Unit 4 Pre Exam – Energy – AP Physics

Multiple-Choice questions

1. A force F is at an angle θ above the horizontal and is used to pull a heavy suitcase of weight mg a distance d along a level floor at constant velocity. The coefficient of friction between the floor and the suitcase is μ. The work done by the force F is:
   A. $Fd\cos\theta - \mu mgd$
   B. $Fd\cos\theta$
   C. $-\mu mgd$
   D. $2Fd\sin\theta - \mu mgd$

2. A 4 kg ball is attached to a 1.5 m long string and whirled in a horizontal circle at a constant speed 5 m/s. How much work is done on the ball during one period?
   A. 9 J
   B. 4.5 J
   C. 2 J
   D. 0 J

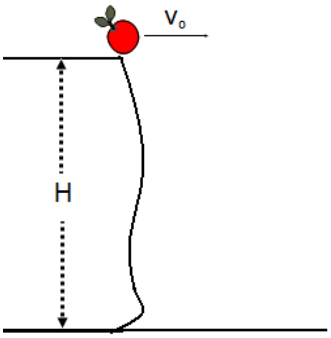
3. You need to move three identical couches from the first to the second floor of an apartment building. The first time, you and a friend make a mistake and carry a couch up to the third floor and then back down to the second floor. The second couch is carried directly from the first to the second floor. On your third trip, you decide to put a ramp over the staircase and you both push the couch up the ramp to the second floor. During which trip did you perform the most work on the couch?
   A. The first trip
   B. The second trip
   C. The third trip
   D. The same work was performed for each trip.

4. A force F is applied in horizontal to a 10 kg block. The block moves at a constant speed of 2 m/s across a horizontal surface. The coefficient of kinetic friction between the block and the surface is 0.5. The work done by the force F in 1.5 minutes is:
   A. 9000 J
   B. 5000 J
   C. 3000 J
   D. 2000 J

5. As shown above, a block with a mass of m slides at a constant velocity V_0 on a horizontal frictionless surface. The block collides with a spring and comes to rest when the spring is compressed to the maximum value. If the spring constant is K, what is the maximum compression in the spring?
   A. $V_0\,(m/K)^{1/2}$
   B. KmV_0
   C. V_0K/m
   D. $V_0\,(K/m)^{1/2}$

6. A crane lifts a 300 kg load at a constant speed to the top of a building 60 m high in 15 s. The average power expended by the crane to overcome gravity is:
   A. 10,000 W
   B. 12,000 W
   C. 15,000 W
   D. 30,000 W

Questions 7-8: An apple of mass m is thrown horizontally from the edge of a cliff of height H, as shown to the right.

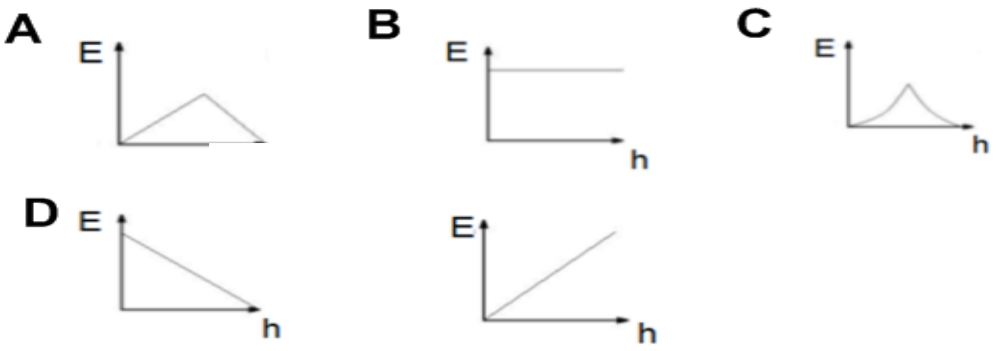


7. What is the total mechanical energy of the apple with respect to the ground when it is at the edge of the cliff?
   A. $\frac{1}{2}\,mv_0^2$
   B. mgH
   C. $mgH + \frac{1}{2}\,mv_0^2$
   D. $\frac{1}{2}\,mv_0^2 - mgH$

