
- B. Static Discharge Head
- C. Static Suction Lift
- D. None of the above

242. Which of the following indicates the vertical distance from the discharge outlet to the point of discharge or liquid level when discharging into the bottom of a water tank?

- A. Dynamic
- B. Static Discharge Head
- C. Static Suction Lift
- D. None of the above

### **Mechanical Efficiency**

243. The pumps behaves different considering mechanical efficiency as well. Changing the system pressure or head has little or no effect on the flow rate in the \_\_\_\_\_.

- A. Centrifugal pump
- C. Positive displacement pump
- B. Vertical turbine
- D. None of the above

### **Net Positive Suction Head - NPSH**

244. In a \_\_\_\_\_, NPSH varies as a function of flow determined by speed. Reducing the speed of the positive displacement pump reduces the NPSH.

- A. Centrifugal pump
- C. Positive displacement pump
- B. Vertical turbine
- D. None of the above

### **Understanding Progressing Cavity Pump Theory**

245. Progressing cavity pumps (PCPs) are a special type of rotary \_\_\_\_\_ where the produced fluid is displaced axially at a constant rate.

- A. Centrifugal pump
- C. Positive displacement pump
- B. Vertical turbine
- D. None of the above

246. Progressing cavity pumps are comprised of two helicoidal gears (rotor and stator), where the rotor is positioned inside the \_\_\_\_\_. The combination of rotational movement and geometry of the rotor inside the stator results in the formation of cavities that move axially from pump suction to pump discharge.

- A. Rotor(s)
- C. Elastomer
- B. Stator(s)
- D. None of the above

247. Which of the following are typically machined from high-strength steel and then coated with a wear resistant material to resist abrasion and reduce stator/rotor friction?

- A. Rotor(s)
- C. Elastomer
- B. Stator(s)
- D. None of the above

248. Which of the following consist of steel tubular with an elastomer core bonded to the steel?

- A. Rotor(s)
- C. Elastomer
- B. Stator(s)
- D. None of the above

249. Which of the following is molded into the shape of an internal helix to match the rotor?

- A. Rotor(s)
- C. Elastomer
- B. Stator(s)
- D. None of the above

250. Which of the following are fundamentally fixed flow rate pumps, like piston pumps and peristaltic pumps, and this type of pump needs a fundamentally different understanding to the types of pumps to which people are more commonly first introduced, namely ones that can be thought of as generating pressure?

- A. Fixed flow rate pump(s)
- C. Positive displacement pump(s)
- B. Progressive cavity pump(s)
- D. None of the above

251. Which of the following are often fitted with cut-off pressure switches, burst disks (deliberately weak and easily replaced), or a bypass pipe that allows a variable amount a fluid to return to the inlet? With a bypass fitted, a fixed flow rate pump is effectively converted to a fixed pressure one.

- A. Fixed flow rate pump(s)
- B. Progressive cavity pump(s)
- C. Positive displacement pump(s)
- D. None of the above

252. At the points where the rotor touches the stator, the surfaces are generally traveling transversely, so small areas of sliding contact occur. These areas need to be lubricated by the fluid being pumped (Hydrodynamic lubrication). This can mean that more torque is required for starting, and if allowed to operate without fluid, called 'run dry', rapid deterioration of the \_\_\_\_\_ can result.

- A. Rotor(s)
- B. Stator(s)
- C. Elastomer
- D. None of the above

253. Which of the following offer long life and reliable service transporting thick or lumpy substances?

- A. Fixed flow rate pump(s)
- B. Progressive cavity pump(s)
- C. Positive displacement pump(s)
- D. None of the above

### Helical Rotor and a Twin Helix

254. Which of the following consists of a helical rotor and a twin helix, twice the wavelength and double the diameter helical hole in a rubber stator? The rotor seals tightly against the rubber stator as it rotates, forming a set of fixed-size cavities in between.

- A. Fixed flow rate pump(s)
- B. Progressive cavity pump(s)
- C. Positive displacement pump(s)
- D. None of the above

255. As the rotor simultaneously rotates and moves around, the combined motion of the eccentrically mounted drive shaft is in the form of a \_\_\_\_\_.

- A. Rotor(s)
- B. Stator(s)
- C. Hypocycloid
- D. None of the above

256. In the typical case of single-helix rotor and double-helix stator, the hypocycloid is just a straight line. The \_\_\_\_\_ must be driven through a set of universal joints or other mechanisms to allow for the movement.

- A. Rotor(s)
- B. Stator(s)
- C. Hypocycloid
- D. None of the above

257. The elastomer core of the stator forms the \_\_\_\_\_. The rotor is held against the inside surface of the stator by angled link arms, bearings (immersed in the fluid) allowing it to roll around the inner surface (un-driven).

- A. Required complex cavities
- B. Stator(s)
- C. Elastomer
- D. None of the above

### Elastomer

258. Elastomer is used for the stator to simplify the creation of the \_\_\_\_\_, created by means of casting, which also improves the quality and longevity of the seals by progressively swelling due to absorption of water and/or other common constituents of pumped fluids.

- A. Complex internal shape
- B. Stator(s)
- C. Elastomer
- D. None of the above

### Vapor Pressure and Cavitation Sub-Section

259. Cavitation is the formation and then immediate implosion of cavities in a liquid – i.e. small liquid-free zones ("bubbles") – that are the consequence of forces acting upon the liquid. It usually occurs when a liquid is subjected to \_\_\_\_\_ that cause the formation of cavities where the pressure is relatively low.

- A. Cyclic stress
- B. Cavitation
- C. Rapid changes of pressure
- D. None of the above

260. Cavitation is a significant cause of wear in some engineering contexts. When entering high pressure areas, cavitation bubbles that implode on a metal surface cause \_\_\_\_\_. These results in surface fatigue of the metal causing a type of wear also called "cavitation".

- A. Cyclic stress
- B. Cavitation
- C. The formation of cavities
- D. None of the above

261. Which of the following is usually divided into two classes of behavior: inertial (or transient) cavitation and non-inertial cavitation?

- A. Cyclic stress
- B. Cavitation
- C. The formation of cavities
- D. None of the above

### Inertial Cavitation

262. Inertial cavitation is the process where a void or bubble in a liquid rapidly collapses, producing \_\_\_\_\_.

- A. An acoustic field
- B. An undesirable phenomenon
- C. A shock wave
- D. None of the above

### Non-Inertial Cavitation

263. Non-inertial cavitation is the process in which a bubble in a fluid is forced to oscillate in size or shape due to some form of energy input, such as \_\_\_\_\_.

- A. An acoustic field
- B. An undesirable phenomenon
- C. A shock wave
- D. None of the above

264. Since the shock waves formed by cavitation are strong enough to significantly damage moving parts, cavitation is usually \_\_\_\_\_.

- A. An acoustic field
- B. An undesirable phenomenon
- C. A shock wave
- D. None of the above

265. It is specifically avoided in the design of machines such as turbines or propellers, and eliminating \_\_\_\_\_ is a major field in the study of fluid dynamics.

- A. An acoustic field
- B. Cavitation
- C. A shock wave
- D. None of the above

### Maintenance of a Vertical Turbine Pump

266. A periodic inspection is recommended as the best means of preventing breakdown and keeping maintenance costs to a minimum.

