AP® Physics C
1998 Multiple Choice Questions
Mechanics

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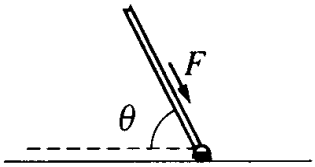
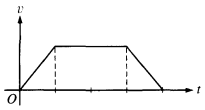


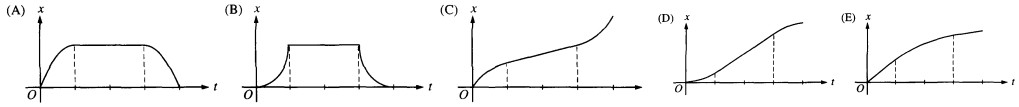
1. A force F is exerted by a broom handle on the head of the broom, which has a mass m. The handle is at an angle θ to the horizontal, as shown above. The work done by the force on the head of the broom as it moves a distance d across a horizontal floor is
(A) Fd sin θ (B) Fd cosθ (C) Fm cosθ (D) Fm tanθ (E) Fmd sinθ

2. The velocity of a projectile at launch has a horizontal component v_h and a vertical component v_v. Air resistance is negligible. When the projectile is at the highest point of its trajectory, which of the following show the vertical and horizontal components of its velocity and the vertical component of its acceleration?

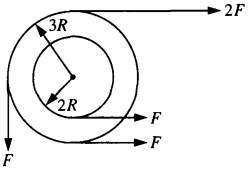
	Vertical Velocity	Horizontal Velocity	Vertical Acceleration
(A)	v_v	v_h	0
(B)	v_v	0	0
(C)	0	v_h	0
(D)	0	0	g
(E)	0	v_h	g



3. The graph above shows the velocity *v* as a function of time *t* for an object moving in a straight line. Which of the following graphs shows the corresponding displacement *x* as a function of time *t* for the same time interval?



4. The position of a toy locomotive moving on a straight track along the x-axis is given by the equation $x = t^3 - 6t^2 + 9t$, where x is in meters and t is in seconds. The net force on the locomotive is equal to zero when t is equal to
(A) zero (B) 2 s (C) 3 s (D) 4 s (E) 5 s



5. A system of two wheels fixed to each other is free to rotate about a frictionless axis through the common center of the wheels and perpendicular to the page. Four forces are exerted tangentially to the rims of the wheels, as shown above. The magnitude of the net torque on the system about the axis is
(A) zero (B) FR (C) 2FR (D) 5FR (E) 14FR

6. A wheel of mass M and radius R rolls on a level surface without slipping. If the angular velocity of the wheel is ω, what is its linear momentum ?
(A) MωR (B) $M\omega^2R$ (C) $M\omega R^2$ (D) $M\omega^2R^2/2$ (E) Zero

Questions 7-8 refer to a ball that is tossed straight up from the surface of a small, spherical asteroid with no atmosphere. The ball rises to a height equal to the asteroid's radius and then falls straight down toward the surface of the asteroid.

7. What forces, if any, act on the ball while it is on the way up?

(A) Only a decreasing gravitational force that acts downward
(B) Only an increasing gravitational force that acts downward
(C) Only a constant gravitational force that acts downward
(D) Both a constant gravitational force that acts downward and a decreasing force that acts upward
(E) No forces act on the ball.

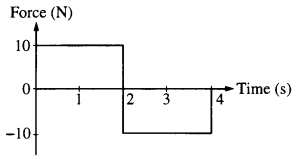
8. The acceleration of the ball at the top of its path is
(A) at its maximum value for the ball's flight
(B) equal to the acceleration at the surface of the asteroid
(C) equal to one-half the acceleration at the surface of the asteroid
(D) equal to one-fourth the acceleration at the surface of the asteroid
(E) zero

9. The equation of motion of a simple harmonic oscillator is $d^2x/dt^2 = -9x$, where x is displacement and t is time. The period of oscillation is
(A) 6π (B) $9/2\pi$ (C) $3/2\pi$ (D) $2\pi/3$ (E) $2\pi/9$

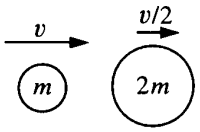
10. A pendulum with a period of 1 s on Earth, where the acceleration due to gravity is g, is taken to another planet, where its period is 2 s. The acceleration due to gravity on the other planet is most nearly
(A) g/4 (B) g/2 (C) g (D) 2g (E) 4g

11. A satellite of mass M moves in a circular orbit of radius R with constant speed v. True statements about this satellite include which of the following?
I. Its angular speed is v/R.
II. Its tangential acceleration is zero.
III. The magnitude of its centripetal acceleration is constant.

