Work energy theorem

1. A person holds a book at rest a few feet above a table. The person then lowers the book at a slow constant speed and places it on the table. Which of the following accurately describes the change in the total mechanical energy of the Earth-book system?

(A) The total mechanical energy is unchanged, because there is no change in the book's kinetic energy as it is lowered to the table.

(B) The total mechanical energy is unchanged, because no work is done on the Earth-book system while the book is lowered.

(C) The total mechanical energy decreases, because the person does positive work on the book by exerting a force that opposes the gravitational force.

(D) The total mechanical energy decreases, because the person does negative work on the book by exerting a force on the book in the direction opposite to its displacement.

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2. A rubber ball with mass 0.20 kg is dropped vertically from a height of 1.5 m above a floor. The ball bounces off of the floor, and during the bounce 0.60 J of energy is dissipated. What is the maximum height of the ball after the bounce?

(A) 0.30 m

(B) 0.90 m

(C) 1.2 m

(D) 1.5 m

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3. An apple is released from rest 500 m above the ground. Due to the combined forces of air resistance and gravity, it has a speed of 40 m s when it reaches the ground. What percentage of the initial mechanical energy of the apple-Earth system was dissipated due to air resistance? Take the potential energy of the apple-Earth system to be zero when the apple reaches the ground.

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(A) 16%

(B) 40%

(C) 60%

(D) 84%

4. An object is moving to the right with speed v_i when a force of magnitude F is exerted on it. In which of the following situations is the object's direction of motion changing and kinetic energy decreasing at the instant shown?

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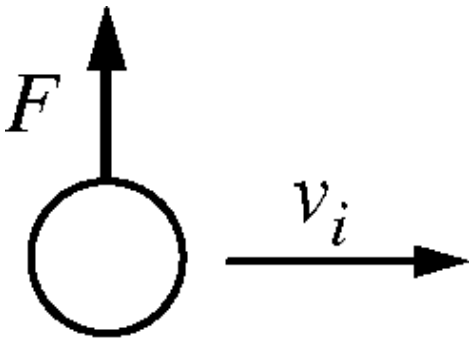
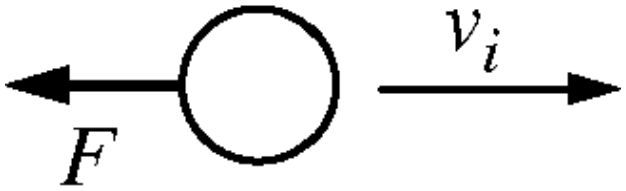
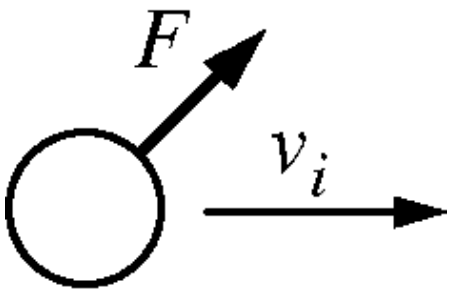
A



B



C



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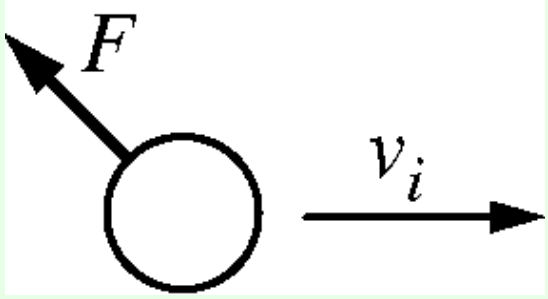
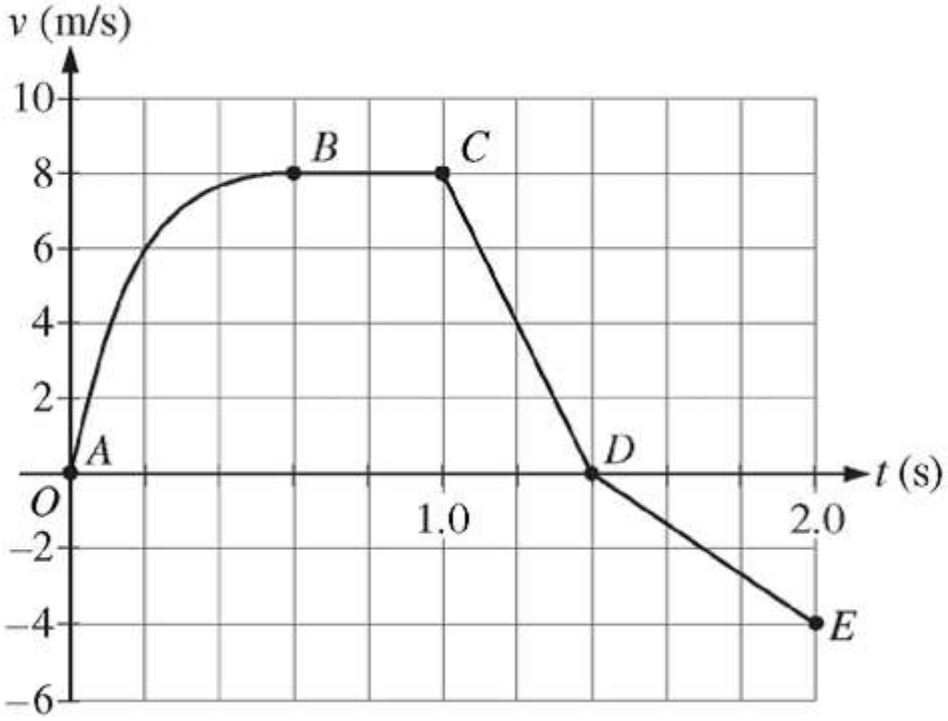


Refer to the following material for answering the questions.