- A. True
- B. False

267. Maintenance personnel should look over the whole installation with a critical eye each time the pump is inspected -- a change in noise level, amplitude of vibration, or performance can be an indication of impending trouble.

- A. True      B. False

268. Any deviation in performance or operation from what is expected can be traced to some specific cause. Determination of the cause of any mis-performance or improper operation is essential to the correction of the trouble -- whether the correction is done by the user, the dealer or reported back to the factory.

- A. True      B. False

269. Ordinarily impellers will not require readjustment if properly set at initial installation. Almost no change in performance can be obtained by minor adjustment of enclosed impellers. All adjustments of the impellers will change the mechanical seal setting. It is recommended that the seal be loosened from the shaft until the adjustment is complete and then reset.

- A. True      B. False

270. Other than the stuffing box lubrication, mechanical seal, and/or lineshaft lubrication, the pump will not require further periodic lubrication.

- A. True      B. False

271. On water pumps and sumps, the suction bearing on the bowl assembly should be repacked when repairs are made, however, no attempt should be made to repack until repairs to the bowl assembly are necessary. Pumps that pump hydrocarbons or have carbon or rubber bearings do not have the suction bearing packed.

- A. True      B. False

272. Maintenance of the stuffing box will consist of greasing the box when required, tightening the packing gland occasionally as the leakage becomes excessive, and installing new packing rings or sets as required.

- A. True      B. False

273. Remove gland and all old packing. If the box contains a lantern ring remove this and all packing below it using two long threaded machine screws. Inspect shaft or sleeve for score marks or rough spots. Be sure by-pass holes (if supplied) are not plugged.

- A. True      B. False

## **Pump Operation & Performance Section**

274. The rate of flow and total head at which the pump efficiency is maximum at a given speed and impeller diameter.

- A. Specific Speed      C. Displacement  
B. Best Efficiency Point      D. None of the above

275. For a positive displacement pump, it is the theoretical volume per revolution of the pump shaft. Calculation methods and terminology may differ between different types of positive displacement pumps.

- A. Specific Speed      C. Displacement  
B. Best Efficiency Point      D. None of the above

276. Which of the following is the total volume throughput per unit of time at suction conditions? The term capacity is also used.
- A. Viscosity                      C. Rate of Flow  
B. Displacement                D. None of the above
277. The amount of pressure / head required to 'force' liquid through pipe and fittings.
- A. Suction Specific Speed    C. Friction Loss  
B. Vapor Pressure                D. None of the above
278. Which of the following is the expression of the energy content of a liquid in reference to an arbitrary datum? It is expressed in units of energy per unit weight of liquid. The measuring unit for head is meters (feet) of liquid.
- A. Head                              C. Head, Suction  
B. Head, Friction                D. None of the above
279. The head required to overcome the friction at the interior surface of a conductor and between fluid particles in motion. It varies with flow, size, type, and conditions of conductors and fittings, and the fluid characteristics.
- A. Head                              C. Head, Friction  
B. Head, Total                    D. None of the above
280. The height of a column or body of fluid above a given point.
- A. Head, Static                    C. Head, Friction  
B. Head Loss                        D. None of the above
281. This is the measure of energy increase, per unit weight of liquid, imparted to the liquid by the pump, and is the difference between total discharge head and total suction head.
- A. Head, Total                    C. Head, Friction  
B. Head, Suction                D. None of the above
282. The bladed member of a rotating assembly of the pump which imparts the principal force to the liquid pumped.
- A. Impeller    C. Casing  
B. Inducer    D. None of the above
283. The pump casing for a centrifugal type of pump, typically spiral or circular in shape.
- A. Impeller    C. Casing  
B. Volute      D. None of the above
284. Which of the following is related to how much suction lift a pump can achieve by creating a partial vacuum?
- A. NPSH        C. NPSH3  
B. NPSHR      D. None of the above
285. Which of the following is determined by the conditions of the installation and is the total suction head of liquid absolute, determined at the first-stage impeller datum minus the absolute vapor pressure in meters (feet) of the liquid at a specific rate of flow expressed in meters (feet) of liquid?
- A. NPSHA      C. NPSH3  
B. NPSHR      D. None of the above



286. Which is the following the minimum NPSH given by the manufacturer/supplier for a pump achieving a specified performance at the specified capacity, speed, and pumped liquid?  
A. NPSH      C. NPSH3  
B. NPSHR     D. None of the above

287. For rotodynamic pumps \_\_\_\_\_ is defined as the value of NPSHR at which the first-stage total head drops by 3% due to cavitation.  
A. NPSH7      C. NPSH3  
B. NPSH5      D. None of the above

### **Pump Efficiency**

288. Which of the following is the Static Discharge Head plus the friction in the discharge line, also referred to as Total Discharge Head?  
A. Dynamic Discharge Head                  C. Total Dynamic Head  
B. Dynamic Suction Head                      D. None of the above

289. Which of the following is the Dynamic Suction Head plus the Dynamic Discharge Head, also referred to as Total Head?  
A. Static Suction Lift                          C. Total Dynamic Head  
B. Dynamic Suction Head                      D. None of the above

290. Which of the following indicates that losses due to friction are factored into the performance?  
A. Dynamic      C. Thermodynamic  
B. Static         D. None of the above

291. Which of the following is the vertical distance from the water line to the centerline of the impeller?  
A. Static Suction Lift                          C. Total Dynamic Head  
B. Dynamic Suction Head                      D. None of the above

292. Pump efficiencies tend to drop over time due to wear (e.g. increasing clearances as impellers reduce in size).  
A. True         B. False

293. Pump efficiency is an important characteristic and pumps should be regularly tested. Thermodynamic pump testing is one method.  
A. True         B. False

294. Subject on how the measurement is taken suction lift and head may also be referred to as static or dynamic.  
A. True         B. False

295. When a system design includes a centrifugal pump, a critical issue in its design is matching the head loss-flow characteristic with the pump so that it operates at or close to the point of its maximum efficiency.  
A. True         B. False

296. Pump efficiency is defined as the ratio of the power imparted on the fluid by the pump in relation to the power supplied to drive the pump. Its value is not fixed for a given pump; efficiency is a function of the discharge and therefore also operating head.

- A. True      B. False

297. For centrifugal pumps, the efficiency tends to improve with flow rate up to a point midway through the operating range (peak efficiency) and then declines as flow rates rise further.

- A. True      B. False

**Specific Gravity**

298. The term specific gravity compares the density of some substance to the \_\_\_\_\_.

- A. Density of water      C. Systems of measure  
B. Pressure              D. None of the above

299. Since specific gravity is the ratio of those densities, the units of measure cancel themselves, and we end up with a whole number that is the same for all systems of measure. Therefore, the specific gravity of water is .5— regardless of the measurement system.

- A. True      B. False

300. Specific gravity is important when sizing a centrifugal pump because it is indicative of the weight of the fluid and its weight will have a direct effect on the amount of \_\_\_\_\_ performed by the pump.

- A. Work      C. Force  
B. Pressure      D. None of the above

**Understanding Pump Viscosity**

301. At 39-deg F (4-deg C), water has a density of 7.84 pounds per gallon or 56.43 pounds per cubic foot.

- A. True      B. False

**Understanding Suction Lift**

302. Suction lift deals with the maximum distance to the intake of a pump. Fire pumps and others may lift about \_\_\_\_\_ of suction.

