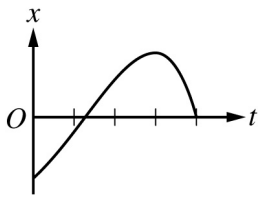
Sample Exam Questions

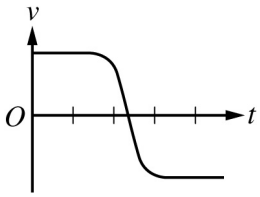
The following are examples of the kinds of multiple-choice questions found on the exam.

Section I: Multiple-Choice Questions

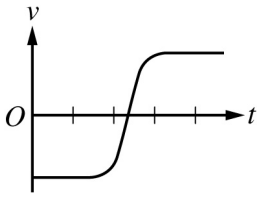


1. The graph shows the position x as a function of time t of an object in linear motion. Which of the following graphs best represents the velocity v of the object as a function of t?

(A)



(B)



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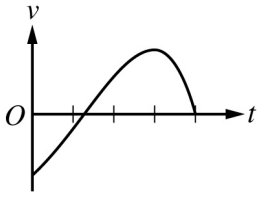

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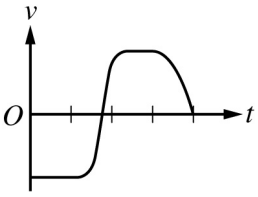
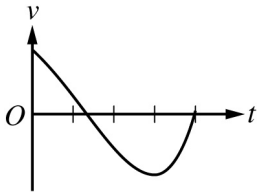
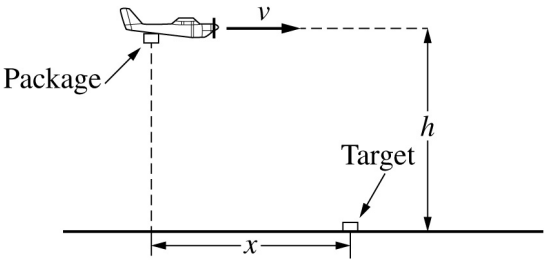


(E)





2. A plane is moving horizontally through the sky with speed v. A package is dropped from the plane and travels a horizontal distance x from the point of release to where it lands on a target. If air resistance is negligible, the height from which the package is released is

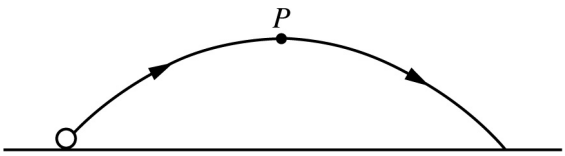
(A) $\frac{1}{2}g\sqrt{\frac{x}{v}}$

(B) $\frac{1}{2}gt^2$

(C) $\frac{1}{2}g\left(\frac{x}{2v}\right)$

(D) $\frac{1}{2}g\left(\frac{x}{v}\right)^2$

(E) $\frac{1}{2}g\left(\frac{v}{x}\right)^2$



3. A small sphere is thrown through the air and follows the parabolic path shown in the figure. Point P is the highest point the sphere reaches. Assuming air resistance is negligible, which of the following claims is true of the sphere while it is in motion?

(A) The vertical component of the sphere's velocity is at a maximum at point P.

(B) The horizontal component of the sphere's velocity is zero at point P.

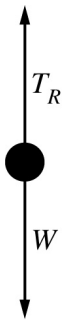
(C) The acceleration of the sphere is constant.

(D) The sphere's speed is constant.

(E) The displacement of the sphere is zero at point P.

4. The swing shown above is attached to a rope that passes over an ideal pulley and then back down to the hands of a child sitting on the swing. The tensions in the rope on the left and one the right are T_L and T_R, respectively, and the weight of the child plus the swing is W. Which of the following free-body diagrams best shows the child and the swing if they are to remain at rest and in equilibrium?

