

Answer Sheet

DIAGNOSTIC TEST

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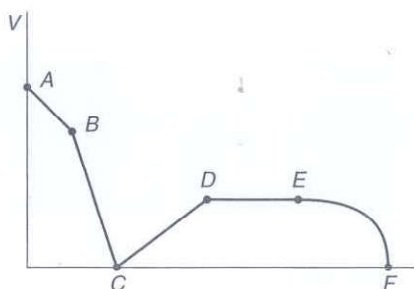
Diagnostic Test

Part A

Instructions: Read the section in the Introduction entitled How to Take the Tests.

Directions: For each group of questions below, there is a set of five lettered choices, followed by numbered questions. For each question select the one choice in the set that best answers the question and fill in the corresponding oval on the answer sheet. You may use a lettered choice once, more than once, or not at all in each set. Do not use a calculator.

Questions 1–3 refer to the graph below, which represents the speed of an object moving along a straight line. The time of observation is represented by t .



- (A) AB
- (B) BC
- (C) CD
- (D) DE
- (E) EF

1. Which choice represents the interval during which the object moves with constant speed?
2. Which choice represents the interval during which the object's speed is increasing?
3. Which choice represents the interval during which the acceleration is changing?

Questions 4–8 refer to the following concepts:

- (A) Energy
- (B) Power
- (C) Momentum
- (D) Acceleration
- (E) Force

To which choice is each of the following units most closely related?

4. m/s^2
5. $\text{kg} \cdot \text{m/s}^2$
6. W
7. $\text{kg} \cdot \text{m/s}$
8. J

Questions 9–13 may express a relationship to speed or velocity given in these choices:

- (A) is proportional to its velocity
- (B) is proportional to the square of its speed
- (C) is proportional to the square root of its speed
- (D) is inversely proportional to its velocity
- (E) is not described by any of the above

GO ON TO THE NEXT PAGE ►

12 Diagnostic Test

For each question select the choice that best completes it:

9. The kinetic energy of a given body
10. The acceleration toward the center of an object moving with constant speed around a given circle
11. The momentum of a given body
12. The displacement per second of an object in equilibrium
13. The displacement of an object starting from rest and moving with constant acceleration

Questions 14 and 15 deal with the characteristics of a simple circuit in the following situation: The following five lengths of thin wire, all of which have the same diameter and length, are connected in a circuit to a battery:

- (A) 3 m of nichrome wire
- (B) 3 m of copper wire
- (C) 3 m of lead wire
- (D) 3 m of steel wire
- (E) 3 m of iron wire

14. In which length of wire is the current greatest?
15. Which length of wire generates the greatest power?

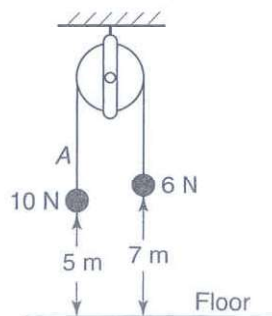
Part B

Directions: Each of the questions or incomplete statements is followed by five suggested answers or completions. Select the choice that best answers the question or completes the statement and fill in the corresponding circle on the answer sheet. Do not use a calculator.

16. The resultant of a 3-newton and a 4-newton force that act on an object in opposite directions to each other is, in newtons,
 - (A) 0
 - (B) 1
 - (C) 5
 - (D) 7
 - (E) 12
17. Two forces, one of 6 newtons and the other of 8 newtons, act on a point at right angles to each other. The resultant of these forces is, in newtons,
 - (A) 0
 - (B) 2
 - (C) 5
 - (D) 10
 - (E) 14

Questions 18–20

As shown in the diagram below, two weights, one of 10 newtons and the other of 6 newtons, are tied to the ends of a flexible string. The string is placed over a pulley that is attached to the ceiling. Frictional losses and the weight of the pulley may be neglected as the weights and the string are allowed to move.