- A. 33.9                      C. 3 -5  
B. 5' to 10'                D. None of the above

303. Pumps operating at a negative minimum inlet pressure are capable of creating a suction lift (non-self-priming). The suction capacity is approximately equal to the level of the negative minimum inlet pressure minus a \_\_\_\_\_ foot safety factor.

- A. 5                      C. 3  
B. 2                      D. None of the above

304. In any cross-section of a generic hydraulic circuit, the NPSH parameter shows the difference between the actual pressure of a \_\_\_\_\_ and the liquid's vapor pressure at a given temperature.

- A. Liquid in a pipeline      C. Temperature  
B. Boiling point              D. None of the above

305. NPSH is an important parameter to take into account when designing a circuit: whenever the liquid pressure drops below the vapor pressure, liquid boiling occurs, and the final effect will be cavitation: \_\_\_\_\_ may reduce or stop the liquid flow, as well as damage the system.

- A. Vapor bubbles
- B. Boiling point
- C. Vapor pressure at a given temperature
- D. None of the above

306. Centrifugal pumps are particularly vulnerable especially when pumping heated solution near the vapor pressure, whereas positive displacement pumps are less affected by cavitation, as they are better able to pump two-phase flow (the mixture of gas and liquid), however, the resultant flow rate of the pump will be diminished because of the gas volumetrically displacing a disproportion of liquid.

- A. True
- B. False

307. The violent collapse of the cavitation bubble creates a shock wave that can literally carve material from internal pump components (usually the leading edge of the impeller) and creates noise often described as "pumping gravel".

- A. True
- B. False

308. The inevitable decrease in vibration can cause other mechanical faults in the pump and associated equipment.

- A. True
- B. False

309. Careful design is required to pump high temperature liquids with a centrifugal pump when the liquid is near its \_\_\_\_\_.

- A. Damage point
- B. Boiling point
- C. Vapor pressure at a given temperature
- D. None of the above

### **Suction Limitations**

310. Regardless of the extent of the vacuum, water can only be "lifted" a set distance or height due to its' \_\_\_\_\_.

- A. Atmospheric pressure
- B. Vaporization pressure
- C. Suction lift
- D. None of the above

311. It must be remembered that \_\_\_\_\_ of the impeller increases as the suction lift increases, and therefore, the pump, where possible, should be located so that the suction line is submerged at all times.

- A. Atmospheric pressure
- B. Cavitation
- C. Suction lift
- D. None of the above

312. Which of the following is the maximum distance from the water level, to the centerline of the impeller? The main type of pump used for suction lift is a vertical shaft turbine pump.

- A. Static Suction Lift
- B. Dynamic Suction Lift
- C. Total Dynamic Suction Lift
- D. None of the above

313. Which of the following exists when a liquid is taken from an open tank to an atmospheric tank where the liquid level is below the centerline of the pump suction.

- A. Suction Lift
- B. Dynamic Suction Lift
- C. Total Dynamic Suction Lift
- D. None of the above

## Motor-Pump Coupling Sub-Section

314. The pump coupling serves two main purposes: It couples or joins the two shafts together to transfer the rotation from motor to impeller and it compensates for small amounts of misalignment between the pump and the motor.

- A. True      B. False

### Rigid Coupling

315. Rigid couplings are most commonly used on vertically mounted pumps. The rigid coupling is usually specially keyed or constructed for joining the coupling to the \_\_\_\_\_. There are two types of rigid couplings: the flanged coupling, and the split coupling.

- A. Pulley                      C. Motor shaft and the pump shaft  
B. Rigid coupling      D. None of the above

### Flexible Coupling

316. The \_\_\_\_\_ provides the ability to compensate for small shaft misalignments.

- A. Flexible coupling              C. Motor shaft and the pump shaft  
B. Rigid coupling              D. None of the above

### Shaft Bearings

317. Proper lubrication means using the correct type and the correct amount of lubrication. Similar to motor bearings, \_\_\_\_\_ can be lubricated either by oil or by grease.

- A. Shaft bearings      C. Packing  
B. Mechanical seals      D. None of the above

### Mechanical Seals- Detailed

318. Mechanical seals are rapidly replacing \_\_\_\_\_ as the means of controlling leakage on rotary and positive-displacement pumps.

- A. Bearings              C. Conventional packing  
B. Mechanical seals      D. None of the above

319. Mechanical seals do not eliminate the problem of excessive stuffing box leakage.

- A. True      B. False

320. Packing is ideal for pumps that operate in closed systems (such as fuel service and air-conditioning, chilled-water, and various cooling systems). They not only conserve the fluid being pumped, but also improve system operation.

- A. True      B. False

321. Most water service pumps use a lead based material for one of the seal faces and ceramic for the other. When the seals wear out, they are simply replaced.

- A. True      B. False

322. You do not need to replace a mechanical seal whenever the seal is removed from the shaft for any reason, or whenever leakage causes undesirable effects on equipment or surrounding spaces.

- A. True      B. False

323. It is okay to touch a new seal on the sealing face.

- A. True      B. False

324. Mechanical shaft seals serve to ensure that position liquid pressure is supplied to the seal faces under all conditions of operation. They also ensure adequate circulation of the liquid at the seal faces to minimize the deposit of foreign matter on the seal parts.  
A. True      B. False

### **Groundwater Treatment/Production System Section**

325. When toxic substances are spilled or dumped near a well, these can leach into \_\_\_\_\_ and contaminate the groundwater drawn from that well.  
A. Karst                      C. Soil moisture  
B. Aquifer                    D. None of the above
326. Which of the following flows slowly through water-bearing formations at different rates?  
A. Groundwater      C. Soil moisture  
B. Drinking water    D. None of the above
327. The level below which all the spaces in the ground are filled with water is called the?  
A. Unconfined aquifer(s)    C. Well(s)  
B. Water table                D. None of the above
328. The area above the water table lies the?  
A. Unsaturated zone      C. Saturated zone  
B. Karst                        D. None of the above
329. The water in the saturated zone is called?  
A. Unconfined aquifer(s)    C. Water table  
B. Groundwater                D. None of the above
330. Which of the following terms are cracks, joints, or fractures in solid rock, through which groundwater moves?  
A. Fractured aquifer(s)      C. Soil moisture  
B. Karst                         D. None of the above
331. Limestone is often located in which of the following?  
A. Unconfined aquifer(s)    C. Fractured aquifer(s)  
B. Soil moisture                D. None of the above
332. Which of the following may move in different directions below the ground than the water flowing on the surface?  
A. Water table                C. Soil moisture  
B. Groundwater                D. None of the above
333. Which of the following is the level to which the water in an artesian aquifer will rise?  
A. Aquifer                      C. Water table  
B. Piezometric surface      D. None of the above
334. Sandstone may become so highly cemented or recrystallized that all of the original space is filled, in this case, the rock is no longer a porous medium and is known as?  
A. Unconfined aquifer(s)    C. Fractured aquifer(s)  
B. Porous media                D. None of the above

335. Which of the following usually flows downhill along the slope of the water table?  
A. Groundwater                      C. Soil moisture  
B. Water table                        D. None of the above

### **Cone of Depression**

336. During pumping, the water level in the well falls below the water table in the?  
A. Water table                        C. Unconfined aquifer  
B. Surrounding aquifer            D. None of the above

337. The movement of water from \_\_\_\_\_ into a well results in the formation of a cone of depression.

- A. Confined aquifer                  C. Water table  
B. An aquifer                         D. None of the above

338. Which of the following describes a three-dimensional inverted cone surrounding the well that represents the volume of water removed as a result of pumping?