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



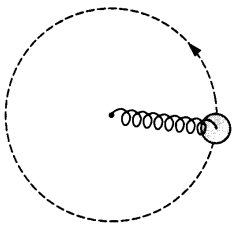
12. The graph above shows the force on an object of mass M as a function of time. For the time interval 0 to 4 s, the total change in the momentum of the object is
(A) 40 kg m/s (B) 20 kg m/s (C) 0 kg m/s (D) -20 kg m/s
(E) indeterminable unless the mass M of the object is known



Top View

13. As shown in the top view above, a disc of mass m is moving horizontally to the right with speed v on a table with negligible friction when it collides with a second disc of mass 2m The second disc is moving horizontally to the right with speed v/2 at the moment of impact The two discs stick together upon impact The speed of the composite body immediately after the collision is
(A) v/3 (B) v/2 (C) 2v/3 (D) 3v/2 (E) 2v

Questions 14-15



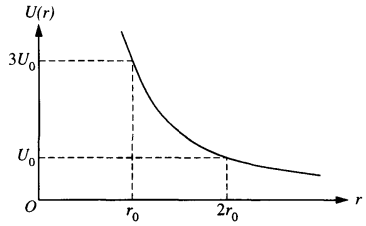
Top View

A spring has a force constant of 100 N/m and an unstretched length of 0.07 m. One end is attached to a post that is free to rotate in the center of a smooth table, as shown in the top view above. The other end is attached to a 1 kg disc moving in uniform circular motion on the table, which stretches the spring by 0.03 m. Friction is negligible.

14. What is the centripetal force on the disc? (A) 0.3 N (B) 3N (C) 10 N (D) 300 N (E) 1,000 N

15. What is the work done on the disc by the spring during one full circle?
(A) 0 J (B) 94 J (C) 186 J (D) 314 J (E) 628 J

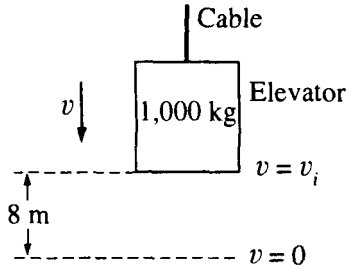
Questions 16-17 refer to the following graph, which represents a hypothetical potential energy curve for a particle of mass *m*.



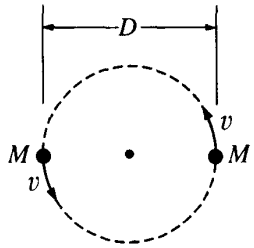
16. If the particle is released from rest at position r_o, its speed at position $2r_o$ is most nearly
(A) $\sqrt{\frac{8U_0}{m}}$ (B) $\sqrt{\frac{6U_0}{m}}$ (C) $\sqrt{\frac{4U_0}{m}}$ (D) $\sqrt{\frac{2U_0}{m}}$ (E) $\sqrt{\frac{U_0}{m}}$

17. If the potential energy function is given by $U(r) = br^{-3/2} + c$, where b and c are constants, which of the following is an expression for the force on the particle?
(A) $\frac{3b}{2}r^{-5/2}$ (B) $\frac{3b}{2}r^{-1/2}$ (C) $\frac{3}{2}r^{-1/2}$ (D) $2br^{-1/2} + cr$ (E) A $\frac{2b}{5}r^{-5/2} + cr$

18. A frictionless pendulum of length 3 m swings with an amplitude of 10°. At its maximum displacement, the potential energy of the pendulum is 10 J. What is the kinetic energy of the pendulum when its potential energy is 5 J ?
(A) 3.3 J (B) 5 J (C) 6.7 J (D) 10 J (E) 15 J

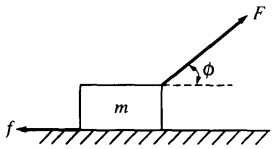


19. A descending elevator of mass 1,000 kg is uniformly decelerated to rest over a distance of 8 m by a cable in which the tension is 11,000 N. The speed v_i of the elevator at the beginning of the 8 m descent is most nearly
(A) 4 m/s (B) 10 m/s (C) 13 m/s (D) 16 m/s (E) 21 m/s