GO ON TO THE NEXT PAGE ►

18. At the instant shown in the diagram, the potential energy of the 10-newton object with respect to the floor is, in joules,

(A) 0
(B) 2
(C) 20
(D) 50
(E) 70

19. At the instant shown, the acceleration of the moving 10-newton object is

(A) 0
(B) less than g
(C) g
(D) $5g$
(E) $10g$

20. At the instant shown, the tension in rope A is

(A) less than 3 N
(B) 3 N
(C) 6 N
(D) more than 6 N but less than 10 N
(E) 10 N

21. How many meters will a 2.00-kilogram ball starting from rest fall freely in 1.00 second?

(A) 4.90
(B) 2.00
(C) 9.81
(D) 19.6
(E) 32

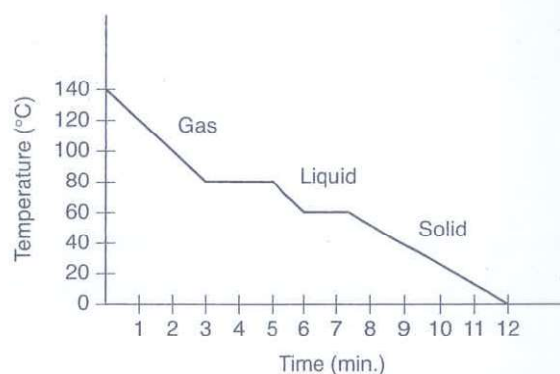
22. An object is observed to have zero acceleration. Which of the following statements is correct?

(A) The object may be in motion.
(B) The object must be at rest.
(C) The object must have zero net force acting on it.
(D) Both (A) and (C) are correct.
(E) None of the above is correct.

23. A beam of parallel rays is reflected from a smooth plane surface. After reflection the rays will be

(A) converging
(B) diverging
(C) parallel
(D) diffused
(E) focused

Questions 24–28 are based on the following diagram showing the response of 2 kilograms of a gas at 140°C . Heat is released at a rate of 6 kilojoules per minute.



24. The boiling point of this substance is

(A) 0°C
(B) 60°C
(C) 80°C
(D) 140°C
(E) 200°C

25. The melting point of this substance is

(A) 0°C
(B) 60°C
(C) 80°C
(D) 140°C
(E) 200°C

26. The heat of vaporization for this substance is

(A) 80 kJ/kg
(B) 12 kJ/kg
(C) 6 kJ/kg
(D) 2 kJ/kg
(E) 24 kJ/kg

14 Diagnostic Test

27. The heat of fusion for this substance is

(A) 3 kJ/kg
 (B) 6 kJ/kg
 (C) 12 kJ/kg
 (D) 20 kJ/kg
 (E) 24 kJ/kg

28. Compared to the specific heat of the substance in the gas state, the specific heat of the substance in the solid state is

(A) more
 (B) less
 (C) the same
 (D) sometimes more, sometimes less
 (E) Not enough information is provided to decide.

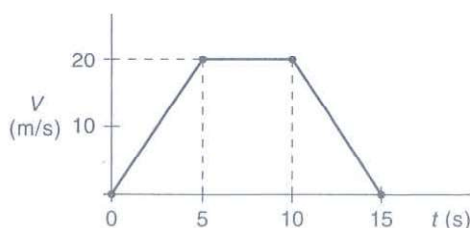
29. Light passes through two parallel slits and falls on a screen. The pattern produced is due to interference and

(A) reflection
 (B) refraction
 (C) polarization
 (D) diffraction
 (E) absorption

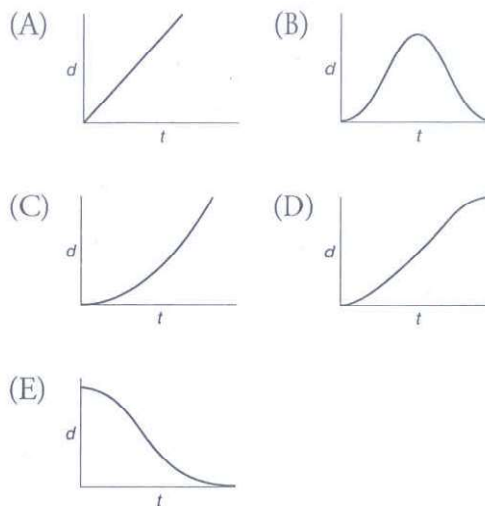
30. A change in temperature of
- 50°C
- is equivalent to a temperature change of

