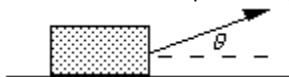


## HW1 – WORK

- In which one of the following situations is zero net work done?
  - A ball rolls down an inclined plane.
  - A physics student stretches a spring.
  - A projectile falls toward the surface of Earth.
  - A box is pulled across a rough floor at constant velocity.
  - A child pulls a wagon across a rough surface causing it to accelerate.
- A concrete block is pulled 7.0 m across a frictionless surface by means of a rope. The tension in the rope is 40 N; and the net work done on the block is 247 J.



What angle does the rope make with the horizontal?

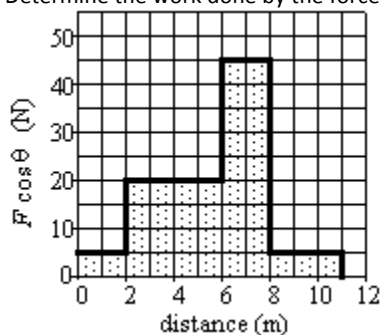
- Mike is cutting the grass using a human-powered lawn mower. He pushes the mower with a force of 45 N directed at an angle of  $41^\circ$  below the horizontal direction. Calculate the work that Mike does on the mower in pushing it 9.1 m across the yard.

- A constant force of 25 N is applied as shown to a block which undergoes a displacement of 7.5 m to the right along a frictionless surface while the force acts. What is the work done by the force? Explain.

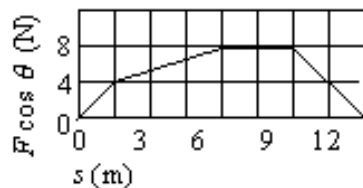


- A 1.0-kg ball on the end of a string is whirled at a constant speed of 2.0 m/s in a horizontal circle of radius 1.5 m. What is the work done by the centripetal force (tension force) during one revolution?
- Brenda carries an 8.0-kg suitcase as she walks 25 m along a horizontal walkway to her room at a constant speed of 1.5 m/s. How much work does Brenda do in carrying her suitcase?

- The graph shows the force component along the displacement as a function of the magnitude of the displacement. Determine the work done by the force during the interval from 2 to 10 m.

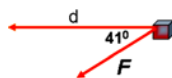


8. The force component acting on an object along the displacement varies with the displacement  $s$  as shown in the graph. Determine the work done on the object as it travels from  $s = 0.0$  to  $12$  m.



SOLUTIONS:

1. D      2.  $\theta = 28^\circ$       3.  $W = 310$  J



4.  $W = -160$  J      The force is slowing down object  
 5. zero Joules – tension force is perpendicular to the direction of motion  
 6. zero Joules – Brenda's force is perpendicular to the direction of motion  
 7. 190 J  
 8. 66 J

## HW 2 WORK – KINETIC ENERGY RELATIONSHIP and ....

- A spring has an elastic constant of  $100\text{Nm}^{-1}$ . When the extension of the spring is 10cm, the potential energy stored in it is
- Katie, a 30.0-kg child, climbs a tree to rescue her cat who is afraid to jump 8.0 m to the ground. How much work does Katie do in order to reach the cat?



- At target practice, Diana holds her bow and pulls the arrow back a distance of 0.30 m by exerting an average force of 40.0 N. What is the potential energy stored in the bow the moment before the arrow is released?
- A bullet of mass 0.01kg is moving at  $500\text{ms}^{-1}$  when it hits a wall. How much work is done by the wall on the bullet if the bullet penetrates 0.1m into the wall?

5. A horizontal force of  $2.00 \times 10^2$  N is applied to a 55.0 kg cart across a 10.0 m level surface, accelerating it  $2.00 \text{ m/s}^2$ . Using the work–kinetic energy theorem, find the force of friction that slows the motion of the cart? (Disregard air resistance.  $g = 9.81 \text{ m/s}^2$ .)
6. A professional skier starts from rest and reaches a speed of 56 m/s on a ski slope  $30.0^\circ$  above the horizontal. Using the work–kinetic energy theorem and disregarding friction, find the minimum distance along the slope the skier would have to travel in order to reach this speed.
7. A 40.0 N crate starting at rest slides down a rough 6.0 m long ramp inclined at  $30.0^\circ$  with the horizontal. The force of friction between the crate and ramp is 6.0 N. Using the work–kinetic energy theorem (but include friction) , find the velocity of the crate at the bottom of the incline.
8. A 15.0 kg crate, initially at rest, slides down a ramp 2.0 m long and inclined at an angle of  $20.0^\circ$  with the horizontal. Using the work–kinetic energy theorem and disregarding friction, find the velocity of the crate at the bottom of the ramp. ( $g = 9.81 \text{ m/s}^2$ .)
9. A parachutist with a mass of 50.0 kg jumps out of an airplane at an altitude of  $1.00 \times 10^3$  m. After the parachute deploys, the parachutist lands with a velocity of 5.00 m/s. Using the work–kinetic energy theorem, find the energy that was lost to air resistance during this jump. ( $g = 9.81 \text{ m/s}^2$ .)

