Practice Test 2

Physics B
Section I

Time—90 minutes
70 Questions

Directions: Each of the questions or incomplete statements below is followed by five suggested answers or completions. Select the one that is best in each case and then fill in the corresponding oval on the answer sheet.

Reference sheets: You may use "Table of Information" on page 228 for Section I. However, you are NOT allowed to use "Advanced Placement Physics B Equations" for Section I.

Calculators: You may NOT use a calculator for Section I.

1. The rate of change of velocity is the definition of
   (A) displacement
   (B) average speed
   (C) average velocity
   (D) instantaneous velocity
   (E) acceleration

2. How much time will elapse between the collisions with the earth for projectiles fired simultaneously at 66 m/s straight up and another at 66 m/s at a 60° angle from the ground?
   (A) 0.0 s
   (B) 1.9 s
   (C) 6.7 s
   (D) 8.0 s
   (E) 9.8 s

3. What horizontal distance will a projectile fired at velocity V at a 30° angle from the horizontal travel before striking the earth, assuming a flat terrain?
   (A) $(V^2\sqrt{3})/2\,g$
   (B) $(V^2\sqrt{3})/4$
   (C) $V/2$
   (D) $(V\sqrt{3})/2$
   (E) $2V/(g\sqrt{3})$

4. To pass a safety test, a car traveling at 20 m/s must be able to come to a complete stop in 35 meters. What is the minimum necessary deceleration that will enable an automobile to pass the test?
   (A) 1.1 m/s^2
   (B) 3.1 m/s^2
   (C) -5.7 m/s^2
   (D) -7.1 m/s^2
   (E) -11 m/s^2

5. A spacecraft has one engine at tail, which can propel it at 300 m/s, as well as stabilizing engines on either side, each of which can propel the craft at 173 m/s perpendicular to the direction of the tail engine's propulsion. If one of the side engines and the rear engine are simultaneously operating, at what angle

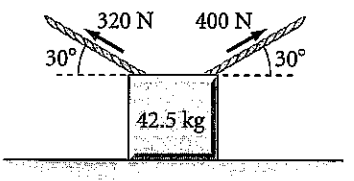
GO ON TO THE NEXT PAGE

will the craft travel relative to the direction with the rear engine alone firing?
(A) 15°
(B) 30°
(C) 45°
(D) 60°
(E) 75°

6. Which one of the following is equivalent to the SI unit for force?
(A) $kg \cdot m^2/s^2$
(B) J·s
(C) J/kg
(D) J/m
(E) kg·m/s

7. An object has a weight of 343 N on the Earth's surface. What is the force on an object due to the foreign gravity of a planet whose acceleration due to gravitation is 7.00 m/s^2 at its surface?
(A) 103 N
(B) 184 N
(C) 213 N
(D) 245 N
(E) 297 N

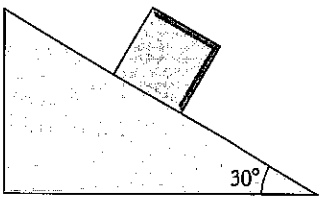
8. What is the normal force for a 100 kg box that has two ropes attached, as shown, acting on it as it rests on a surface?



(A) 98 N
(B) 380 N
(C) 540 N
(D) 590 N
(E) 620 N

9. In terms of gravity, g, the acceleration of a box of mass M that slides down a 60° incline whose surface has a coefficient of friction for which $\mu = 0.20$ is
(A) $g(\sqrt{3} - 0.2)/2$
(B) $Mg/2$
(C) $\sqrt{3}Mg$
(D) $(g\sqrt{3})/4$
(E) $g/2$

Questions 10 & 11 refer to the following diagram, in which a 12 kg box slides down a frictionless 30° incline from rest.