- A. Water table                        C. Cone of depression  
B. Groundwater                      D. None of the above

339. Which of the following is the vertical drop in the height between the water level in the well prior to pumping and the water level in the well during pumping?

- A. Drawdown                         C. Cone of depression  
B. Groundwater                      D. None of the above

340. When a water well is installed in \_\_\_\_\_, water moves from the aquifer into the well through small holes or slits in the well casing or, in some types of wells, through the open bottom of the well?

- A. Confined aquifer                  C. Water table  
B. An unconfined aquifer         D. None of the above

### **Where Is Ground Water Stored?**

341. Areas where ground water exists in sufficient quantities to supply wells or springs are called aquifers, that literally means?

- A. Water table                        C. Cone of depression  
B. Water bearer                      D. None of the above

342. Which of the following stores water in the spaces between particles of sand, gravel, soil, and rock as well as cracks, pores, and channels in relatively solid rocks?

- A. Water table                        C. Unconfined aquifer  
B. Aquifer(s)                         D. None of the above

343. Which of the following is regulated largely by its porosity, or the relative amount of open space present to hold water?

- A. Water table                        C. An aquifer's storage capacity  
B. Groundwater                      D. None of the above

344. If the aquifer is sandwiched between layers of comparatively impermeable materials, it is called?

- A. Confined aquifer                  C. Water table  
B. Unconfined aquifer              D. None of the above

345. Which of the following are frequently found at greater depths than unconfined aquifers?

- A. Confined aquifer(s)
- B. Unconfined aquifer(s)
- C. Water table
- D. None of the above

### Does Groundwater Move?

346. Groundwater can move sideways as well as up or down. This movement is in response to gravity, differences in elevation, and?

- A. Permeable zones
- B. Differences in pressure
- C. Saturated zone
- D. None of the above

347. Groundwater can move even more quickly in karst aquifers, which are areas in \_\_\_\_\_ and similar rocks where fractures or cracks have been widened by the action of the ground water to form sinkholes, tunnels, or even caves?

- A. Karst aquifer(s)
- B. Saturated zone
- C. Water soluble limestone
- D. None of the above

### Groundwater Quality

348. The layers of soil and particles of sand, gravel, crushed rocks, and larger rocks were thought to act as filters, trapping contaminants before they could reach the ground water.

- A. True
- B. False

349. It is known that some contaminants can pass through all of these filtering layers into \_\_\_\_\_ to contaminate ground water.

- A. Permeable zones
- B. Unsaturated zone
- C. Saturated zone
- D. None of the above

### How Does Ground Water Become Contaminated?

350. Groundwater contamination can begin on the surface of the ground, in the ground above the water table, or in the ground below the?

- A. Water table
- B. Ground water
- C. Permeable zones
- D. None of the above

351. If the contaminant is introduced straight into the area below \_\_\_\_\_, the primary process that can affect the impact of the contaminant is dilution by the surrounding ground water.

- A. Water table
- B. Saturated zone
- C. Unsaturated zone
- D. None of the above

### What Kinds of Substances Can Contaminate Groundwater, and Where Do They Come from?

352. Substances that can pollute \_\_\_\_\_ can be divided into two basic categories: substances that occur naturally and substances produced or introduced by man's activities.

- A. Synthetic organic chemical(s)
- B. Groundwater
- C. Permeable zones
- D. None of the above

353. A substantial number of today's groundwater contamination problems stem from man's activities and can be introduced into ground water from?

- A. Contaminant(s)
- B. Saturated zone
- C. A variety of sources
- D. None of the above

### Abandoned Wells

354. If which of the following is abandoned without being properly sealed, it can act as a direct channel for contaminants to reach ground water?

- A. A well
- B. Alternative sources of water
- C. Supplies of clean ground water
- D. None of the above

### Water Well Reports and Hydrogeology

#### Hydrogeologic Data

355. For hydrogeologists to make reliable assessments about the current and future status of ground water, they need to know where ground water occurs in the subsurface, what the properties are of the various geologic units below the surface, and how fast and in what direction ground water is moving.

- A. True
- B. False

#### Nature of the Aquifer

356. An unconfined aquifer has the \_\_\_\_\_ as its upper surface; there are no significant low-permeability layers between the water table and the surface.

- A. Hydraulic head
- B. Water table
- C. Permeability area
- D. None of the above

357. According to the text, the top of the aquifer, can rise or fall depending on water use and amount of recharge to the aquifer and is called?

- A. Hydraulic head
- B. Water table
- C. Permeability zone
- D. None of the above

358. Which of the following terms has a low-permeability geologic formation as its upper boundary?

- A. Hydraulic head
- B. Water table
- C. A confined aquifer
- D. None of the above

#### Hydraulic Head (h)

359. The hydraulic head is a measure of the water at a certain depth possesses because of its elevation and the pressure exerted through the weight of the water above it.

- A. True
- B. False

360. Which of the following has units of feet, and generally parallels to the elevation of water in the well?

- A. Hydraulic head
- B. Water table
- C. Permeability zone
- D. None of the above

#### Permeability of the Aquifer (K)

361. Which of the following \_\_\_\_\_ or the permeability of the aquifer is a measure of how fast ground water can move through the aquifer?

- A. Hydraulic head
- B. Hydraulic conductivity
- C. Storage coefficient of the aquifer
- D. None of the above

362. Which of the following terms has units of distance/time, e.g., feet/day, although it does not represent an actual speed?

- A. Hydraulic head
- B. Hydraulic conductivity
- C. Storage coefficient of the aquifer
- D. None of the above



### **In What Direction Is Groundwater Flowing?**

363. The direction of groundwater flow is from higher to lower?

- A. Hydraulic head
- B. Hydraulic conductivity
- C. Storage coefficient of the aquifer
- D. None of the above

364. Which of the following can be measured by lowering a probe through the observation port of a number of wells, all within the same relative time period?

- A. Hydraulic head
- B. Hydraulic conductivity
- C. Storage coefficient of the aquifer
- D. None of the above

### **What Is the Drawdown Associated with Pumping of a Well?**

365. There is a relationship between the pumping rate of the well, the transmissivity of the aquifer, the distance between wells, \_\_\_\_\_, and the duration of the pumping event.

- A. Hydraulic head
- B. Hydraulic conductivity
- C. Storage coefficient of the aquifer
- D. None of the above

### **Depth to First Water-Bearing Zone**

366. Some report the depth at which water is first encountered in?

- A. The drill hole
- B. Static water level (SWL)
- C. Recharge and discharge zone(s)
- D. None of the above

### **Static Water Level**

367. The driving force for ground water movement is the hydraulic head, and the \_\_\_\_\_ is a measure of that force.

- A. Hydrogeologic investigation(s)
- B. Static water level (SWL)
- C. Recharge and discharge zone(s)
- D. None of the above

368. Which of the following is a better gauge that a different aquifer has been encountered than the lithologic description?