10. A horizontal force of  $2.00 \times 10^2 \text{ N}$  is applied to a 55.0 kg cart across a 10.0 m level surface, accelerating it  $2.00 \text{ m/s}^2$ . Using the work–kinetic energy theorem, find the force of friction that slows the motion of the cart? (Disregard air resistance.  $g = 9.81 \text{ m/s}^2$ .)

11. In the presence of frictional force,

- nonmechanical energy is negligible and mechanical energy is no longer conserved.
- nonmechanical energy is negligible and mechanical energy is conserved.
- nonmechanical energy is no longer negligible and mechanical energy is conserved.
- nonmechanical energy is no longer negligible and mechanical energy is no longer conserved.

12. Why doesn't the principle of mechanical energy conservation hold in situations when frictional forces are present?

- Kinetic energy is not simply converted to a form of potential energy.
- Potential energy is simply converted to a form of gravitational energy.
- Chemical energy is not simply converted to electrical energy.
- Kinetic energy is simply converted to a form of gravitational energy.

### Answers

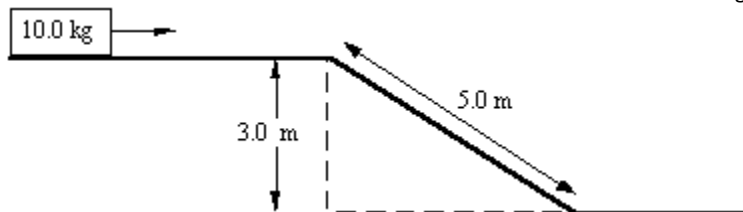
1. 0.5J    2.  $W = 2400 \text{ J}$     3.  $\text{elastic PE} = Fd = (40.0 \text{ N})(0.30 \text{ m}) = 12 \text{ J}$     4.  $W = \Delta KE = 1.25 \text{ kJ}$   
 5. 90.0 N    6. 320 m    7. 6.4 m/s    8. 3.7 m/s    9. 489 000 J  
 10. 90.0 N    11. D    12. A

### HW3 – CONSERVATION OF ENERGY

- A pebble rolls off the roof of Science Hall and falls vertically. Just before it reaches the ground, the pebble's speed is 17 m/s. Neglect air resistance and determine the height of Science Hall.

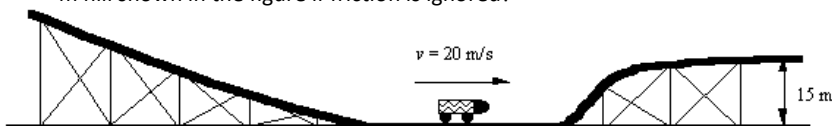
Use the following to answer questions 2 - 5:

A 10.0-kg crate slides along a horizontal frictionless surface at a constant speed of 4.0 m/s. The crate then slides down a frictionless incline and across a second horizontal surface as shown in the figure.



- What is the kinetic energy of the crate as it slides on the upper surface?
- While the crate slides along the upper surface, how much gravitational potential energy does it have compared to what it would have on the lower surface?
- What is the speed of the crate when it arrives at the lower surface?
- What is the kinetic energy of the crate as it slides on the lower surface?

6. A roller-coaster car is moving at 20 m/s along a straight horizontal track. What will its speed be after climbing the 15-m hill shown in the figure if friction is ignored?



7. A 3.0-kg block falls from rest through a distance of 6.0 m in an evacuated tube near the surface of the earth. What is its speed after it has fallen the 6.0 m distance?

8. A bicyclist is traveling at a speed of 20.0 m/s as he approaches the bottom of a hill. He decides to coast up the hill and stops upon reaching the top. Determine the vertical height of the hill.

9. A skier leaves the top of a slope with an initial speed of 5.0 m/s. Her speed at the bottom of the slope is 13 m/s. What is the height of the slope?

10. A roller coaster starts from rest at the top of an 18-m hill as shown. The car travels to the bottom of the hill and continues up the next hill that is 10.0 m high.

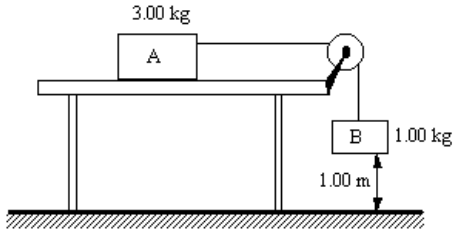


How fast is the car moving at the top of the 10.0-m hill if friction is ignored?

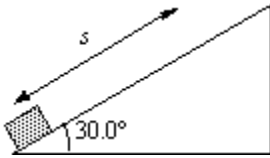
11. An engineer is asked to design a playground slide such that the speed a child reaches at the bottom does not exceed 6.0 m/s. Determine the maximum height that the slide can be.

12. A care package is dropped from rest from a helicopter hovering 25 m above the ground. What is the speed of the package just before it reaches the ground? Neglect air resistance

13. Two boxes are connected to each other as shown. The system is released from rest and the 1.00-kg box falls through a distance of 1.00 m. The surface of the table is frictionless. What is the kinetic energy of box B just before it reaches the floor?