(A) 323 K
 (B) 273 K
 (C) -273 K
 (D) 50 K
 (E) 100 K

Questions 31–33 are based on the velocity versus time graph shown below for an object undergoing one-dimensional motion:



31. Which of the following sketches represents the corresponding displacement versus time graph for this motion?



32. What is the total distance traveled by this object during the entire 15-second interval?

(A) 300 m
 (B) 250 m
 (C) 200 m
 (D) 150 m
 (E) 100 m

33. The object is initially traveling east. During which interval of time is a net force acting west on the object?

(A) 0–5 s
 (B) 5–10 s
 (C) 10–15 s
 (D) 0–15 s
 (E) None of the above

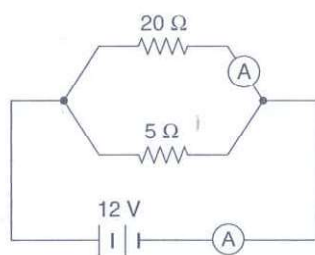
34. The amplitude of a sound wave is detected as its

(A) wavelength
 (B) frequency
 (C) pitch
 (D) resonance
 (E) loudness

35. If the velocity of light in a medium depends on its frequency, the medium is said to be

(A) coherent
(B) refractive
(C) dispersive
(D) diffractive
(E) resonant

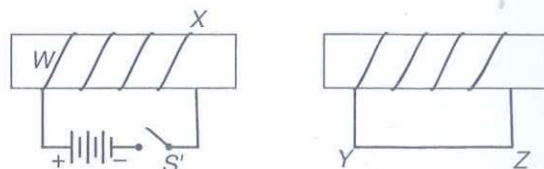
Questions 36–38 are based on the parallel circuit shown below:



36. What is the value of the equivalent resistance of this circuit?
- (A) $25\ \Omega$
(B) $20\ \Omega$
(C) $10\ \Omega$
(D) $5\ \Omega$
(E) $4\ \Omega$
37. What is the value of the current flowing in the circuit?
- (A) 48 A
(B) 3 A
(C) 12 A
(D) 5 A
(E) 16 A
38. What is the value of the current flowing through the $20\text{-}\Omega$ resistor?
- (A) 4 A
(B) 12 A
(C) 240 A
(D) 0.6 A
(E) 2.4 A

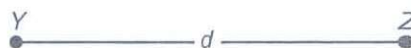
Questions 39 and 40

X is a coil of copper wire with many turns wound on a soft iron core. Another coil wound on an iron core is near it, as shown below.



39. If switch S' is closed and kept closed, the end of the core that is marked W
- (A) becomes an N-pole momentarily
(B) becomes and stays an N-pole
(C) becomes an S-pole momentarily
(D) becomes and stays an S-pole
(E) exhibits no effect because of the current
40. The instant after switch S' is closed
- (A) there will be no current in wire YZ
(B) conventional current in wire YZ will be from Y to Z
(C) conventional current in wire YZ will be from Z to Y
(D) conventional current in wire YZ will be from Z to Y and then from Y to Z
(E) conventional current in wire YZ will be from Y to Z and then from Z to Y

41. The diagram below represents two equal negative point charges, Y and Z, that are a distance d apart. Where would the electric field intensity due to these two charges be zero?