(A)



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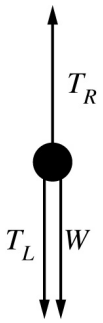

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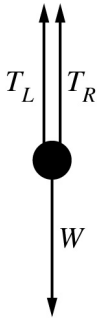

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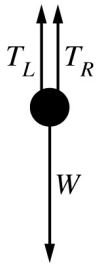

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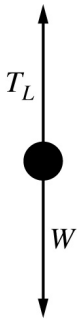
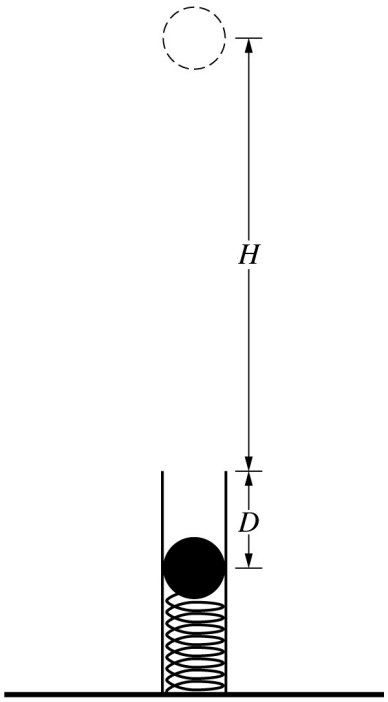




5. An experiment is performed to determine the unknown mass of a sphere. A spring-loaded launcher is used to launch the sphere. The launcher is set to exert a force with an average magnitude of F on the sphere over a distance D. The sphere is launched vertically upward and takes a time t to reach a height H, as shown in the figure. Which of the following gives the minimum data needed to determine the mass of the sphere?

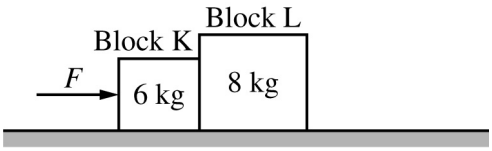
(A) F only

(B) F and D only

(C) F, H, and t

(D) H, t, and D

(E) F, D, and H



6. Blocks K and L are initially at rest on a horizontal surface of negligible friction. A horizontal force F is exerted on block K, as shown in the figure, and the blocks move to the right with an acceleration of $2\frac{m}{s^2}$. The magnitude of the force exerted on block K by block L is

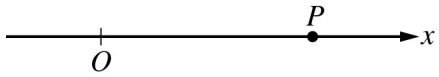
(A) zero

(B) 2 N

(C) 12 N

(D) 16 N

(E) 28 N



7. A particle P is located on the x-axis, as shown in the figure. A force exerted on the particle is given by the equation $F = kx^3$, where $k = 4\frac{\text{N}}{\text{m}^3}$. How much work is done by the force in moving the particle from $x = 2$ m to $x = 1$ m?

   (A) 15 J

   (B) 28 J

   (C) 32 J

   (D) 36 J

   (E) 60 J

8. A motor rated with power P is used to lift an object of weight at constant speed to a height H in time t. The work done in lifting the box is W. A motor rated with power $2P$ is used to lift the same object to the same height H in time t_2. The new work done in lifting the box is W_2. Which of the following claims correctly describes the relationships between the two times and two values of work done and is supported with appropriate reasoning?

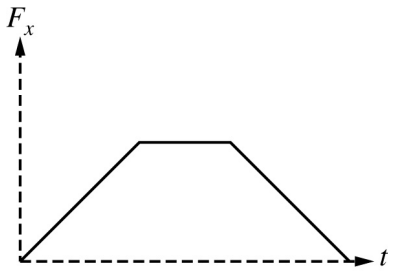
   (A) $W_2 > W$ and $t_2 < t$, because the more-powerful motor can do more work and do the work faster.

   (B) $W_2 > W$ and $t_2 < t$, because whenever the work is done faster, more work will be done.

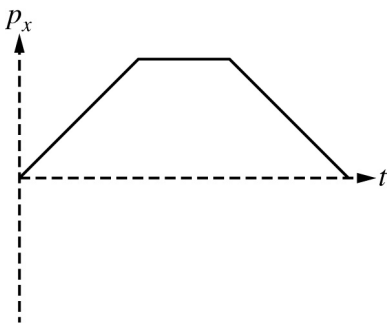
   (C) $W_2 = W$ and $t_2 < t$, because the object is lifted to the same height and the more-powerful motor can do work faster.

