PHYSICS C

MECHANICS: SAMPLE EXAM 3

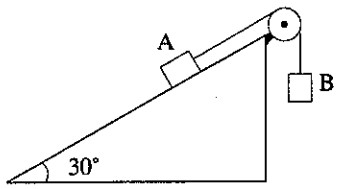
Time – 45 minutes

35 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.

Questions 1 and 2

Block A has mass 0.4 kg and is at rest on an inclined plane of slope angle 30 degrees. It is attached by means of a massless chord passing over a massless, frictionless pulley to block B, which hangs freely. Assume that the inclined plane is frictionless. The system is initially in static equilibrium.



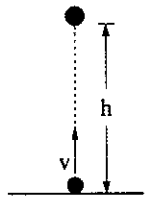
1. If the system is in static equilibrium, the mass of block B must be closest to

   (A) 0.20 kg
   (B) 0.35 kg
   (C) 0.46 kg
   (D) 0.80 kg
   (E) 2.00 kg

2. If the chord is cut, what will the acceleration of block A become?

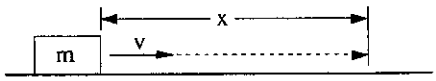
   (A) 0
   (B) 4.9 m/s^2
   (C) 8.5 m/s^2
   (D) 9.8 m/s^2
   (E) 11 m/s^2

3. A ball of mass m is thrown vertically upward with an initial speed of v, as shown below. It reaches a maximum altitude of h. If some air resistance is present, the amount of work this air resistance does on the ball as it is rises to altitude h may be expressed as



   (A) mgh
   (B) mg (h – v)
   (C) mgh + 0.5mv^2
   (D) 0.5mv^2 – mgh
   (E) 0.5mv^2

4. As shown below, an object of mass m moves at initial speed v on a horizontal plane. Friction brings it to rest over a distance x. The average force of friction on the object while it is slowing down is



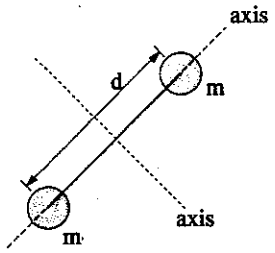
   (A) $\frac{mv}{x}$
   (B) $\frac{mv^2}{x}$
   (C) $\frac{0.5mv^2}{x}$
   (D) $\frac{2mv}{x}$
   (E) $\frac{mg}{xv}$

5. An object moves in uniform circular motion. Its kinetic energy is directly proportional to

I. the centripetal force
II. the radius of the circle
III. the period of the circular motion

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

Questions 6 - 8
Two small spheres, each of mass m and of negligible radius, are connected by a massless rigid rod of length d, as shown below.



6. The gravitational force between the two spheres is

(A) 0
(B) $\frac{Gm}{d^2}$
(C) $G\left(\frac{m}{d}\right)^2$
(D) $G\left(\frac{m}{2d}\right)^2$
(E) $4G\left(\frac{m}{d}\right)^2$

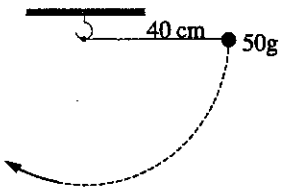
7. The moment of inertia about an axis perpendicular to the connecting rod and through its center is

(A) 0
(B) $0.25md^2$
(C) $0.50md^2$
(D) md^2
(E) $4md^2$

8. The moment of inertia about and axis which passes through the rod and both spheres is

(A) 0
(B) $0.25md^2$
(C) $0.50md^2$
(D) md^2
(E) $4md^2$

Questions 9 - 11
A ball of mass 50 grams is fixed to the end of a 40 cm long string of negligible mass, as shown below in the diagram. The other end of the string is tied to a fixed point. The ball is free to swing on the string. Initially, the ball is held so the string is taut and horizontal. The ball is then released and is observed to swing in a vertical plane.



9. Neglecting friction, the maximum kinetic energy of the ball as it swings is closest to

(A) 0.2 J
(B) 2 J
(C) 20 J
(D) 200 J
(E) 2000 J

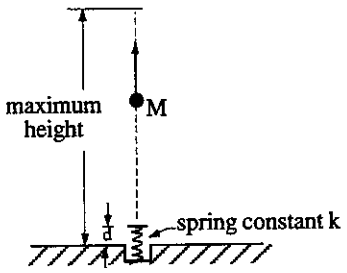
10. Neglecting friction, the time it takes the ball to return to its original position is closest to

(A) 0.2 s
(B) 0.8 s
(C) 1.3 s
(D) 2.8 s
(E) 12.6 s

11. The maximum tension in the string will be

(A) 0.5 N
(B) 1.0 N
(C) 1.5 N
(D) 2.0 N
(E) 2.5 N

12. In the diagram below, a spring is mounted vertically in a hole so that when it is compressed a distance d from equilibrium the top is flush with the ground. The spring constant is k. A marble of mass m is placed on the compressed spring, which is then released. Assuming no friction, in the system, the maximum height the marble will reach is