8. What is the kinetic energy of the apple just before it hits the ground?
   A. $\frac{1}{2}\,mv_0^2 + mgH$
   B. $\frac{1}{2}\,mv_0^2 - mgH$
   C. mgH
   D. $\frac{1}{2}\,mv_0^2$

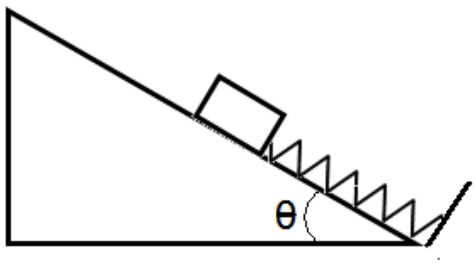
9. Two projectiles A and B are launched from the ground with velocities of 50 m/s at 60° (projectile A) and 50 m/s at 30° (projectile B) with respect to the horizontal. Assuming there is no air resistance involved, which projectile has greater kinetic energy when it reaches the highest point?
   A. projectile A
   B. projectile B
   C. they both have the same non-zero kinetic energy
   D. they both have zero kinetic energy

10. A metal ball is held stationary at a height h_0 above the floor and then thrown downward. Assuming the collision with the floor is elastic, which graph best shows the relationship between the net energy E of the metal ball and its height h with respect to the floor?

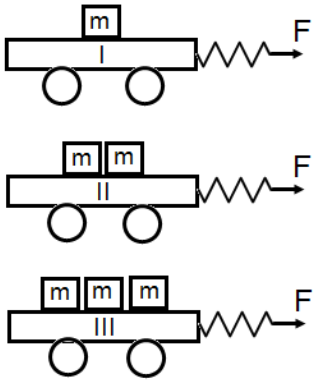


11. A rocket is launched from the surface of a planet with mass M and radius R. What is the minimum velocity the rocket must be given to completely escape from the planet's gravitational field?
   A. $(2GM/R)^{1/2}$
   B. $(2GM/R)^{3}$
   C. $(GM/R)^{1/2}$
   D. $2GM/R$

12. A block of mass m is placed on the frictionless inclined plane with an incline angle θ. The block is just in a contact with a free end on an unstretched spring with a spring constant k. If the block is released from rest, what is the maximum compression in the spring:
   A. kmg sinθ
   B. kmg cosθ
   C. 2mg sinθ /k
   D. mg/k



Questions 13-15: In a physics lab, a student uses three light, frictionless wheeled carts as shown to the right. Each cart is loaded with blocks of equal mass.



13. The same force F is applied to each cart and they move equal distances d. In which one of these three cases is more work done by force F?
    A. cart I
    B. cart II
    C. cart III
    D. the same work is done on each cart

14. The same force F is applied to each cart and they move equal distances d. Which cart will have more kinetic energy at the end of distance d?
    A. cart I
    B. cart II
    C. cart III
    D. all three will have the same kinetic energy

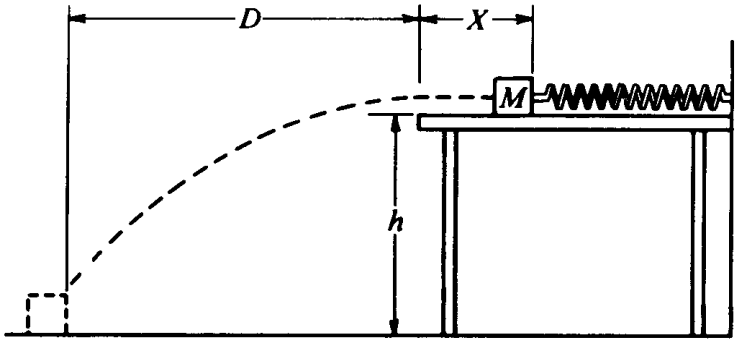
15. The same force F is applied to each cart and they move equal distances d. Which cart will move faster at the end of distance d?
    A. cart I
    B. cart II
    C. cart III
    D. all three will move with the same velocity

Directions: For each of the following, two of the suggested answers will be correct. <u>Select the best two choices</u> to earn credit. No partial credit will be earned if only one correct choice is selected.