- A. Water-bearing zone(s)
- B. SWL
- C. Recharge and discharge zone(s)
- D. None of the above

369. Which of the following have important effects in groundwater protection and identifying the relation between area groundwater and local streams?

- A. Water-bearing zone(s)
- B. SWL
- C. Recharge and discharge zone(s)
- D. None of the above

### **Water-Bearing Zones**

370. Arriving at accurate approximations of aquifer parameters or calculating ground water velocity requires us to know the thickness of the?

- A. Water-bearing zone(s)
- B. SWL
- C. Recharge and discharge zone(s)
- D. None of the above

### **Basic Rotary Drilling Methods**

371. Rotary drilling uses two methods that include: direct and reverse mud rotary, direct air rotary, and?

- A. Advanced methods
- B. Typical drilling fluid(s)
- C. Drill through casing driver methods
- D. None of the above

### The Rotary Drill String

372. Rotary drilling methods use a drill string, which typically consists of a bit, collar, drill pipe and?

- A. The drill collar
- B. A Sub
- C. A kelly
- D. None of the above

373. Which of the following is a section of heavy walled pipe that can be hexagonal, square, or rounded with grooves?

- A. The flighting
- B. The plug
- C. A kelly
- D. None of the above

374. Which of the following is several feet longer than the drill pipe being used and fits into the table drive much like the splines on a drive shaft fit into a transmission?

- A. The drill collar
- B. The Sub
- C. The kelly
- D. None of the above

375. Some rotary rigs use a top drive to turn \_\_\_\_\_ and are like a drill press.

- A. The drill collar
- B. Drag bit(s)
- C. The drill string
- D. None of the above

376. Drill pipe can be used in various lengths but are typically 20-foot sections and may be connected to the drive unit with?

- A. The drill collar
- B. A Sub
- C. A kelly
- D. None of the above

377. A sub is a length of pipe used to connect pipes and/or act as shock absorber (between the drill pipes and drive unit, at the end of the drill pipe is?)

- A. The drill collar
- B. Drag bit(s)
- C. Shock absorber
- D. None of the above

378. Which of the following or stabilizer is typically very heavy and is often gauged close to the diameter of the bit being used?

- A. The drill collar
- B. Drag bit(s)
- C. Shock absorber
- D. None of the above

379. Which of the following aids in maintaining a consistent borehole diameter and primarily helps to prevent borehole deviation?

- A. The drill collar
- B. Drag bit(s)
- C. Shock absorber
- D. None of the above

380. Several types of bits may be used; such as drag bits or?

- A. The flighting
- B. The plug
- C. Roller bits
- D. None of the above

381. Which of the following are normally used in unconsolidated to semi-consolidated sand, silt, and clay-rich formations?

- A. The drill collar
- B. Drag bit(s)
- C. Roller bit(s)
- D. None of the above

(S) Means the answer can be plural or singular in nature

382. Drag bits come in many shapes and sizes and cut with a shearing action aided by the jetting of drilling fluids from?

- A. The drill collar
- B. Nozzles or jets in the bit
- C. Shock absorber (floating sub)
- D. None of the above

383. Roller bits, such as \_\_\_\_\_, typically utilize interlocking teeth or buttons on individual rotating cones to cut, crush, or chip through the formation.

- A. The flighting
- B. The plug
- C. The common tri-cone bit
- D. None of the above

384. Roller bits can be used in consolidated formations and even hard rock applications if equipped with carbide buttons. These types of bits are often referred to as?

- A. Roller button bits
- B. The Kelly
- C. Reamers
- D. None of the above

385. Which of the following are bits that can be utilized to enlarge, straighten, or clean an existing borehole?

- A. Roller button bits
- B. The Kelly
- C. Reamers
- D. None of the above

386. Which of the following terms are used to enlarge deeper sections of an existing borehole without requiring the enlargement of the entire upper well bore?

- A. Cutting blades
- B. Under reamers
- C. Reamers
- D. None of the above

387. Under reaming involves the projection of \_\_\_\_\_ beneath permanently installed casing in loosely consolidated sediments.

- A. Cutting blades
- B. Under reamers
- C. Reamers
- D. None of the above

### **Direct Rotary Method**

388. The drilling fluid that is pumped by \_\_\_\_\_ and/or air compressor is jetted out of ports in the bit.

- A. The drilling fluid
- B. The rig's mud pump
- C. The cutting's containment systems
- D. None of the above

389. Which of the following pressurizes the borehole and helps to keep the hole open while removing cuttings?

- A. The drilling fluid
- B. The rig's mud pump
- C. The cutting's containment systems
- D. None of the above

390. Large drill rigs may utilize \_\_\_\_\_ that separate the cuttings from the drilling fluid before a pickup pump recirculates the drilling fluid back down the borehole, where the process is then repeated.

- A. The drilling fluid
- B. The rig's mud pump
- C. The cutting's containment systems
- D. None of the above

(S) Means the answer can be plural or singular in nature

391. Mud pits may be dug into the ground adjacent to the rig in order to contain and settle out cuttings from this missing term before recirculating.

- A. The flighting
- B. The borehole
- C. The drilling fluid
- D. None of the above

**Air Rotary Method**

392. Which of the following is kept in a pressured condition while drilling, in order to maintain the circulation of drilling fluid to the surface?

- A. The flighting
- B. The borehole
- C. The drilling fluid
- D. None of the above

393. Which of the following is added while drilling with air in order to maintain sufficient hole pressurization so that cuttings may be lifted to the surface efficiently while maintaining hole stability.

- A. Chemical stabilizer
- B. Mud
- C. Biodegradable foam or surfactant (soap)
- D. None of the above

394. The air hammer makes use of compressed air to drive a piston up and down which makes \_\_\_\_\_ move up and down while the drill string rotates.

- A. The air rotary method
- B. A roller button bit
- C. The hammer bit
- D. None of the above

395. Which of the following's action produces great rock breaking force and is very valuable for drilling through solid rock or consolidated formations?

- A. The mud rotary method
- B. Drilling
- C. The combined rotating and hammering
- D. None of the above

396. \_\_\_\_\_ in hard rock or consolidated formations may be used when drilling pressures are too high or borehole sizes are too large for the efficient operation of an air hammer.

- A. The air rotary method
- B. A roller button bit
- C. The hammer bit
- D. None of the above

**What is a Significant Deficiency?**

397. Significant deficiencies cause, or have the potential to cause, the introduction of contamination into water delivered to customers include defects in design, operation, or maintenance of?

- A. Well screen
- B. The aquifer
- C. The source, treatment or distribution systems
- D. None of the above

**Selecting an Appropriate Well Site**

398. The ideal well location has good drainage and is higher than?

- A. The quality of drinking water
- B. The possibility of contamination
- C. The surrounding ground surface
- D. None of the above

399. Which of the following should be at a lower elevation than the well, and the distances to those contamination sources must be in accordance with the State or Local Water Well Construction Codes?

- A. Surface drainage(s)
- B. Preliminary aquifer parameters
- C. All possible sources of contamination
- D. None of the above

### **Common Well Construction Specifications**

400. Which of the following should always be located and constructed in such a manner that they yield safe water at all times and under all conditions?

- A. Water wells
- B. The aquifer
- C. A pumping test
- D. None of the above

### **Choice of Casing**

401. As with casing, the choice of well screen is as important as its placement, the size of the openings in the casing are dependent on the grain size of the filter or?