- (A) On Y
(B) On Z
(C) On both Y and Z
(D) Midway between Y and Z
(E) None of the above

GO ON TO THE NEXT PAGE ►

16 Diagnostic Test

42. A positive charge is moving with constant speed at right angles to a uniform magnetic field. If the speed of the charge were doubled, the force exerted on the particle by the magnetic field would be
- (A) unaffected
 - (B) quadrupled
 - (C) doubled
 - (D) halved
 - (E) reduced to one fourth of the original value
43. Of the following, the particle whose mass is closest to that of the neutron is the
- (A) meson
 - (B) deuteron
 - (C) neutrino
 - (D) proton
 - (E) positron
44. The time of one vibration of a simple pendulum may be decreased by
- (A) increasing the length of the pendulum
 - (B) decreasing the length of the pendulum
 - (C) using a heavier bob
 - (D) using a lighter bob
 - (E) taking the pendulum up to the top of the Empire State Building
45. The gravitational force between two masses is equal to 36 newtons. If the distance between them is tripled, then the force of gravity will be
- (A) 36 N
 - (B) 18 N
 - (C) 9 N
 - (D) 4 N
 - (E) 27 N
46. A planet is orbiting a star in an elliptical orbit. On the basis of Kepler's second law, which of the following statements will be correct as the planet gets closer to the star?
- (A) The kinetic energy increases, while the potential energy decreases.
 - (B) The kinetic energy decreases, while the potential energy increases.
 - (C) The sum of the kinetic and potential energies remains constant throughout the orbit.
 - (D) Both (A) and (C) are correct.
 - (E) Both (B) and (C) are correct.
47. It is certain that a rod is electrically charged if it
- (A) repels a pith ball
 - (B) attracts a pith ball
 - (C) attracts the N-pole of a compass needle
 - (D) repels the N-pole of a compass needle
 - (E) points north
48. The rate of heat production of a wire immersed in ice water and carrying an electric current is proportional to
- (A) the current
 - (B) the reciprocal of the current
 - (C) the reciprocal of the square of the current
 - (D) the square of the current
 - (E) the square root of the current
49. According to electromagnetic theory, Lenz's law can be explained best by which of the following laws of physics?
- (A) Law of conservation of linear momentum
 - (B) Law of conservation of angular momentum
 - (C) Law of conservation of energy
 - (D) Law of universal gravitation
 - (E) None of the above

50. A planet has half the mass of Earth and half the radius. Compared to the acceleration due to gravity at the surface of Earth, the acceleration due to gravity at the surface of this other planet is
- (A) the same
 - (B) halved
 - (C) doubled
 - (D) quartered
 - (E) quadrupled
51. Boyle's law describes the behavior of a gas when
- (A) its pressure is kept constant
 - (B) its volume is kept constant
 - (C) its density is kept constant
 - (D) its mass is kept constant
 - (E) nothing is kept constant
52. Electrical appliances are usually grounded in order to
- (A) maintain a balanced charge distribution
 - (B) prevent a buildup of heat
 - (C) run properly using household electricity
 - (D) prevent a buildup of static charges
 - (E) prevent an overload in the circuit
53. The force acting on a satellite in circular orbit around Earth is chiefly
- (A) the satellite's inertia
 - (B) the satellite's mass
 - (C) Earth's mass
 - (D) Earth's gravitational pull
 - (E) the Sun's gravitational pull
54. An object that is black
- (A) absorbs black light
 - (B) reflects black light
 - (C) absorbs all light
 - (D) reflects all light
 - (E) refracts all light
55. If the intensity of monochromatic light is increased while incident on a pair of narrow slits in a diffraction experiment, the spacing between maxima in the pattern will
- (A) increase
 - (B) decrease
 - (C) remain the same
 - (D) increase or decrease depending on frequency
 - (E) not enough information provided
56. A 60-watt, 110-volt tungsten filament lamp is operated on 120 volts. Which of the following statements regarding the lamp is (are) true?
- I. It will consume more than 60 watts while operating.
 - II. It will have a lower resistance than at 110 volts.
 - III. It will be brighter than at 110 volts.
 - IV. It will burn out after operating $\frac{1}{2}$ hour or less.
- (A) I, II, and III only
 - (B) I and III only
 - (C) II and IV only
 - (D) IV only
 - (E) None of the above
57. A man standing in an elevator is taken up by the elevator at constant speed. Which of the following is (are) true of the push that the man exerts on the floor of the elevator?
- I. It is equal to his weight.
 - II. It is equal to less than his weight.
 - III. It is equal to more than his weight.
 - IV. It is dependent on the value of the constant speed.
- (A) I only
 - (B) II only
 - (C) III only
 - (D) IV only
 - (E) None of the above

