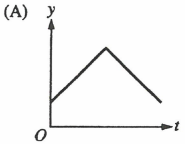
Section I

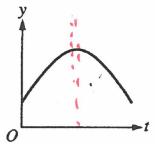
PHYSICS B
SECTION I
Time—90 minutes
70 Questions

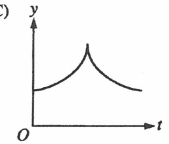
Directions: Each of the questions or incomplete statements below is followed by five suggested answers or completions. Select the one that is best in each case and then fill in the corresponding oval on the answer sheet.

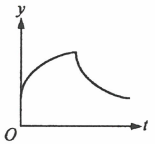
Note: To simplify calculations, you may use $g = 10\ \text{m/s}^2$ in all problems.

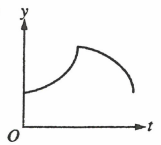
1. A person throws a marble straight up into the air, releasing it a short height above the ground and catching it at that same height. If air resistance is negligible, which of the following graphs of position y versus time t is correct for the motion of the marble as it goes up and then comes down?

(A) 

(B) 

(C) 

(D) 

(E) 

AP Review #1

#1 33 questions

Wave pherom
optics 25, 29
modern 28, 30, 31, 32

13.5 pts 3 bonus pts

#1 1-33 pts
modern 28, 30, 31, 32
14 pts
14.5 pt (for 2016)

#2 34-70 no 36
modern 61, 62, 63
16 pts

2. A rocket lifts a payload upward from the surface of Earth. The radius of Earth is R, and the weight of the payload on the surface of Earth is W. The force of Earth's gravity on the payload is $\frac{W}{2}$ when the rocket's distance from the center of Earth is

(A) R
(B) $\sqrt{2}R$
(C) $2R$
(D) $2\sqrt{2}R$
(E) $4R$

$F_g = \frac{Gmm}{r^2}$

$\frac{1 \cdot 1}{(\sqrt{2})^2}$

Questions 3-4

An object is thrown with an initial speed v near the surface of Earth. Assume that air resistance is negligible and the gravitational field is constant.

3. If the object is thrown vertically upward, the direction and magnitude of its acceleration while it is in the air is

9.81 m/s²

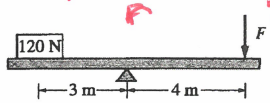
(A) upward and decreasing
(B) upward and constant
(C) downward and decreasing
(D) downward and increasing
(E) downward and constant

4. If the object is thrown horizontally, the direction and magnitude of its acceleration while it is in the air is

9.81 m/s²

(A) upward and decreasing
(B) upward and constant
(C) downward and decreasing
(D) downward and increasing
(E) downward and constant

$\tau = \tau$
$Fr = Fr$
$F = \frac{Fr}{r} = \frac{(120)(3)}{4} = 30(3) = 90$



5. An object weighing 120 N is set on a rigid beam of negligible mass at a distance of 3 m from a pivot, as shown above. A vertical force is to be applied to the other end of the beam a distance of 4 m from the pivot to keep the beam at rest and horizontal. What is the magnitude F of the force required?

(A) 10 N
(B) 30 N
(C) 90 N
(D) 120 N
(E) 160 N

6. Inertia can be best described as the

(A) force that keeps an object in motion with constant velocity
(B) force that keeps an object at rest
(C) force that overcomes friction
(D) property responsible for an object's resistance to changes in motion
(E) property responsible for slowing down an object

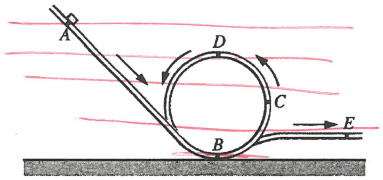
AP Review #3

#2 34-70, no 36
36 questions

optics 48, 49, 64, 65
modern 61, 62, 63

14.5 pts 3.5 bonus pts

Questions 7-9



A block released from rest at position *A* slides with negligible friction down an inclined track, around a vertical loop, and then along a horizontal portion of the track, as shown above. The block never leaves the track.

7. After the block is released, in which of the following sequences of positions is the speed of the block ordered from fastest to slowest?

(A) *B C D E*
(B) *B E C D*
(C) *D C E B*
(D) *E B C D*
(E) *E D C B*

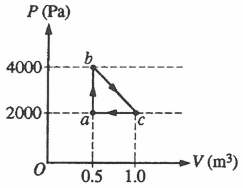
8. Which of the following is true of the net force on the block when it is at position *C*?

(A) It is directed vertically downward only.
(B) It is directed vertically upward only.
(C) It is directed to the left only.
(D) It is directed to the right only.
(E) It has components both to the left and vertically downward.

9. The gravitational potential energy and the kinetic energy of the block are most nearly equal at which position? (Consider the potential energy to be zero at position *B*.)

(A) *A*
(B) *B*
(C) *C*
(D) *D*
(E) *E*

Questions 10-11



A sample of an ideal gas is taken through the cycle *abca*, as shown in the *PV* diagram above.