- A. The anticipated flow rate
- B. The well
- C. Gravel pack
- D. None of the above

### **Selecting an Optimum Pumping Rate**

402. Specific capacities for each of the pumping steps are compared. The highest  $S_c$  observed is normally associated with?

- A. The anticipated flow rate
- B. The well
- C. The optimum pumping rate
- D. None of the above

## **Electrical Motors Section**

### **Understanding Motors**

403. The classic division of electric motors has been that of Direct Current (DC) types vs. Alternating Current (AC) types.

- A. True
- B. False

404. Many classic DC motors run happily on AC power.

- A. True
- B. False

405. The ongoing trend toward electronic control further muddles the distinction; as modern drivers have moved the commutator out of the motor shell. For this new breed of motor, driver circuits are relied upon to generate sinusoidal AC drive currents, or some approximation of.

- A. True
- B. False

406. The two best motor examples are: the brushless DC motor and the stepping motor, both being polyphase AC motors requiring external electronic control.

- A. True
- B. False

407. There is a clearer distinction between a synchronous motor and asynchronous types. In the synchronous types, the rotor rotates in synchrony with the oscillating field or current (e.g. permanent magnet motors).

- A. True
- B. False

408. A DC motor is designed to run on DC electric power. Two examples of pure DC designs are Michael Faraday's homopolar motor (which is uncommon), and the ball bearing motor, which is (so far) a novelty.

- A. True
- B. False

409. By far the most common DC motor types are the brushed and brushless types, which use internal and external commutation respectively to create an oscillating AC current from the DC source -- so they are not purely DC machines in a strict sense.  
A. True      B. False

### Brushed DC Motors

410. Which of the following design generates an oscillating current in a wound rotor with a split ring commutator, and either a wound or permanent magnet stator?  
A. Classic DC motor      C. Classic commutator DC motor  
B. A split ring commutator      D. None of the above
411. Which of the following consists of a coil wound around a rotor which is then powered by any type of battery?  
A. Brushes      C. Rotor  
B. A split ring commutator      D. None of the above
412. Many of the limitations of the \_\_\_\_\_ are due to the need for brushes to press against the commutator. This creates friction.  
A. Classic DC motor      C. Classic commutator DC motor  
B. A split ring commutator      D. None of the above
413. At higher speeds, \_\_\_\_\_ have increasing difficulty in maintaining contact.  
A. Brushes      C. Rotor  
B. A split ring commutator      D. None of the above
414. Brushes may bounce off the irregularities in the \_\_\_\_\_, creating sparks. This limits the maximum speed of the machine.  
A. Commutator surface      C. Rotor  
B. A split ring commutator      D. None of the above
415. Brushes eventually wear out and require replacement, and the \_\_\_\_\_ itself is subject to wear and maintenance.  
A. Brushes      C. Rotor  
B. Commutator      D. None of the above
416. Which of the following on a large machine is a costly element, requiring precision assembly of many parts?  
A. Brushes      C. Rotor  
B. Commutator assembly      D. None of the above

### Brushless DC Motors

417. Some of the problems of the brushed DC motor are eliminated in the \_\_\_\_\_ design.  
A. Rotor's position      C. Brushless  
B. Hall Effect      D. None of the above

418. In the brushless motor, the mechanical "rotating switch" or commutator/brush gear assembly is replaced by an external electronic switch synchronized to the \_\_\_\_\_.

- A. Rotor's position
- B. Hall Effect sensors
- C. Motors
- D. None of the above

419. Brushless motors are typically \_\_\_\_\_% efficient, whereas DC motors with brush gear are typically 75-80% efficient.

- A. 85-90
- B. 75-84
- C. 95-99
- D. None of the above

420. Midway between ordinary DC motors and stepper motors lies the realm of the brushless DC motor. Built in a fashion very similar to \_\_\_\_\_, these often use a permanent magnet external rotor, three phases of driving coils, one or more Hall Effect sensors to sense the position of the rotor, and the associated drive electronics.

- A. Hall effect sensors
- B. Stepper motors
- C. Coils
- D. None of the above

421. Which of the following are activated one phase after the other by the drive electronics, as cued by the signals from the Hall effect sensors? In effect, they act as three-phase synchronous motors containing their own variable-frequency drive electronics.

- A. Hall effect sensors
- B. Stepper motors
- C. Coils
- D. None of the above

### Universal Motors

422. A variant of the wound field DC motor is the universal motor. The name derives from the fact that it may use AC or DC supply current, although in practice they are nearly always used with \_\_\_\_\_ supplies.

- A. AC
- B. DC
- C. AC or DC supply current
- D. None of the above

423. The principle is that in a wound field \_\_\_\_\_ the current in both the field and the armature (and hence the resultant magnetic fields) will alternate (reverse polarity) at the same time, and hence the mechanical force generated is always in the same direction.

- A. AC motor
- B. DC motor
- C. AC or DC motors
- D. None of the above

424. In practice, the motor must be specially designed to cope with the \_\_\_\_\_ current (impedance must be taken into account, as must the pulsating force), and the resultant motor is generally less efficient than an equivalent pure DC motor.

- A. AC
- B. DC
- C. AC or DC supply current
- D. None of the above

425. The advantage of the universal motor is that AC supplies may be used on motors that have the typical characteristics of \_\_\_\_\_ motors, specifically high starting torque and very compact design if high running speeds are used.

- A. AC
- B. DC
- C. AC or DC supply current
- D. None of the above

426. The negative aspect is the maintenance and short life problems caused by the commutator. As a result, such motors are usually used in \_\_\_\_\_ devices such as food mixers and power tools which are used only intermittently.

- A. AC
- B. DC
- C. AC or DC supply current
- D. None of the above

427. Continuous speed control of a universal motor running on \_\_\_\_\_ is very easily accomplished using a thyristor circuit, while stepped speed control can be accomplished using multiple taps on the field coil.

- A. AC
- B. DC
- C. AC or DC supply current
- D. None of the above

### AC Motor Sub-Section

428. In 1882, Nicola Tesla identified the rotating magnetic field principle, and pioneered the use of a rotary field of force to operate machines. He exploited the principle to design a \_\_\_\_\_ in 1883. In 1885, Galileo Ferraris independently researched the concept.

- A. Rotary field of force
- B. Unique two-phase induction motor
- C. Rotating magnetic field principle
- D. None of the above

429. Before the invention of the \_\_\_\_\_, motors operated by continually passing a conductor through a stationary magnetic field (as in homopolar motors).

- A. Rotary field of force
- B. Stationary magnetic field
- C. Rotating magnetic field
- D. None of the above

430. Tesla had suggested that the commutators from a machine could be removed and the device could operate on \_\_\_\_\_.

- A. A rotary field of force
- B. A stationary magnetic field
- C. A rotating magnetic field principle
- D. None of the above

### Components

**A typical AC motor consists of two parts:**

431. An outside stationary stator having coils supplied with AC current to produce a \_\_\_\_\_.

- A. Rotating magnetic field
- B. Torque to the load
- C. Torque by the rotating field
- D. None of the above

432. An inside rotor attached to the output shaft that is given a \_\_\_\_\_.

- A. Rotating magnetic field
- B. Torque to the load
- C. Torque by the rotating field
- D. None of the above

### Torque motors

433. A torque motor is a specialized form of induction motor that is capable of operating indefinitely at stall (with the rotor blocked from turning) without damage. In this mode, the motor will apply a steady stall \_\_\_\_\_.