18 Diagnostic Test

58. An object with a constant mass rests on a smooth and perfectly horizontal table. If a horizontal force F is applied, acceleration a results. If F is doubled without changing the direction, what will be the effect(s) on the acceleration?
- The acceleration will remain the same.
 - The acceleration will be doubled
 - The acceleration will decrease.
 - The acceleration will increase but not double.
- (A) I, II, and III only
(B) II only
(C) II and IV only
(D) IV only
(E) None of the above
59. A projectile is launched from level ground with a velocity of 100 m/s at a 30° angle to the horizontal. If air resistance is neglected, approximately how high will the projectile rise?
- (A) 50 m
(B) 250 m
(C) 125 m
(D) 98 m
(E) 500 m
60. A man pulls an object up an inclined plane with a force F and notes that the object's acceleration is 5 meters per second squared. He doubles the force without changing its direction. Which of the following will then be true of the acceleration?
- It decreases.
 - It increases.
 - It remains the same.
 - It is doubled.
- (A) I, II, and III only
(B) I and III only
(C) II and IV only
(D) IV only
(E) None of the above
61. An object with mass m is moving at constant velocity v , in a horizontal circle with radius r .
- The momentum is directly proportional to v .
 - The kinetic energy varies inversely with v^2 .
 - The centripetal acceleration varies directly with m .
- Which of the above statements is (are) correct?
- (A) I only
(B) I and II
(C) I, II, and III
(D) II and III
(E) All of the above
62. Assume that you have two balls of identical volume, one weighing 2 newtons and the other 10 newtons. Both are falling freely after being released from the same point simultaneously. Which of the following will be true?
- The 10-N ball falling freely from rest will be accelerated at a greater rate than the 2-N ball.
 - At the end of 4 s of free fall, the 10-N ball will have 5 times the momentum of the 2-N ball.
 - At the end of 4 s of free fall, the 10-N ball will have the same kinetic energy as the 2-N ball.
 - The 10-N ball possesses greater inertia than the 2-N ball.
- (A) I, II, and III only
(B) I and III only
(C) II and IV only
(D) IV only
(E) None of the above

63. Lighted candle X , shown below, is placed 20 centimeters from Y . An observer places her eye 45 centimeters on the other side of Y and, looking toward X , sees an image of X .



Which of the following may object Y be?

- I. A new convex mirror of 10-cm focal length of the type often used in the laboratory.
- II. A new convex lens of 10-cm focal length of the type often used in the laboratory.
- III. A new concave mirror of 10-cm focal length of the type often used in the laboratory.
- IV. A new concave lens of 10-cm focal length of the type often used in the laboratory.

- (A) I, II, and III only
- (B) I and III only
- (C) II and IV only
- (D) IV only
- (E) None of the above

64. A lens is used to produce a sharp image on a screen. When the right half of the lens is covered with an opaque material, how will the image be affected?

- I. The right half of the image will disappear.
- II. The left half of the image will disappear.
- III. The image size will become approximately half of the original size.
- IV. The image brightness will become approximately half of the original brightness.

- (A) I, II, and III only
- (B) I and III only
- (C) II and IV only
- (D) IV only
- (E) None of the above

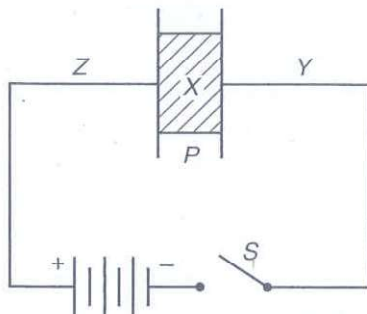
65. When a beam of light goes from a rarer to a denser medium such as glass and has an angle of incidence equal to zero, which of the following properties of the beam of light does (do) NOT change?