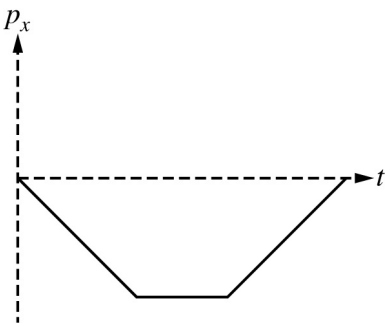
   (D) $W_2 > W$ and $t_2 < t$, because the object is lifted to the same height and the more-powerful motor can do work faster.

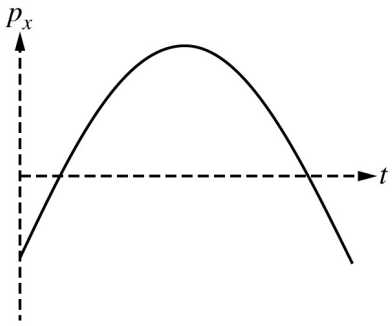
   (E) $W_2 = W$ and $t_2 = t$, because the object is lifted to the same height, and the work done and the time to do the work will be the same.



9. An object is moving in a straight line along the x-axis. The net force F_x exerted on the object as a function of time t is shown in the graph. Which of the following could be the momentum p_x of the object as a function of t ?

(A)


(B)


(C)


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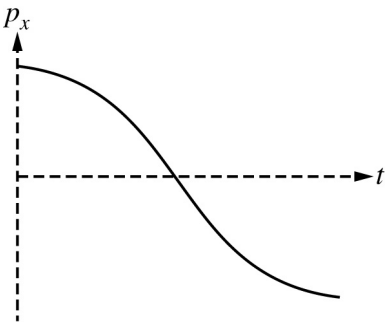

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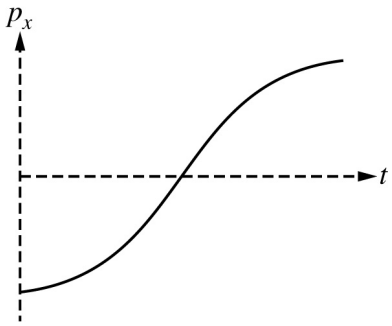
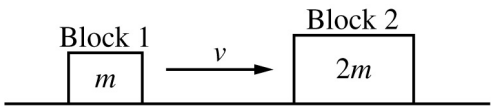




10. Block 1 of mass m is moving with speed v to the right on a horizontal surface of negligible friction, as shown in the figure. Block 1 makes an elastic, head-on collision with block 2 of mass $2m$, which is at rest. Which of the following are correct velocities v_1 and v_2 for blocks 1 and 2, respectively, immediately after the collision?

(A) $v_1 = \frac{1}{3}v$ and $v_2 = \frac{2}{3}v$

(B) $v_1 = -\frac{1}{3}v$ and $v_2 = \frac{2}{3}v$

(C) $v_1 = 0$ and $v_2 = \frac{1}{2}v$

(D) $v_1 = -\frac{1}{2}v$ and $v_2 = \frac{1}{2}v$

(E) $v_1 = \frac{1}{2}v$ and $v_2 = \frac{1}{2}v$

11. A figure skater is spinning with her arms outstretched such that her rotational inertia is I. She is spinning with an angular speed ω_0. She pulls in her arms such that her rotational inertia reduces to $\frac{1}{3}I$. Her new angular speed will be

(A) $\frac{1}{6}\omega_0$

(B) $\frac{1}{3}\omega_0$

(C) ω_0

(D) $3\omega_0$

(E) $6\omega_0$

12. A wheel of radius 15 cm has a rotational inertia of $2.3\ \text{kg} \cdot \text{m}^2$. The wheel is spinning at a rate of 6.5 revolutions per second. A frictional force is applied tangentially to the wheel to bring it to a stop. The work done by the torque to stop the wheel is most nearly

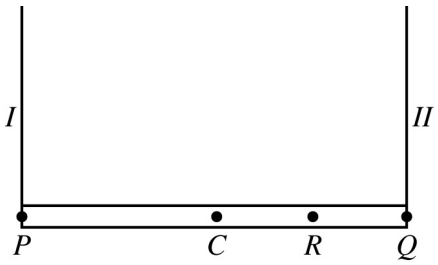
(A) zero

(B) -50 J

(C) -100 J

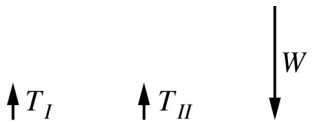
(D) -1920 J

(E) -3840 J



13. A horizontal rod is supported at each end by ropes I and II, which are attached to the rod at points P and Q, respectively, as shown in the figure. The two ropes have negligible mass, and the rod has a nonuniform mass distribution such that the rod's center of mass is at point R. Point C is the center of the rod. The rod remains horizontal. Which of the following vectors could represent the tensions T_I and T_{II} in ropes I and II, respectively, and the weight W of the rod?