- A. Rotating magnetic field
- B. Torque to the load
- C. Torque by the rotating field
- D. None of the above



## Slip Ring

434. The slip ring or wound rotor motor is an induction machine where the rotor comprises a set of coils that are terminated in slip rings to which \_\_\_\_\_ can be connected.

- A. Speed/current and speed/torque
- B. External impedances
- C. Energized and de-energized
- D. None of the above

435. The stator is the same as is used with a standard squirrel cage motor. By changing the impedance connected to the rotor circuit, the \_\_\_\_\_ can be altered.

- A. Slip ring starter
- B. Stepper motors
- C. Speed/current and speed/torque curves
- D. None of the above

436. Which of the following is used primarily to start a high inertia load or a load that requires a very high starting torque across the full speed range?

- A. Slip ring motor
- B. Stepper motor
- C. Standard squirrel cage motor
- D. None of the above

437. By correctly selecting the resistors used in the secondary resistance or \_\_\_\_\_, the motor is able to produce maximum torque at a relatively low current from zero speed to full speed.

- A. Slip ring starter
- B. Stepper
- C. Standard squirrel cage
- D. None of the above

438. A secondary use of the \_\_\_\_\_ is to provide a means of speed control.

- A. Slip ring motor
- B. Stepper motors
- C. Standard squirrel cage motor
- D. None of the above

439. Because the torque curve of the motor is effectively modified by the resistance connected to the rotor circuit, the speed of the motor can be altered. Increasing the value of resistance on the \_\_\_\_\_ will move the speed of maximum torque down.

- A. Rotor circuit
- B. Resistance
- C. Secondary resistors
- D. None of the above

440. If the resistance connected to the rotor is increased beyond the point where the maximum torque occurs at zero speed, the torque will be further reduced. When used with a load that has a torque curve that increases with speed, the motor will operate at the speed where the torque developed by the motor is equal to the \_\_\_\_\_.

- A. Motor torque
- B. Resistance
- C. Load torque
- D. None of the above

441. Reducing the load will cause the motor to speed up, and increasing the load will cause the motor to slow down until the \_\_\_\_\_ and motor torque are equal.

- A. Load
- B. Resistance
- C. Secondary resistors
- D. None of the above

442. Operated in this manner, the slip losses are dissipated in the secondary resistors and can be very significant. The \_\_\_\_\_ is also very poor.

- A. Motor torque
- B. Resistance
- C. Speed regulation
- D. None of the above

## Stepper Motors

443. Closely related in design to three-phase AC synchronous motors are \_\_\_\_\_, where an internal rotor containing permanent magnets or a large iron core with salient poles is controlled by a set of external magnets that are switched electronically.

- A. Slip ring starters
- C. Standard squirrel cage motor
- B. Stepper motors
- D. None of the above

## Electric Motor Maintenance Sub-Section

### General

444. Make a habit of checking that the motor is securely bolted to its platform. Mounting bolts can vibrate loose. Check to see that rotating parts aren't rubbing on stationary parts of the motor, causing damage to the motor.

- A. True
- B. False

445. Even if windings are protected from moisture, minerals in the pumped water can attach to the windings and cause early failure. Motors that operate at 3600-rpm experience twice as much wear as motors operating at 1800 rpm. Regular maintenance is especially critical for 3600-rpm motors and pumps.

- A. True
- B. False

### Motor Electrical System

446. Wide temperature fluctuations during the year can cause electrical connections (especially in aluminum wire) to expand and contract, loosening connectors. Loose electrical connections cause heat buildup and arcing at electrical terminals.

- A. True
- B. False

447. The voltage drop across loose connections will cause the motor to operate at less than its rated voltage, increasing internal motor temperature. Increased heat will break down motor winding insulation, resulting in electrical shorts and motor failures. A loose or broken connection can also unbalance the phases of three-phase power and damage the motor windings.

- A. True
- B. False

### Motor Bearings

448. Lubricate the motor according to the manufacturer's instructions. Intervals between lubrication will vary with motor speed, power draw, load, ambient temperatures, exposure to moisture, and seasonal or continuous operation.

- A. True
- B. False

449. Electric motors should not be greased daily. Bearings can be ruined by either over- or under-greasing.

- A. True
- B. False

450. Even a current of 15 milliamps (one milliamp is one one-thousandth of an amp) can cause serious injury or death. Always play it safe!

- A. True
- B. False

## Electrical Understanding Sub-Section

### Understanding Voltage

451. Voltage, electrical potential difference, electric tension or electric pressure and measured in units of electric potential.  
A. True      B. False
452. Volts, or joules per coulomb is the electric potential difference between two points, or the difference in electric potential energy of a unit charge transported between two points.  
A. True      B. False
453. A voltmeter can be used to measure the \_\_\_\_\_ between two points in a system?  
A. Energy      C. Voltage  
B. Electric potential      D. None of the above
454. Voltage can be caused by \_\_\_\_\_ or, by electric current through a magnetic field, by time-varying magnetic fields, or some combination of these three.  
A. Static electric fields      V. Electric potential difference  
B. Electromotive force      D. None of the above
455. Which of the following is defined so that negatively charged objects are pulled towards higher voltages?  
A. Voltage      C. Electric potential difference  
B. Electromotive force      D. None of the above
456. Which of the following must be distinguished from electric potential energy by noting that the "potential" is a "per-unit-charge" quantity?  
A. Pressure      C. Charge  
B. Electric potential      D. None of the above
457. Which of the following is equal to the work done per unit charge against a static electric field to move the charge between two points?  
A. Energy      C. Voltage  
B. Electric potential      D. None of the above
458. Which of the following along with the dynamic electromagnetic field must be included in determining the voltage between two points?  
A. Electric current      C. A static (unchanging) electric field  
B. Electromotive force      D. None of the above
459. Which of the following is now obsolete but tension is still used?  
A. Pressure      C. Charge  
B. Electric potential      D. None of the above
460. Which of the following may represent either a source of energy or lost, used, or stored energy?  
A. Voltage      C. Electric potential difference  
B. Electromotive force      D. None of the above

461. Which of the following can flow from lower voltage to higher voltage, but only when a source of energy is present to "push" it?  
A. Pressure C. Charge  
B. Current D. None of the above

**Understanding Three-Phase Power**

462. Which of the following represents electric power is a common method of alternating-current electric power generation, transmission, and distribution?  
A. Three phase(s) C. Balanced load  
B. Di-phase distribution D. None of the above

463. Which of the following are more inexpensive than others because it uses less conductor material to transmit electric power than equivalent single-phase or two-phase systems at the same voltage?  
A. Three-phase system C. Supply conductor  
B. Single phase D. None of the above

464. Which of the following terms has the effect of giving constant power transfer over each cycle of the current and makes it possible to produce a rotating magnetic field in an electric motor?  
A. This delay between phases C. Linear balanced load  
B. The lowest phase order D. None of the above

465. Three-phase systems may have a?  
A. Neutral wire C. Non-linear balanced load  
B. One phase system D. None of the above

466. In a three-phase system, \_\_\_\_\_ carry three alternating currents (which reach their instantaneous peak values at different times).  
A. A balanced load C. Instantaneous peak values  
B. Three circuit conductors D. None of the above

467. Taking one conductor as the reference, the other two currents are delayed in time by one-third and two-thirds of one cycle of the?  
A. Electric current C. Lowest phase order  
B. Phase system D. None of the above

468. Which of the following is common not to have a neutral wire as the loads can simply be connected between phases?  
A. High-voltage distribution situations C. Linear balanced load  
B. Two-phase system D. None of the above

**Three-phase has properties that make it very desirable in electric power systems:**

469. Power transfer into a \_\_\_\_\_ is constant, which helps to reduce generator and motor vibrations.  
A. High-voltage distribution situations C. Linear balanced load  
B. Two-phase system D. None of the above

470. Which of the following can produce a magnetic field that rotates in a specified direction, which simplifies the design of electric motors?