10. What is the change in internal energy of the gas for the process *bc*?

(A) −1500 J
(B) −500 J
(C) 0 J
(D) +500 J
(E) +1500 J

11. If 1000 J of heat is added to the gas during process *ab*, what is the change in internal energy of the gas for process *ab*?

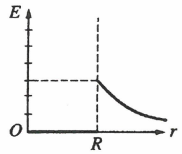
(A) −2000 J
(B) −1000 J
(C) 0 J
(D) +1000 J
(E) +2000 J

12. At room temperature and one atmosphere of pressure, which of the following materials is the best conductor of heat?

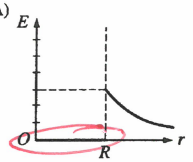
(A) Air
(B) Helium
(C) Silver
(D) Water
(E) Wood

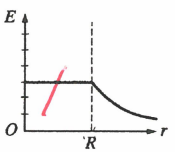
13. What is the acceleration of an object of mass 4.5×10^{-5} kg with a charge of 9×10^{-9} C under the influence of an electric field of magnitude 5000 V/m, assuming gravity is negligible?

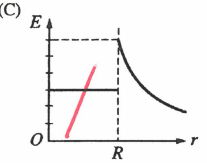
(A) 0.05 m/s²
(B) 0.5 m/s²
(C) 0.9 m/s²
(D) 1.0 m/s²
(E) 5.0 m/s²

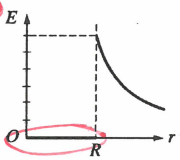


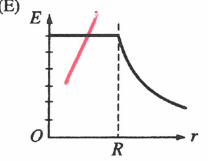
14. A conducting spherical shell of radius *R* has charge *q* uniformly distributed on its outer surface. The graph above represents electric field strength *E* versus distance *r* from the center of the spherical shell. Which of the following graphs best represents *E* versus *r* when the charge on the spherical shell is doubled to 2*q*?

(A)


(B)


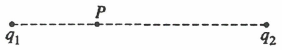
(C)


(D)


(E)


15. A charged particle is in a region that contains both an electric and a magnetic field. The kinetic energy of the particle is 9 μJ at point X and 11 μJ at point Y in the figure above. If the only forces present are electromagnetic, what is the work done by the electric force on the particle as it moves from X to Y along the path shown?

(A) 0 μJ
(B) 1 μJ
(C) 2 μJ
(D) 11 μJ
(E) 20 μJ



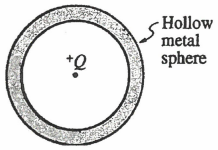
16. Two point charges of unknown magnitudes q_1 and q_2 are placed as shown above. The electric field intensity is zero at point P, which is closer to q_1 than to q_2. Which of the following is true of the signs of the charges and their magnitudes?

	Signs	Magnitudes
(A)	Opposite	Equal
(B)	Opposite	$q_1 > q_2$
(C)	Same	Equal
(D)	Same	$q_1 > q_2$
(E)	Same	$q_1 < q_2$

17. A 60 W, 120 V lightbulb has a resistance of

(A) 0.5 Ω
(B) 2.0 Ω
(C) 120 Ω
(D) 240 Ω
(E) 480 Ω

Questions 18-19



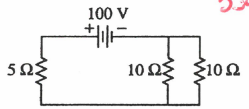
Charge $+Q$ is located at the center of the hollow metal sphere shown in cross section above. The net charge on the sphere is zero.

18. What are the induced charges, if any, on the inner and outer surfaces of the sphere?

	Inner Surface	Outer Surface
(A)	Zero	Zero
(B)	$-Q$	Zero
(C)	$-Q$	$+Q$
(D)	$+Q$	$-Q$
(E)	$+Q$	$+Q$

19. If the potential of the inner surface is V, what is the potential of the outer surface?

(A) Less than zero
(B) Zero
(C) Between zero and V
(D) V
(E) Greater than V



20. In the circuit shown above, what is the current in the 5 Ω resistor?

(A) 40 A
(B) 25 A
(C) 20 A
(D) 10 A
(E) 4 A

21. Balls 1 and 2 are each thrown horizontally from the same height above level ground, but ball 2 has a greater initial velocity after leaving the thrower's hand. If air resistance is negligible, how do the accelerations of the balls and the times it takes them to hit the ground compare?

	Acceleration a	Time to Hit Ground
(A)	Greater for ball 2	Greater for ball 2
(B)	Greater for ball 2	Equal
(C)	Equal	Greater for ball 2
(D)	Equal	Less for ball 2
(E)	Equal	Equal

22. Two objects, X and Y, accelerate from rest with the same constant acceleration. Object X accelerates for twice the time as object Y. Which of the following is true of these objects at the end of their respective periods of acceleration?

(A) Object X is moving at the same speed as object Y.
(B) Object X is moving four times faster than object Y.
(C) Object X has traveled the same distance as object Y.
(D) Object X has traveled twice as far as object Y.
(E) Object X has traveled four times as far as object Y.