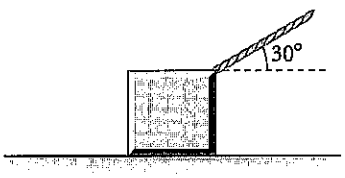
10. If it starts from rest, after sliding along the incline for 6.0 seconds the box will have traveled a distance of
(A) 44 m
(B) 66 m
(C) 88 m
(D) 120 m
(E) 180 m

11. If it starts from rest, after sliding along the incline for 6.0 seconds the speed of the box is
(A) 29 m/s
(B) 35 m/s
(C) 39 m/s
(D) 49 m/s
(E) 59 m/s

12. Which of the following forces is not a conservative force?
(A) Friction
(B) Elastic
(C) Gravitational
(D) Electric
(E) None of the above

13. A 4-kg ball traveling at 8 m/s intersects and compresses a spring with constant $k =$ 6.4 N/m. After the spring then expands, the speed of the ball as it returns past the equilibrium point will be
(A) 4 m/s
(B) 8 m/s
(C) 12 m/s
(D) 16 m/s
(E) 18 m/s

14. A box of mass M is pulled a long a surface with a friction constant μ by a rope pulled at a 30° angle from the horizontal with a force F_R. What is the acceleration of the object, assuming the force is strong enough to set it in motion?

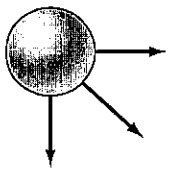


(A) $[-F_R\sqrt{3}/2 - \mu(Mg - F_R/2)]/M$
(B) $[F_R\sqrt{3}/2 - \mu(Mg - F_R/2)]/M$
(C) $[F_R\sqrt{3}/2 + \mu(Mg + F_R/2)]/M$
(D) $[F_R\sqrt{3}/2 - \mu(Mg + F_R/2)]/M$
(E) $[F_R\sqrt{3}/2 - \mu(F_R/2 - Mg)]/M$

15. A 50 kg object is dropped from a height of 100 meters. Its kinetic energy is what percentage of its total energy when it is 10 meters from the ground where it lands?
(A) 57%
(B) 73%
(C) 81%
(D) 90%
(E) 99%

16. A hard object traveling at 15 m/s strikes an identical object at rest. When next observed, the second object is traveling at 15 m/s in the direction of the first, while the first object is at rest. No outside forces act on these objects during the collision. This collision is best described as
(A) elastic
(B) having lost thermal energy
(C) partially inelastic
(D) perfectly inelastic
(E) having lost momentum

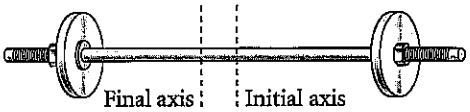
17.



An object of mass M explodes into four pieces. Three of these pieces have a velocity of V and a mass of $M/4$, as shown above. Both of the velocity components of the fourth piece have a magnitude of
(A) $V\sqrt{2}/2$
(B) $(2 + \sqrt{2})V/2$
(C) $1 + \sqrt{2}V$
(D) $V/3$
(E) Not enough information is provided to determine the magnitude.

18. An object of mass M traveling at velocity V strikes an object of mass $M/2$ traveling at $V/4$ along the same path in the same direction perfectly inelastically. What is the resulting velocity?
(A) $\sqrt{9MV/8}$
(B) $3MV$
(C) $3V/4$
(D) $4V/M$
(E) $4V/5$

19. (Not to scale)



What is the difference between the moments of inertia when a barbell is spun around its

GO ON TO THE NEXT PAGE

midpoint and when the axis of rotation is shifted 10 cm to one side as shown? Assume that the each weight is 50 kg, that they are initially 1.6 meters apart, and that the bar has negligible mass.
(A) 1000 kg·m^2
(B) 100 kg·m^2
(C) 50 kg·m^2
(D) 10 kg·m^2
(E) 1 kg·ms^2

20. The angular velocity (in standard SI units) of a point on a uniformly rotating object that has a frequency of 20 rev/min is
(A) $2\pi/3$ rad/s
(B) 6π rad/s
(C) $3/2\pi$ rad/s
(D) $10/\pi$ rad/s
(E) not uniform

21. The units of the product of Hertz and Watts are
(A) J/s
(B) kg·m
(C) J/s^2
(D) J·s
(E) kg·m^2

22. What is the speed of an oscillating object of mass M attached to a spring (constant = k N/m) that has an amplitude of A meters when it is x meters from equilibrium? (Assume that $x < A$.)
(A) $\sqrt{[Mk(A^2 - x^2)]}$
(B) $\sqrt{[k(A^2 - x^2)/M]}$
(C) $\sqrt{[M(A^2 - x^2)]/k}$
(D) $M\sqrt{(kA^2 - kx^2)}$
(E) $M\sqrt{(kx^2 - kA^2)}$