- A. A balanced load
- B. Three-phase systems
- C. Instantaneous peak values
- D. None of the above

471. Three is \_\_\_\_\_ order to exhibit all of these properties.

- A. The highest phase order
- B. Number
- C. The lowest phase order
- D. None of the above

472. The phase currents tend to assist out one another, summing to zero in the case of a linear balanced load.

- A. True
- B. False

### 3 Or 4 Wire

473. A three-phase motor is more compact and less costly than a single-phase motor of the same voltage class and rating and single-phase DC motor.

- A. True
- B. False

474. Large types of loads do not require the revolving magnetic field characteristic of three-phase motors but take advantage of the higher voltage and power level usually associated with three-phase distribution.

- A. True
- B. False

475. Which of the following occur in two varieties: three-wire and four-wire?

- A. Three-phase circuits
- B. Two-phase system
- C. Instantaneous phase order
- D. None of the above

476. The three-wire system is used when the loads on the 3 live wires will be balanced, for example in motors or heating elements with?

- A. A balanced load
- B. 3 identical coils
- C. Instantaneous peak values
- D. None of the above

### Sine waves are measured and compared by certain features.

477. In each cycle, there are one reversal and three maximums.

- A. True
- B. False

478. The amplitude of the sine wave tells you the maximum value of current or?

- A. Sine wave
- B. Magnetic field
- C. Voltage
- D. None of the above

479. A cycle is one complete repetition of the wave form; it is produced by one complete revolution-360° -of the conductor through the?

- A. Sine wave
- B. Magnetic field
- C. Voltage
- D. None of the above

480. Which of the following terms peaks in the positive direction at 90°, crosses the zero axis at 180°, peaks in the negative direction at 270°, then reaches zero again at 360°?

- A. Sine wave
- B. Magnetic field
- C. Voltage
- D. None of the above

## SCADA Section

481. The acronym SCADA refers to the centralized computer systems that control and monitor the entire sites, or they are the complex systems spread out over large areas. Nearly all the control actions are automatically performed by the remote terminal units (RTUs) or by the programmable logic controllers (PLCs).

- A. True      B. False

482. Data acquisition starts at the HMI level, which includes the equipment status reports, and meter readings. Data is then formatted in such way that the operator of the control room can make the supervisory decisions to override or adjust normal HMI controls, by using the PLC.

- A. True      B. False

483. SCADA systems implement the distributed databases known as Excel databases, containing data elements called rows or columns.

- A. True      B. False

484. The key attribute of a SCADA system is its capability to perform a supervisory operation over a variety of other proprietary devices.

- A. True      B. False

485. The internet is linked to the SCADA system's databases, to provide the diagnostic data, management information and trending information such as logistic information, detailed schematics for a certain machine or sensor, maintenance procedures and troubleshooting guides.

- A. True      B. False

486. The HMI, or Human Machine Interface, is a device apparatus that gives the processed data to the human operator. A human operator uses HMI to control processes.

- A. True      B. False

487. The information provided by the HMI to the operating personnel is graphical, in the form of mimic diagrams. This means the schematic representation of the plant that is being controlled is obtainable to the operator.

- A. True      B. False

488. Which of the following terms can convert electrical signals coming from the equipment into digital values like the status- open/closed – from a valve or switch, or the measurements like flow, pressure, current or voltage?

- A. RTU      C. PLC  
B. HMI      D. None of the above

489. By converting and sending the electrical signals to the equipment, \_\_\_\_\_ may control the equipment, like closing or opening a valve or a switch, or setting the speed of the pump.

- A. RTU      C. SCADA system  
B. HMI      D. None of the above

490. A 'supervisory Station' refers to the software and servers responsible for communication with the field equipment (PLCs, RTUs etc.), and after that, to \_\_\_\_\_ software running on the workstations in the control room, or somewhere else.

- A. RTU
- B. HMI
- C. SCADA system
- D. None of the above

491. The monitoring function or remote management of the \_\_\_\_\_ is referred to as telemetry.

- A. SCADA operator
- B. SCADA implementation(s)
- C. SCADA system(s)
- D. None of the above

492. An important part of most SCADA implementations is \_\_\_\_\_. The system monitors whether certain alarm conditions are satisfied, to determine when an alarm event has occurred.

- A. Policies and procedures
- B. The cyber security team
- C. Alarm handling
- D. None of the above

493. Once an alarm event has been detected, one or more actions are taken (such as the activation of one or more alarm indicators, and perhaps the generation of email or text messages so that management or \_\_\_\_\_ are informed).

- A. SCADA operator
- B. SCADA implementation(s)
- C. Remote SCADA operators
- D. None of the above

494. In many cases, a \_\_\_\_\_ may have to recognize the alarm event; this may deactivate some alarm indicators, whereas other indicators remain active until the alarm conditions are cleared.

- A. SCADA operator
- B. SCADA implementation(s)
- C. SCADA
- D. None of the above

495. Which of the following terms might automatically monitor whether the value in an analogue point lies outside high and low- limit values associated with that point?

- A. SCADA operator
- B. SCADA implementation(s)
- C. SCADA system(s)
- D. None of the above

496. Which of the following terms translates the electrical signals from the equipment to digital values such as the open/closed status from a switch or a valve, or measurements such as pressure, flow, voltage or current? By translating and sending these electrical signals out to equipment the RTU can control equipment, such as opening or closing a switch or a valve, or setting the speed of a pump.

- A. RTU
- B. HMI
- C. PLCs
- D. None of the above

497. In the first production, mainframe systems were used for computing. At the time SCADA was established, networks did not exist. Therefore, the \_\_\_\_\_ did not have any connectivity to other systems, meaning they were independent systems.

- A. SCADA systems
- B. Independent systems
- C. Multiple stations
- D. None of the above

498. The information between multiple stations was shared in real time through \_\_\_\_\_ and the processing was distributed between various multiple stations. The cost and size of the stations were reduced in comparison to the ones used in the first generation.

- A. RTU            C. LAN
- B. HMI            D. None of the above

499. The interaction between the system and the master station is done through the WAN protocols like the \_\_\_\_\_.

- A. Internet Protocols (IP)      C. Remote or distant operation
- B. Common IT practices      D. None of the above

500. Since the standard protocols used and the \_\_\_\_\_ can be accessed through the internet, the vulnerability of the system is enlarged.

- A. Networked SCADA systems      C. SCADA system(s)
- B. SCADA implementation(s)      D. None of the above