20. Two identical stars, a fixed distance D apart, revolve in a circle about their mutual center of mass, as shown above. Each star has mass M and speed *v*. G is the universal gravitational constant. Which of the following is a correct relationship among these quantities?
(A) $v^2 = GM/D$ (B) $v^2 = GM/2D$ (C) $v^2 = GM/D^2$ (D) $v^2 = MGD$ (E) $v^2 = 2GM^2/D$

Questions 21-22



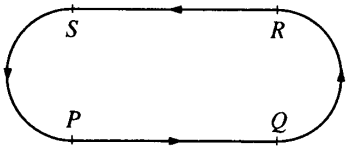
A block of mass m is accelerated across a rough surface by a force of magnitude F that is exerted at an angle ϕ with the horizontal, as shown above. The frictional force on the block exerted by the surface has magnitude *f*.

21. What is the acceleration of the block?
(A) F/*m* (B) Fcosϕ /m (C) (F-*f*)/*m* (D) (Fcosϕ-*f*)/*m* (E) (Fsinϕ-*mg*)/*m*

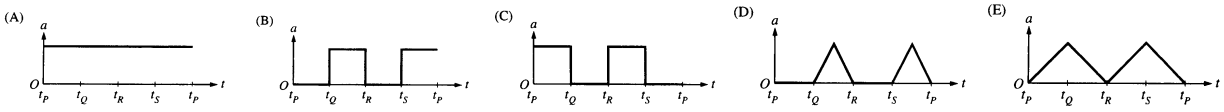
22. What is the coefficient of friction between the block and the surface?
(A) *f*/*mg* (B) *mg*/*f* (C) (*mg*-Fcosϕ)/*f* (D) *f*/(*mg*-Fcosϕ) (E) *f*/(*mg*-Fsinϕ)

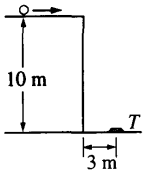
23. This question was not counted when the exam was scored.

24. Two people are initially standing still on frictionless ice. They push on each other so that one person, of mass 120 kg, moves to the left at 2 m/s, while the other person, of mass 80 kg, moves to the right at 3 m/s. What is the velocity of their center of mass?
(A) Zero (B) 0.5 m/s to the left (C) 1 m/s to the right (D) 2.4 m/s to the left (E) 2.5 m/s to the right



25. A figure of a dancer on a music box moves counterclockwise at constant speed around the path shown above. The path is such that the lengths of its segments, *PQ*, *QR*, *RS*, and *SP*, are equal. Arcs *QR* and *SP* are semicircles. Which of the following best represents the magnitude of the dancer's acceleration as a function of time t during one trip around the path, beginning at point *P* ?





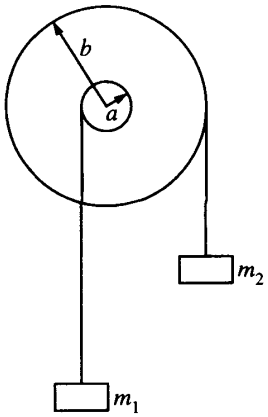
26. A target *T* lies flat on the ground 3 m from the side of a building that is 10 m tall, as shown above. A student rolls a ball off the horizontal roof of the building in the direction of the target. Air resistance is negligible. The horizontal speed with which the ball must leave the roof if it is to strike the target is most nearly

(A) 3/10 m/s (B) $\sqrt{2}$ m/s (C) $\frac{3}{\sqrt{2}}$ m/s (D) 3 m/s (E) $10\sqrt{\frac{5}{3}}$ m/s

27. To stretch a certain nonlinear spring by an amount x requires a force F given by $F = 40x - 6x^2$, where F is in newtons and x is in meters. What is the change in potential energy when the spring is stretched 2 meters from its equilibrium position? (A) 16 J (B) 28 J (C) 56 J (D) 64 J (E) 80 J

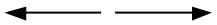
28. When a block slides a certain distance down an incline, the work done by gravity is 300 J. What is the work done by gravity if this block slides the same distance up the incline?
(A) 300 J (B) Zero (C) -300 J
(D) It cannot be determined without knowing the distance the block slides.
(E) It cannot be determined without knowing the coefficient of friction.