(A) d

(B) $\left(\frac{2k}{m}\right)d^2$

(C) $\left(\frac{k}{2mg}\right)d^2$

(D) $\left(\frac{2k}{mg}\right)d^2$

(E) $\frac{kd}{mg}$

13. An object of mass m has constant acceleration *a* over distance x. The work done on the object over this distance is

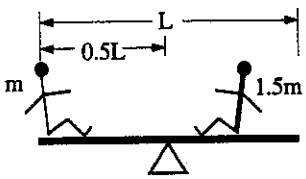
(A) 0
(B) 0.5m*a*x
(C) 0.5mx^2
(D) m*a*x
(E) 2mx

14. An object is in simple harmonic motion. At which point is its potential energy the greatest?

I. at equilibrium
II. at positive amplitude
III. at negative amplitude

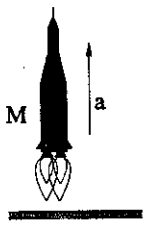
(A) I only
(B) II only
(C) III only
(D) I and II
(E) II and III

15. A seesaw is made out of a board of negligible mass mounted on a pivot at its center, as shown below. The length of the board is L. A child of mass m sits at the far left end of the seesaw. How far to the right of the pivot must a child of mass 1.5m sit if the seesaw is to balance?



(A) 0.33L
(B) 0.50L
(C) 0.67L
(D) 1.00L
(E) 1.50L

16. A rocket of mass M lifts off from the ground with acceleration a, as shown below. Assuming no air resistance, the upward force of the thrust of the rocket must be



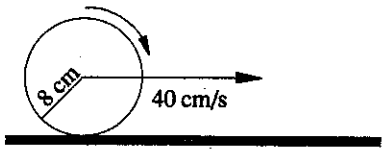
(A) Ma
(B) Mg
(C) $\frac{Ma}{g}$
(D) M (a+g)
(E) 2Ma – 3Mg

17. An object is in damped harmonic motion. Over time, which of the following decreases?

I. the amplitude
II. the period
III. the angular frequency

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

18. A ball of radius 8 cm rolls without slipping at 40 cm/s, as shown below. The rotational velocity of the ball must be



(A) 2.5 rad/s
(B) 5.0 rad/s
(C) 10 rad/s
(D) 160 rad/s
(E) 329 rad/s

Questions 19 - 21
As an object falls, the force of air resistance exerted on it can be written as kv, where v is the instantaneous velocity of the object and k is a proportionality constant.

19. If M represents mass, L represents length, and T represents time, the dimensions of k must be

(A) $\frac{M}{T}$

(B) $\frac{M}{L}$

(C) $\frac{L}{T}$

(D) $\frac{L}{T^2}$

(E) LT

20. The "terminal velocity" of the object is the maximum velocity it approaches as a limit. This velocity may be written as

(A) $\frac{mg}{k}$

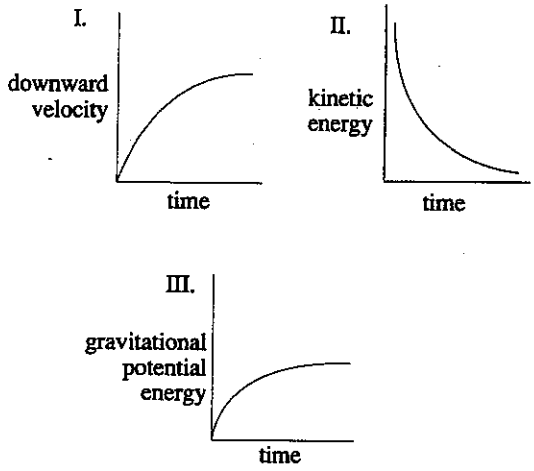
(B) mk

(C) gk

(D) $\frac{mk}{g}$

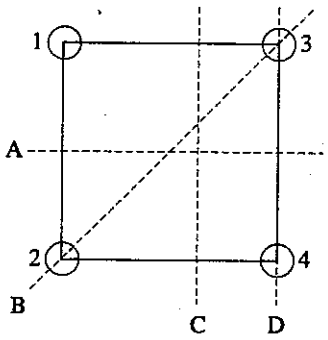
(E) k

21. Which of the graphs below best describes the motion of the falling object?



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

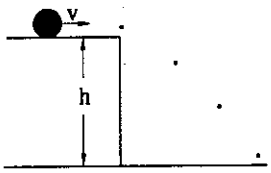
22. In the diagram below, objects 1 and 2 each have mass m while objects 3 and 4 each have mass 2m. Note four lines A, B, C, and D. The center of mass of the system is most likely to be at the intersection of lines



(A) A and B
(B) B and C
(C) A and D
(D) A and C
(E) B and D

Questions 23 and 24

A ball rolls off a table of height h at horizontal speed v, as shown below. The ball moves as a projectile until it hits the floor. Assume that air resistance is negligible.



23. Which quantity remains constant while the ball is executing its projectile motion?

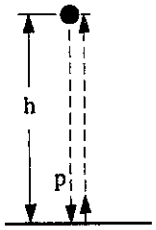
I. its horizontal speed
II. its vertical speed
III. its vertical acceleration

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

24. What is the magnitude of the velocity of the ball just as it reaches the floor (assuming the floor to be uniformly horizontal)?