Work energy theorem



A cart is constrained to move along a straight line. A varying net force along the direction of motion is exerted on the cart. The cart's velocity v as a function of time t is shown in the graph above. The five labeled points divide the graph into four sections.

5. During some part of the motion, the work done on the cart is negative. What feature of the motion indicates this?

(A) The speed is increasing.

(B) The speed is decreasing.

(C) The acceleration is positive.

(D) The acceleration is negative.

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6. A block of mass M is sliding with an initial speed v_i along a horizontal surface with negligible friction. A constant force of magnitude F_A is exerted on the object at an upward angle of $60°$ from the horizontal, causing the object to speed up. If the block remains in contact with the floor, what is the change in the block's kinetic energy as it moves a horizontal distance Δx ?

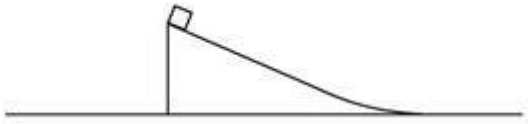
(A) $\frac{1}{2}F_A\Delta x$

(B) $F_A\Delta x$

(C) $\frac{1}{2}Mv_i^2+\frac{1}{2}F_A\Delta x$

(D) $\frac{1}{2}Mv_i^2+F_A\Delta x$

7.



The figure above shows part of a system consisting of a block at the top of an inclined plane that rests on a table, which is located on Earth. The block and plane are at rest when the block is released. In trial 1 there is no friction between the block and the plane or between the plane and the table. In trial 2 the plane is fixed to the table so it cannot move, but there is still no friction between the block and the plane.

Indicate whether the speed of the block relative to the table when the block reaches the bottom of the plane is greater in trial 1 or trial 2. Justify your answer in a clear, coherent, paragraph-length explanation.

Please respond on separate paper, following directions from your teacher.

Part 1

1 point is earned for any mention of energy conversion

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1 point is earned f or indicating that the same amount of potential energy is converted to kinetic energy in each trial

1 point is earned for indicating that the kinetic energy is shared between the block and plane in trial 1

1 point is earned for indicating that the block has all the kinetic energy in trial 2

1 point is earned for a description of the motion of the plane in each trial

1 point is earned for using momentum or forces to explain the motion in each trial

1 point is earned for a coherent argument that leads to a correct conclusion

For example: The speed of the block is greater in trial 2. Since gravity is the only force doing work in both trials, energy is conserved. The potential energy of the block at the top of the plane is converted into kinetic energy. In trial 1 the plane is free to move, so if the block ends up going to the right, the plane has to move to the left to conserve momentum.

0	1	2	3	4	5	6	7

The student response earns all of the following points:

1 point is earned for any mention of energy conversion

1 point is earned f or indicating that the same amount of potential energy is converted to kinetic energy in each trial

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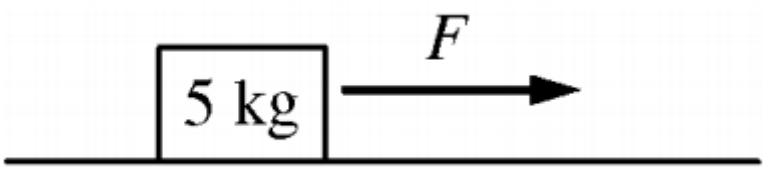
8.



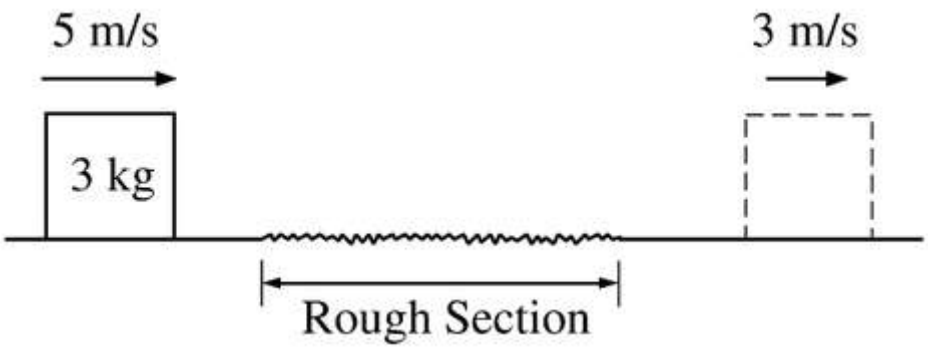
A force *F* is exerted on a 5 kg block to move it across a rough surface, as shown above. The magnitude of the force is initially 5 N, and the block moves at a constant velocity. While the block is moving, the force is instantaneously increased to 12 N. How much kinetic energy does the block now gain as it moves a distance of 2 m?

(A) 10 J

(B) 14 J

(C) 24 J

(D) 34 J



A block of mass 3 kg slides along a horizontal surface that has negligible friction except for one section, as shown above. The block arrives at the rough section with a speed of 5 m/s and leaves it 0.5 s later with a speed of 3 m/s.

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9. What is the magnitude of the average frictional force exerted on the block by the rough section of the surface?

(A) 30 N

(B) 12 N

(C) 4.5 N

(D) 4 N

(E) 3 N

10. What is the magnitude of the work done by the frictional force exerted on the block by the rough section of the surface?

(A) 24 J

(B) 16 J

(C) 8 J

(D) 6 J

(E) 3 J