29. A particle moves in the xy-plane with coordinates given by
$x = A\cos\omega t$ and $y = A\sin\omega t$,
where A = 1.5 meters and ω = 2.0 radians per second. What is the magnitude of the particle's acceleration?
(A) Zero (B) 1.3 m/s^2 (C) 3.0 m/s^2 (D) 4.5 m/s^2 (E) 6.0 m/s^2



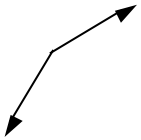
30. For the wheel-and-axle system shown above, which of the following expresses the condition required for the system to be in static equilibrium?
(A) $m_1 = m_2$ (B) $am_1 = bm_2$ (C) $am_2 = bm_1$
(D) $a^2m_1 = b^2m^2$ (E) $b^2m_1 = a^2m_2$

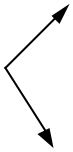
31. An object having an initial momentum that may be represented by the vector above strikes an object that is initially at rest. Which of the following sets of vectors may represent the momenta of the two objects after the collision?

(A) 

(B) 

(C) 

(D) 

(E) 

Questions 32-33

A wheel with rotational inertia *I* is mounted on a fixed, frictionless axle. The angular speed ω of the wheel is increased from zero to ω_f in a time interval T.

32. What is the average net torque on the wheel during this time interval?

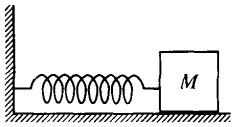
(A) $\frac{\omega_f}{T}$ (B) $\frac{\omega_f}{T^2}$ (C) $\frac{I\omega_f^2}{T}$ (D) $\frac{I\omega_f}{T^2}$ (E) $\frac{I\omega_f}{T}$

33. What is the average power input to the wheel during this time interval?

(A) $\frac{I\omega_f}{2T}$ (B) $\frac{I\omega_f^2}{2T}$ (C) $\frac{I\omega_f^2}{2T^2}$ (D) $\frac{I^2\omega_f}{2T^2}$ (E) $\frac{I^2\omega_f^2}{2T^2}$

34. An object is released from rest at time t = 0 and falls through the air, which exerts a resistive force such that the acceleration a of the object is given by a = g - bv, where v is the object's speed and b is a constant. If limiting cases for large and small values of t are considered, which of the following is a possible expression for the speed of the object as an explicit function of time?

(A) $v = g(1 - e^{-bt})/b$ (B) $V = (ge^{ht})/b$ (C) $v = gt - bt^2$ (D) $v = (g + a)t/b$ (E) $v = v_0 + gt$, $v_0 \neq O$



35. An ideal massless spring is fixed to the wall at one end, as shown above. A block of mass M attached to the other end of the spring oscillates with amplitude A on a frictionless, horizontal surface. The maximum speed of the block is v_m. The force constant of the spring is

(A) $\frac{Mg}{A}$ (B) $\frac{Mgv_m}{2A}$ (C) $\frac{Mv_m^2}{2A}$ (D) $\frac{Mv_m^2}{A^2}$ (E) $\frac{Mv_m^2}{2A^2}$

Chapter V Answers to the 1998 AP Physics C Examination

- Section I: Multiple Choice
  - Blank Answer Sheet
- Section II: Free Response

Section I: Multiple Choice

Listed below are the correct answers to the multiple-choice questions and the percentage of AP candidates who answered each question correctly.

Answer Key and Percent Answering Correctly

Mechanics			Electricity & Magnetism		
Item No.	Correct Answer	Percent Correct	Item No.	Correct Answer	Percent Correct
1	B	82%	36	B	74%
2	E	82%	37	E	65%
3	D	78%	38	C	77%
4	B	67%	39	E	93%
5	C	69%	40	D	79%
6	A	56%	41	C	56%
7	A	56%	42	D	75%
8	D	45%	43	D	29%
9	D	18%	44	A	75%
10	A	53%	45	C	80%
11	E	45%	46	E	61%
12	C	68%	47	D	34%
13	C	81%	48	C	45%
14	B	61%	49	A	49%
15	A	42%	50	D	33%
16	C	54%	51	A	28%
17	A	50%	52	C	45%
18	B	82%	53	E	50%
19	A	35%	54	E	63%
20	B	18%	55	B	26%
21	D	89%	56	E	50%
22	E	42%	57	A	19%
*23	—	—	58	A	53%
24	A	67%	59	C	50%
25	B	56%	60	B	24%
26	C	63%	61	A	74%
27	D	46%	62	D	64%
28	C	59%	63	E	39%
29	E	29%	64	B	71%
30	B	71%	65	D	27%
31	E	48%	66	B	46%
32	E	65%	67	A	24%
33	B	36%	68	E	30%
34	A	37%	69	B	62%
35	D	58%	70	A	61%

*This question was not counted when the exam was scored.