- I. Amplitude
- II. Speed
- III. Wavelength
- IV. Direction

- (A) I, II, and III only
- (B) I and III only
- (C) II and IV only
- (D) IV only
- (E) None of the above

20 Diagnostic Test

66. Capacitor P is connected to a battery through switch S and wires Y and Z , as shown below. The capacitor's dielectric is marked X .



For a short time after the switch is closed, electrons will move through which of the following?

- I. Y
 - II. X
 - III. Z
 - IV. S
- (A) I, II, and III only
 - (B) I and III only
 - (C) II and IV only
 - (D) IV only
 - (E) I, III, and IV only
67. A point source of light is placed at the principal focus of a convex lens. Which of the following will be true of the refracted light?
- I. It will diverge.
 - II. It will be parallel to the principal axis.
 - III. It will seem to come from a point $\frac{1}{2}$ of the radius of curvature from the lens.
 - IV. It will converge.
- (A) I, II, and III only
 - (B) I and III only
 - (C) II only
 - (D) IV only
 - (E) None of the above

68. Which of the following statements is (are) correct about the photoelectric effect?
- I. The number of electrons emitted is independent of the intensity of the incident light.
 - II. The stopping potential decreases with increased frequency.
 - III. In a graph of maximum kinetic energy versus incident frequency, all metals have different threshold frequencies, but all have the same slope.
 - IV. The maximum kinetic energy of the emitted electrons is independent of the intensity of the incident light.
- (A) I only
 - (B) III only
 - (C) II and IV
 - (D) II, III, and IV
 - (E) III and IV
69. Which of the following is (are) true of an object starting from rest and accelerating uniformly?
- I. Its kinetic energy is proportional to its displacement.
 - II. Its displacement is proportional to the square root of its velocity.
 - III. Its kinetic energy is proportional to the square of its speed.
 - IV. Its velocity is proportional to the square of elapsed time.
- (A) I, II, and III only
 - (B) I and III only
 - (C) II and IV only
 - (D) IV only
 - (E) None of the above
70. Which of the following particles, all moving with the same velocity, will have the longest de Broglie wavelength?
- (A) An electron
 - (B) A proton
 - (C) A neutron
 - (D) An alpha particle
 - (E) A photon

Questions 71–73

Monochromatic light falls on a metal surface that has a work function of 6.7×10^{-19} joule. Each photon has an energy of 8.0×10^{-19} joule. (Planck's constant = 6.63×10^{-34} joule-second. One electron volt = 1.60×10^{-19} joule.)

71. What is the maximum kinetic energy, in joules, of the photoelectrons emitted by the surface?
- (A) 1.3×10^{-19}
 (B) 1.6×10^{-19}
 (C) 2.6×10^{-19}
 (D) 6.7×10^{-19}
 (E) 8.0×10^{-19}
72. What is the energy of each photon, in electron volts?
- (A) 1.6
 (B) 1.6×10^{-19}
 (C) 5.0
 (D) 6.7
 (E) 8.0
73. What is the frequency of each photon, in hertz?
- (A) 3.7×10^{14}
 (B) 4.2×10^{14}
 (C) 1.2×10^{15}
 (D) 3.7×10^{15}
 (E) 7.0×10^{15}

74. What is the relationship between the atomic number, Z , the mass number, A , and the number of neutrons, N , in a nucleus?

- (A) $Z = AN$
 (B) $Z = \frac{A}{N}$
 (C) $Z = \frac{N}{A}$
 (D) $Z = A - N$
 (E) $Z = N - A$

75. When lead, $^{214}_{82}\text{Pb}$, emits a beta particle, the resultant nucleus will be

- (A) $^{214}_{83}\text{Bi}$
 (B) $^{214}_{84}\text{Po}$
 (C) $^{213}_{82}\text{Pb}$
 (D) $^{214}_{81}\text{Tl}$
 (E) $^{213}_{81}\text{Tl}$



If there is still time remaining, you may review your answers.