23. The "red shift" exhibited by the light of galaxies whose distance from the Earth is increasing is a visual example of
(A) the Hall effect
(B) the photoelectric effect
(C) the Compton effect
(D) the Doppler effect
(E) none of the above

24. The length of a string fixed at both ends whose third harmonic has a wavelength of 0.96 m is
(A) 0.32 m
(B) 0.64 m
(C) 0.96 m
(D) 1.44 m
(E) 2.88 m

25. The frequency of a simple pendulum of length 9.8 cm is most nearly
(A) $1/20\pi$ Hz
(B) $10/\pi$ Hz
(C) $1/2\pi$ Hz
(D) $5/\pi$ Hz
(E) $\pi/10$ Hz

26. The apparent weight of a 600 kg object of volume 0.375 m^3 submerged in a liquid of density of 1.25×10^3 kg/m^3 is
(A) 180 N
(B) 250 N
(C) 480 N
(D) 1300 N
(E) 4700 N

27. A conduit of radius 7 R carries a uniformly dense liquid to a spigot of radius R at the same height, where it has a velocity of V. What is its initial velocity?
(A) 0.02V
(B) 0.11V
(C) V
(D) 7V
(E) 49V

28. The pressure in a pipe carrying a liquid with a density of ρ and an initial velocity V at the inlet is P, which is x meters lower than its outlet, which has a velocity of $2V$. In these terms, what is the final pressure?
(A) $P/2\rho\,(3V^2 + 2gx)$
(B) $P - 1/2\rho\,(3V^2 + 2gx)$
(C) $P + 1/2\rho\,(-3V^2 + \rho gx)$
(D) $[1/2\rho\,(V^2 - 4V^2) - \rho gx]/P$
(E) $P[1/2\rho\,(V^2 - 4V^2) - \rho gx]$

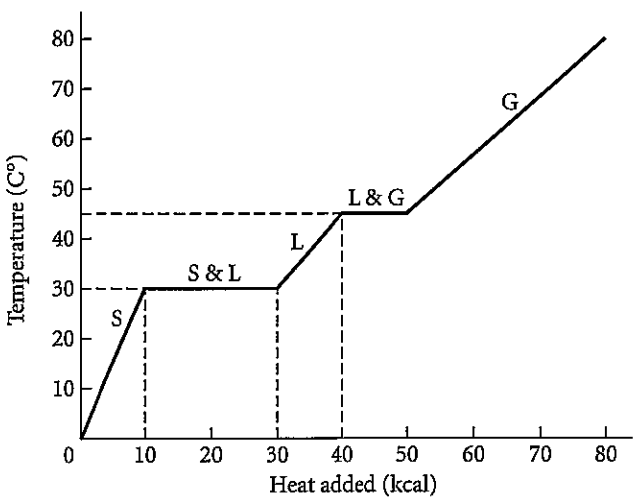
29. The units of specific gravity are
(A) kg/m^3
(B) g/m^3
(C) m/s^2
(D) N/m
(E) none of the above

30. A sold cube of a substance has a volume of 2.7×10^{10} m^3 at 60.0 °C. When heated to 810 °C, how much longer will each of its sides be if its coefficient of linear expansion is $\alpha = 30 \times 10^{-6}$ °C^{-1}?
(A) 0.59 m
(B) 1.2 m
(C) 68 m
(D) 710 m
(E) 1200 m

31. In an ideal gas, if the pressure doubles while the volume is quartered, the new temperature will
(A) quadruple
(B) double
(C) stay the same
(D) be halved
(E) be quartered

Questions 32 and 33 refer to the following diagram.

The relation between temperature and heat added for 1 kg of an unknown substance as well as the state at that temperature is as follows.