23. A builder is replacing a concrete wall with a wooden one and wants the new wall to have the same area and rate of heat flow through it as the old wall. The thermal conductivities of wood and concrete are 0.1 W/m·K and 0.8 W/m·K, respectively. If the concrete wall is 40 cm thick and the temperature difference across the two walls is the same, what thickness of wooden wall is needed?

(A) 2 cm
(B) 4 cm
(C) 5 cm
(D) 20 cm
(E) 32 cm

24. A series of measurements are made of the pressure P and the volume V of a sample of nitrogen gas kept at a constant temperature. It is desired to represent the data graphically so that the graph will be a straight line if the behavior of the gas is ideal. Accordingly, which of the following should be plotted?

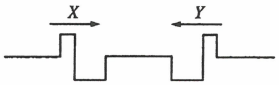
(A) P as a function of V
(B) V/P as a function of V
(C) P/V as a function of V
(D) P as a function of $1/V$
(E) $1/P$ as a function of $1/V$

25. An object is placed 12 cm in front of a concave mirror. The mirror forms a real inverted image that is the same size as the object, also at 12 cm in front of the mirror. The focal length of the mirror is

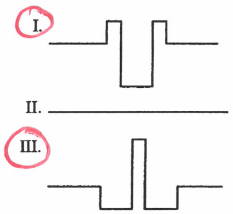
(A) 3.0 cm
(B) 4.0 cm
(C) 6.0 cm
(D) 12 cm
(E) 24 cm

26. At a point of observation, the time between successive crests of a passing wave is 0.2 s. Which of the following must be true of the wave?

(A) Its wavelength is 0.2 m.
(B) Its wavelength is 5 m.
(C) Its period is 5 s.
(D) Its frequency is 5 Hz.
(E) Its velocity of propagation is 5 m/s.



27. The two wave pulses, X and Y, shown above are moving toward each other in the same medium. Which of the following interference patterns could result at some instant as the pulses pass through each other?



(A) I only
(B) II only
(C) I and III only
(D) II and III only
(E) I, II, and III

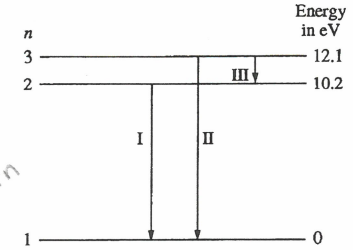
28. Which of the following experimental observations provides the best support for the statement, "Light behaves like a wave" ?

(A) Light can be reflected by a mirror.
(B) Light is scattered when passing through smoke.
(C) Monochromatic light forms bright and dark bands after passing through two narrow slits.
(D) White light can be broken into component colors by a prism.
(E) Light is bent by a gravitational field.

29. When a light wave passes from air into glass, quantities that remain constant include which of the following?

I. Frequency
II. Wavelength
III. Speed

(A) I only
(B) II only
(C) I and III only
(D) II and III only
(E) I, II, and III



30. The figure above shows a portion of the energy level diagram for hydrogen. Possible transitions among the energy levels are represented by arrows I, II, and III. Which of the following lists the transitions in order of their associated wavelengths of light, from shortest wavelength to longest wavelength?

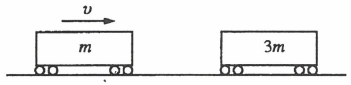
(A) I, II, III
(B) I, III, II
(C) II, I, III
(D) II, III, I
(E) III, I, II

31. $^{238}_{92}U$ undergoes a series of reactions in which it emits eight $^{4}_{2}He$ nuclei and six electrons. What is the isotope that results from this series of reactions?

(A) $^{222}_{66}Dy$
(B) $^{206}_{81}Tl$
(C) $^{206}_{82}Pb$
(D) $^{207}_{82}Pb$
(E) $^{214}_{88}Ra$

32. A deuterium nucleus $^{2}_{1}H$ interacts with a lithium nucleus $^{7}_{3}Li$. Which of the following could NOT possibly occur as the end products of this reaction because of violation of conservation of charge or mass number?

(A) $^{4}_{2}He + {}^{3}_{1}H + {}^{2}_{1}H$
(B) $2\ {}^{3}_{1}H + {}^{1}_{1}H + 2\ {}^{1}_{0}n$
(C) $2\ {}^{4}_{2}He + {}^{1}_{0}n$
(D) $^{7}_{3}Li + {}^{2}_{1}H$
(E) $^{8}_{3}Li + {}^{1}_{1}H$



33. A railroad car of mass m is moving with speed v when it collides with and connects to a second railroad car of mass $3m$, initially at rest, as shown above. How do the speed and kinetic energy of the connected cars compare to those of the single car of mass m before the collision?

	Speed	Kinetic Energy
(A)	Less	Less
(B)	Less	The same
(C)	The same	Less
(D)	The same	The same
(E)	Greater	The same

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