16. The following are characteristics of energy:
    A. The amount of energy in an isolated system can be changed by an external force performing work on it.
    B. Thermal energy can never be changed into mechanical energy.
    C. Mechanical energy can be changed into thermal energy.
    D. Energy is only present in an object when it is moving.

17. A constant force, F, is applied to a block sitting on a bench. There could be other forces acting on the block at the same time. In which of the following cases is no work done on the block by F?
    A. The force is applied to the block, and it moves in the same direction as the force.
    B. The force is applied to the block, and the block moves in the opposite direction of the force.
    C. The block does not move.
    D. The force is applied perpendicular to the block's motion.

AP Physics – Unit 4 - Pre-Exam – Free Response Questions



1) One end of a spring is attached to a solid wall while the other end just reaches to the edge of a horizontal, frictionless tabletop, which is a distance *h* above the floor. A block of mass M is placed against the end of the spring and pushed toward the wall until the spring has been compressed a distance X, as shown above. The block is released, follows the trajectory shown, and strikes the floor a horizontal distance D from the edge of the table. Air resistance is negligible.

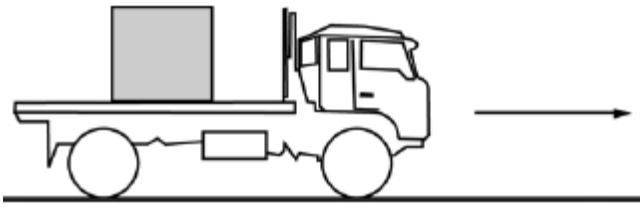
   Determine expressions for the following quantities in terms of M, X, D, h, and g. Note that these symbols do not include the spring constant.

a. The time elapsed from the instant the block leaves the table to the instant it strikes the floor

b. The horizontal component of the velocity of the block just before it hits the floor

c. The work done on the block by the spring

d. The spring constant

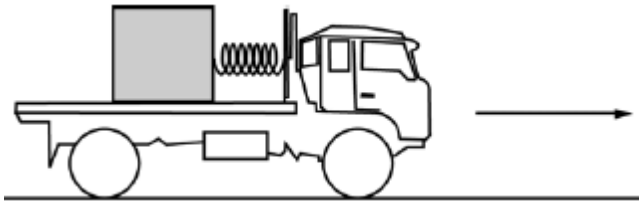


2) A 4700 kg truck carrying a 900. kg crate is traveling at 25 m/s to the right along a straight, level highway, as shown above. The truck driver then applies the brakes, and as it slows down, the truck travels 55 m in the next 3.0 s. The crate does not slide on the back of the truck.

   a) Calculate the magnitude of the acceleration of the truck, assuming it is constant.
   b) Draw and label all the forces acting on the crate during braking.
   c)
      i) Calculate the minimum coefficient of friction between the crate and truck that prevents the crate from sliding.
      ii) Indicate whether this friction is static or kinetic.

      ____ Static ____Kinetic

Now assume the bed of the truck is frictionless, but there is a spring of spring constant 9200 N/m attaching the crate to the truck, as shown below. The truck is initially at rest.



d) If the truck and crate have the same acceleration, calculate the extension of the spring as the truck accelerates from rest to 25 m s in 10 s.

e) At some later time, the truck is moving at a constant speed of 25 m/s and the crate is in equilibrium. Indicate whether the extension of the spring is greater than, less than, or the same as in part (d) when the truck was accelerating.

___ Greater ___ Less ___ The same

Explain your reasoning.