32. The heat of vaporization for this substance is approximately
(A) 10 kcal/kg
(B) 15 °C
(C) 20 kcal/kg
(D) 45 °C
(E) 50 kcal/kg

33. According to this chart, the specific heat of the liquid form of this substance is
(A) approximately 0.67 kcal/kg·°C
(B) approximately 1.5 kg·°C/kcal
(C) approximately 15 °C
(D) approximately 10 kcal
(E) none of these

34. The slope of the line in a PV diagram representing an isochoric process would be
(A) 0
(B) positive
(C) negative
(D) a function of volume
(E) infinite

35. At what hypothetical heat output per second would the real efficiency of an engine with a heat input of 5100 J/s at 627 °C and a heat output temperature of 27 °C be equal to its ideal efficiency?
(A) 330 J/s
(B) 900 J/s
(C) 1700 J/s
(D) 2300 J/s
(E) 3300 J/s

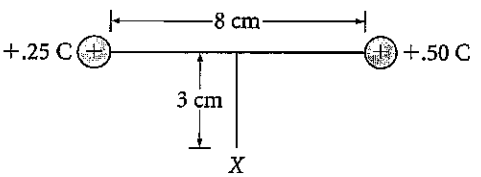
36. The repulsive force between point charges, one of charge 4.0×10^{-6} C and the other of charge 4.9×10^{-6} C, that are 1.0 cm apart is
(A) 180 N
(B) 360 N
(C) 1800 N
(D) 3600 N
(E) 18000 N

GO ON TO THE NEXT PAGE

37. Which of the following is NOT true for electric field lines?
(A) The number of lines in a given area depicts the relative strength of the electric field in that area.
(B) The number of field lines leaving a charge is proportional to the magnitude of that charge.
(C) Electric field lines start on positive charges.
(D) Electric field lines finish on negative charges.
(E) The direction of an electric field is perpendicular to the field line at each point along it.

38. The magnitude of the electric field measured at a distance of 15 cm from an unknown charge is 6×10^3 N/C. What is the magnitude of the electric field measured 5 cm further away?
(A) 3.8×10^3 N/C
(B) 4.5×10^3 N/C
(C) 8.0×10^3 N/C
(D) 1.1×10^4 N/C
(E) 4.5×10^4 N/C

39.



The magnitude of the electric field at point X, which is 3 cm directly below the midpoint of 2 charges that are 8 cm apart as shown, is
(A) 18×10^{11} N/C
(B) 32×10^{12} N/C
(C) 48×10^{13} N/C
(D) 16×10^{14} N/C
(E) 54×10^{14} N/C

40. The units of capacitance are equivalent to
I. Henrys
II. Volts/Coulomb
III. Farads
(A) I only
(B) II only
(C) III only
(D) I and II only
(E) II and III only

41. For a capacitor, which of the following dimensions for faces of parallel plates that are 2 mm apart would produce a capacitance of 8.85×10^{-14} F?
(A) 2 cm × 2 cm
(B) 5 cm × 6 cm
(C) 4 mm × 5 mm
(D) 0.4 mm × 0.8 mm
(E) 0.1 mm × 0.1 mm

42. Initially at rest, a -4.0×10^{-14} C charge of mass 5.0×10^{-19} kg is accelerated across a 100 V potential. Its final velocity will be
(A) 7.1×10^2 m/s
(B) 4.0×10^3 m/s
(C) 2.0×10^4 m/s
(D) 1.4×10^5 m/s
(E) 4.1×10^6 m/s

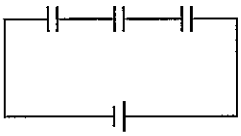
43. Four 12 V batteries are connected in series and produce a current of 3 A. What is the resistance of the circuit?
(A) 3 Ω/4
(B) 16 Ω
(C) 16 Ω/3
(D) 4 Ω/3
(E) 4 Ω

44. Which of the following is the minimum fuse rating that could handle a chandelier containing ten 60-watt bulbs and twenty 45-watt bulbs when connected to a standard 120 V circuit?
(A) 2 A
(B) 9 A
(C) 13 A
(D) 17 A
(E) 22 A

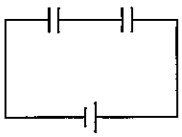
45. When attached to a 120 V electric potential source, the resistance of 60-watt light bulb is
(A) 0.5 Ω
(B) 2 Ω
(C) 3 Ω
(D) 60 Ω
(E) 240 Ω

46. Which of the following circuits, where all capacitors have a capacitance of C, has an equivalent capacitance of 1.5 C?