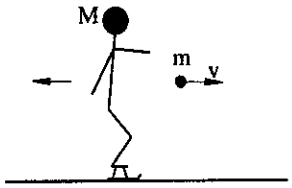
(A) v
(B) $v + g$
(C) $\sqrt{2gh}$
(D) $\sqrt{v^2 + 2gh}$
(E) $v - 2gh$

25. A ball is dropped from height h as diagrammed below. It strikes a sidewalk with momentum p and then bounces back up to its original height. The impulse given to the ball by the sidewalk is closest in magnitude to



(A) 0
(B) 1.4p
(C) p
(D) 2p
(E) 4p

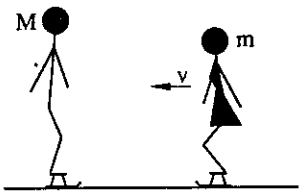
26. In the diagram below, a man of mass M standing on frictionless ice throws a ball of mass m. Assume M>>m. If the ball is thrown at speed v relative to the ice, the magnitude of the recoil velocity of the man is



I. much less than v
II. much greater than v
III. directly proportional to M

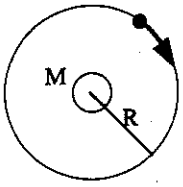
(A) I only
(B) II only
(C) III only
(D) I and III
(E) II and III

27. A man of mass M stands on frictionless stands at rest. An ice skater of mass m skates up to him at speed v, as shown below. They collide inelastically. The speed of the pair after the collision should be



(A) $\frac{mv}{M+m}$
(B) $\frac{mv}{M}$
(C) $\frac{Mv}{m}$
(D) $\frac{(M-m)v}{M+m}$
(E) v

Questions 28 and 29
A satellite is in a circular orbit of radius R about a planet of mass M, as shown in the diagram below.



28. The kinetic energy of the satellite in its orbit is

I. directly proportional to R
II. inversely proportional to R
III. inversely proportional to M

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

29. The angular momentum of the satellite in its orbit is

I. directly proportional to R
II. directly proportional to the square root of R
III. directly proportional to the square root of M

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

Questions 30 and 31
An object of moment of inertia I is intially at rest. A net torque T accelerates the object to angular velocity ω in time t.

30. The magnitude of the rate of change of angular momentum of the object is

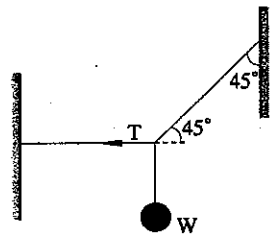
I. T
II. $\frac{I\omega}{t}$
III. $I\omega$

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

31. The power with which the object is accelerated is

(A) $\frac{I\omega^2}{t^2}$
(B) $\frac{I\omega^2}{t}$
(C) $\frac{I\omega}{t}$
(D) $\frac{I\omega^2}{2t}$
(E) $\frac{I\omega^2}{2t}$

32. A weight W hangs in static equilibrium as shown below. Tension T in the diagram must have magnitude nearest to

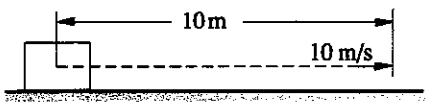


(A) 0.5W
(B) 0.7W
(C) 1.0W
(D) 1.4W
(E) 2.0W

33. An object is in uniform circular horizontal motion at the end of a chord of length L. Its tangential speed is v. The chord is pulled in to length 0.5L in such a way that the tension in the chord remains constant. As a result, the tangential speed

(A) remains constant
(B) increases to 2v
(C) decreases to 0.5v
(D) increases to 1.4v
(E) decreases to 0.7v

34. As shown below, an object begins at rest and accelerates to 10 m/s over a distance of 10 m. Assuming the acceleration to be constant, the magnitude of the acceleration is most nearly



(A) 1 m/s²
(B) 2 m/s²
(C) 4 m/s²
(D) 5 m/s²
(E) 10 m/s²

35. An object moves according to $x = A \sin \omega t$, where x is displacement from equilibrium, A is the amplitude of the motion, ω is the angular frequency, and t is time. Which of the equations below would indicate motion out of phase with the motion of the object described above?

I. $x = 0.5A \sin \omega t$

II. $x = A \cos \omega t$

III. $x = A \cos\left(\omega t - \frac{\pi}{2}\right)$

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

Name Key Date

AP Physics

Part 1 Answer Sheet Exam # SE #3

Place the best answer to each question in the space provided.

1. A	19. A	
2. B	20. A	
3. D	21. A	
4. C	22. D	
5. D	23. D	
6. C	24. D	
7. C	25. D	
8. A	26. A	
9. A	27. A	
10. C	28. B	
11. C	29. E	
12. C	30. D	
13. D	31. D	
14. E	32. C	
15. A	33. E	
16. D	34. D	
17. A	35. B	
18. B		

Number correct _____ x 1 = _____

Number left blank _____ x 1 = _____

Number incorrect _____ x -.25 = _____

Score (out of 35) _____

Grade _____ AP Score _____