(A)



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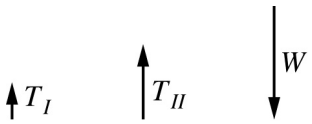

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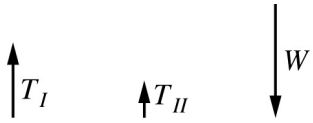
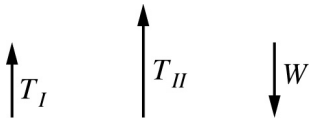
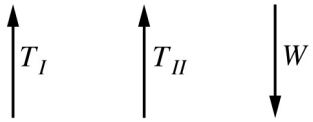
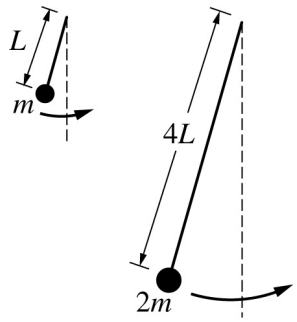


(D)



(E)





14. A small sphere of mass m is at the end of a light string of length L. The sphere is pulled back a small distance and released. The sphere swings with a period of motion T. The process is repeated with a sphere of mass $2m$ and a light string of length $4L$. The new period of motion will be

(A) $8T$

(B) $2T$

(C) $\frac{1}{2}T$

(D) $\frac{1}{4}T$

(E) $\frac{1}{8}T$

15. The acceleration due to gravity at Earth's surface is g. Astronauts are traveling to another planet that has three times the radius and four times the mass of Earth. The acceleration due to gravity at the surface of the other planet is

(A) $\frac{4}{9}g$

(B) g

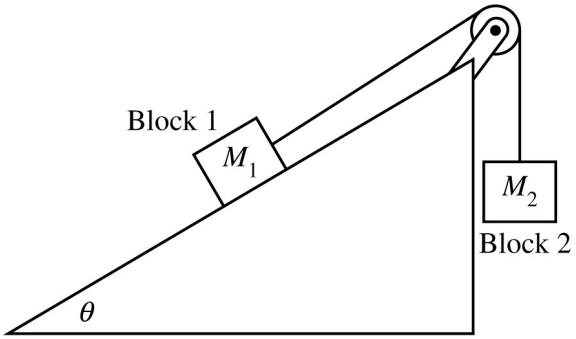
(C) $\frac{4}{3}g$

(D) $\frac{16}{9}g$

(E) $\frac{9}{4}g$

Section II: Free-Response Questions

The following are examples of the of free-response questions found on the exam. Note that on the actual AP Exam, there will be three questions.



1. Students set up a system of two blocks and an inclined plane, as shown in the figure. Block 1 of mass M_1 is on an surface that is inclined at an angle θ to the horizontal. The friction between block 1 and the surface is negligible. A string is attached to block 1, extends over an ideal pulley, and is then attached to block 2 of mass M_2.

   (a) In an initial setup, $M_1 = 3M$ and $M_2 = M$. Calculate the value of θ that would allow the system to remain in equilibrium.

   The original inclined plane is now replaced with one that has a rough surface. The coefficients of static and kinetic friction between block 1 and the surface are μ_s and μ_k, respectively. Block 1 is again chosen so that $M_1 = M$.

   (b) Derive an expression for the maximum value of M_2 that would allow this system to remain in equilibrium. Express your answer in terms of M, μ_s, μ_k, and physical constants, as appropriate.

   Block 2 of mass M_2 is now chosen such that block 1 will accelerate up the inclined plane.

   (c)

   i. Derive an expression for the magnitude of the acceleration of block 1. Express your answer in terms of M_1, M_2, μ_s, μ_k, θ, and physical constants, as appropriate.

   ii. Derive an expression for the tension in the string. Express your answer in terms of M_1, M_2, μ_s, μ_k, θ, and physical constants, as appropriate.