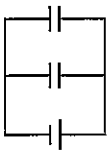
(A)



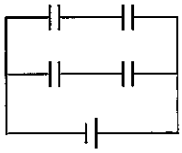
(B)



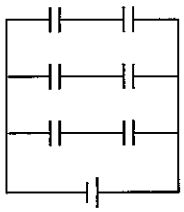
(C)



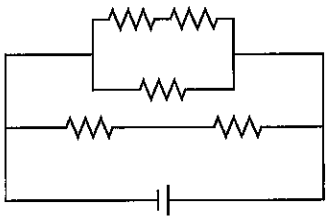
(D)



(E)



47.



If all resistors in this circuit are the same type, what rating of resistor should be used so that the current is 6 A when attached to an 18 V battery?

(A) 6 Ω
(B) 4 Ω
(C) 3 Ω
(D) 2 Ω
(E) 1 Ω

48. A 0.5 m wire carrying a 2.5 A current is placed parallel to a magnetic field of strength 0.125 T. What is the resultant force on the wire?

(A) 0.03 N
(B) 0.2 N
(C) 0.6 N
(D) 10 N
(E) None of the above

49. The force on a 0.0050 C charge traveling at 3.0 m/s that enters a 4.5 T magnetic field at a 60° angle between the velocity vector and the magnetic field is

(A) 0.017 N
(B) $0.034\sqrt{2}$ N
(C) $0.034\sqrt{3}$ N
(D) $0.068\sqrt{2}$ N
(E) $0.068\sqrt{3}$ N

50. Find the force per unit length between two parallel wires that are carrying 6.0 amps each and that are 2 cm apart.

(A) 150 μ_0/π N/m
(B) 900 μ_0/π N/m
(C) 150 $\mu_0/2\pi$ N/m
(D) 900 $\mu_0/2\pi$ N/m
(E) 900 $\pi\mu_0$ N/m

51. A 24-turn loop that encloses an area of 0.8 m^2 is at a 60° angle from a magnetic field. If the strength of the magnetic field changes from 7 T to 12 T over 6 seconds, the average induced emf is

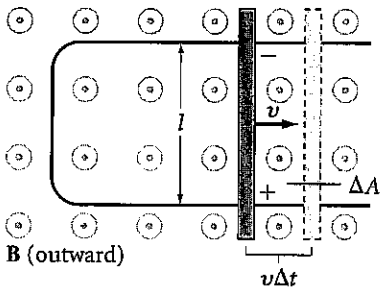
(A) −8 V
(B) −0.5 V
(C) 0 V
(D) 0.5 V
(E) 8 V

52. A 12 V to 1.5 V ideal transformer has 40 loops in its primary coil. If a 3 A current is applied to the primary coil, what is the current in the secondary coil?

(A) 0.38 A
(B) 9 A
(C) 18 A
(D) 24 A
(E) 27 A

GO ON TO THE NEXT PAGE

53. A rectangular conductor with one moving side is oriented with a magnetic field, as shown. If the length of the moving side is 2.8 cm and the strength of the magnetic field is 32 T, at what velocity should the moving section travel so that 2.7 V of potential difference is induced?



(A) 3.0 m/s
(B) 8.0 m/s
(C) 13 m/s
(D) 24 m/s
(E) 33 m/s

54. The frequency of the fifth harmonic for a 75 cm string that has a wave velocity of 303 m/s is
(A) 10.1 Hz
(B) 90.0 Hz
(C) 540 Hz
(D) 760 Hz
(E) 1010 Hz

55. How many beats per minute are heard when the two highest strings of a guitar are played, where the *E* string has a frequency of 330 Hz and the *B* string has a frequency of 247 Hz?
(A) 11,500
(B) 4,980
(C) 780
(D) 83
(E) 1.27

56. The velocity of a wave along a 25 cm-long, 40-gram string under 900 N of tension is
(A) 0.04 m/s
(B) 8.0 m/s
(C) 75 m/s
(D) 380 m/s
(E) 5600 m/s

57. For a vibrating column of air in a tube opened at both ends, the ratio of the number of nodes in the displacement of air to the number of nodes in the pressure in the air in the *n*th harmonic is
(A) $n - 1/n$
(B) $n/(n-1)$
(C) 1
(D) $n + 1/n$
(E) $n/(n+1)$

58. Using a single-slit diffraction apparatus of slit width *D* for monochromatic light, which of the following equations describes where minima occur in the resulting pattern for an angle θ?
(A) $D\sin(\theta + m/2) = m\lambda$, for $m = 1, 2, 3 \ldots$
(B) $D\sin(\theta + 1/2) = m\lambda$ for $m = 0, 1, 2, 3 \ldots$
(C) $D\sin(\theta + 1/2) = m\lambda$ for $m = 1, 2, 3 \ldots$
(D) $D\sin\theta = m\lambda$ for $m = 0, 1, 2, 3 \ldots$
(E) $D\sin\theta = m\lambda$ for $m = 1, 2, 3 \ldots$

59. If the eighth-order fringe resulting from monochromatic light that has a frequency of $6.4 \times 10^{14}\ s^{-1}$ passing through a double slit is at 30°, what is the distance between slits?
(A) 1.1×10^{-3} m
(B) 3.5×10^{-4} m
(C) 8.2×10^{-4} m
(D) 9.5×10^{-5} m
(E) 7.5×10^{-6} m

60. The frequency of an infrared light beam with a wavelength of 2.7×10^{-4} m is
(A) $0.90 \times 10^{-12}\ s^{-1}$
(B) $1.1 \times 10^{-12}\ s^{-1}$
(C) 0.90×10^{12} Hz
(D) 1.1×10^{12} Hz
(E) 9.9×10^{4} Hz

61. An object placed 15 cm from a concave spherical mirror with a 10 cm radius of curvature has an image distance of
(A) 3.75 cm
(B) 6 cm
(C) 7.5 cm
(D) 10 cm
(E) 30 cm

62. An object that is 0.18 m high is placed 0.10 m from a thin double convex converging lens with a focal length of 0.04 m. What is the resulting image height?
(A) 0.12 m inverted
(B) 0.12 m upright
(C) 0.27 m inverted
(D) 0.27 m upright
(E) None of the above

63. From a vacuum, an incident ray enters a form of glass at 45° and is refracted at a 60° angle from the surface. What is the index of refraction of the glass?
(A) 0.707
(B) 0.867
(C) 1.33
(D) 1.41
(E) 1.73

64. A possible wavelength for a photon of wavelength 2.1×10^{-10} m scattered from an electron of a block of graphite is
(A) 2.1×10^{-11} m
(B) 4.2×10^{-11} m
(C) 9.9×10^{-11} m
(D) 1.9×10^{-10} m
(E) 2.2×10^{-10} m

65. A product of gamma decay is
(A) a high energy photon
(B) a transmuted element
(C) an electron
(D) a positron
(E) a neutrino

66. According to the Heisenberg uncertainty principle, $h/2\pi$ is the limit of accuracy for the product of
I. position and momentum
II. mass and volume
III. time and energy
(A) I only
(B) I and II only
(C) II and III only
(D) I and III only
(E) I, II, and III

67. Rutherford's "planetary" model of the atom did not provide for
(A) the behavior of alpha particles fired at a thin gold foil
(B) the emission of line spectra
(C) a positively charged nucleus
(D) the great distance between the nucleus and an electron
(E) a small, dense nucleus

68. The de Broglie wavelength of a 3-gram particle traveling at 36 m/hr is
(A) 1.4×10^{-12} m
(B) 7.3×10^{-14} m
(C) 2.2×10^{-29} m
(D) 6.1×10^{-34} m
(E) 1.9×10^{-39} m

GO ON TO THE NEXT PAGE

69. As a photon passes through matter and directly interacts with its constituents, all of the following are possible direct consequences EXCEPT
(A) the Compton effect
(B) the photoelectric effect
(C) an atomic electron is excited
(D) a positron and electron are annihilated
(E) pair production

70. The number of neutrons in an element notated as ${}^{A}_{Z}X$ is
(A) A
(B) Z
(C) $Z - A$
(D) $A - Z$
(E) $A + Z$

STOP

END OF SECTION I

IF YOU FINISH BEFORE TIME IS CALLED, YOU MAY CHECK YOUR WORK ON THIS SECTION.

DO NOT GO ON TO SECTION II UNTIL YOU ARE TOLD TO DO SO.