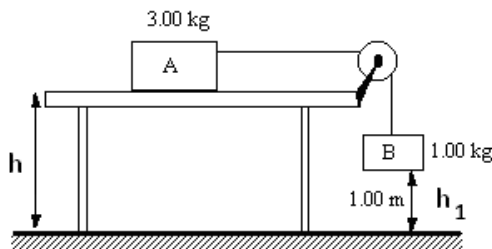


14. A physics student shoves a 0.50-kg block from the bottom of a frictionless 30.0° inclined plane. The student performs 4.0 J of work and the block slides a distance  $s$  along the incline before it stops. Determine the value of  $s$ .



- \*\*\*\*\*
1.  $PE_{top} = KE_{bottom}$      $mgh = \frac{1}{2} mv^2$      $gh = \frac{1}{2} v^2$      $h = v^2/2g = 289/(2 \times 9.8) = 15$  m
  2.  $KE = \frac{1}{2} mv^2 = 80$  J    3.  $PE = mgh = 290$  J
  4.  $mgh + \frac{1}{2} mv_1^2 = \frac{1}{2} mv_2^2$      $290 + 80 = \frac{1}{2} mv_2^2$      $370 = 5.0 v_2^2$      $v_2 = 8.6$  m/s
  5.  $mgh + \frac{1}{2} mv_1^2 = \frac{1}{2} mv_2^2 = 370$  J    or     $KE = \frac{1}{2} mv_2^2 = 370$  J
  6.  $KE_{bottom} = PE_{top}$      $\frac{1}{2} m v_1^2 = mgh + \frac{1}{2} m v_2^2$      $\frac{1}{2} v_1^2 = gh + \frac{1}{2} v_2^2$      $200 = 150 + \frac{1}{2} v_2^2$      $v_2 = 10$  m/s
  7.  $\Delta PE = KE$      $mg \Delta h = \frac{1}{2} mv^2$      $g \Delta h = \frac{1}{2} v^2$      $120 = v^2$      $v = 11$  m/s
  8.  $\frac{1}{2} m v^2 = mgh$      $\frac{1}{2} v^2 = gh$      $h = 20$  m
  9.  $mgh + \frac{1}{2} mv_1^2 = 0 + \frac{1}{2} m v_2^2$      $gh + \frac{1}{2} v_1^2 = 0 + \frac{1}{2} v_2^2$      $10h + 12.5 = 84.5$      $h = 7.3$  m
  10.  $mgh_1 + \frac{1}{2} mv_1^2 = mgh_2 + \frac{1}{2} m v_2^2$      $gh_1 + \frac{1}{2} v_1^2 = gh_2 + \frac{1}{2} v_2^2$      $180 + 0 = 100 + \frac{1}{2} v_2^2$      $v_2 = 13$  m/s
  11.  $mgh = \frac{1}{2} m v^2$      $gh = \frac{1}{2} v^2$      $10h = 18$      $v = 1.8$  m
  12.  $mgh = \frac{1}{2} m v^2$      $gh = \frac{1}{2} v^2$      $250 = \frac{1}{2} v^2$      $v = 22$  m/s

13.



$$m_A g h + m_B g h_1 = m_A g h + \frac{1}{2} m_A v^2 + 0 + \frac{1}{2} m_B v^2$$

$$m_B g h_1 = \frac{1}{2} m_A v^2 + \frac{1}{2} m_B v^2$$

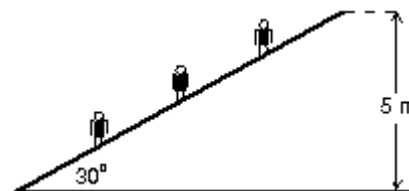
$$10 = 2 v^2 \quad v^2 = 5 \quad KE_B = \frac{1}{2} m_B v^2 = 2.5 \text{ J}$$

$$14. \quad 4.0 \text{ J} = m g h + \frac{1}{2} m v^2 \quad 4.0 = m g h + 0 \quad h = 0.8 \text{ m} \quad s = h / \sin 30^\circ = 1.6 \text{ m}$$

#### HW 4 – POWER and ....

25. The kinetic energy of a car is  $8 \times 10^6 \text{ J}$  as it travels along a horizontal road. How much power is required to stop the car in 10 s?

26. An escalator is used to move 20 people (60 kg each) per minute from the first floor of a department store to the second floor, 5 m above. The power required is approximately:



27. A 51-kg woman runs up a flight of stairs in 5.0 s. Her net upward displacement is 5.0 m. Approximately, what average power did the woman exert while she was running?

28. What power is needed to lift a 49-kg person a vertical distance of 5.0 m in 20.0 s?

29. An escalator is 30.0 meters long and slants at  $30.0^\circ$  relative to the horizontal. If it moves at 1.00 m/s, at what rate does it do work in lifting a 50.0 kg man from the bottom to the top of the escalator?

30. How much power is needed to lift a 75-kg student vertically upward at a constant speed of 0.33 m/s?

34. An electric train develops a power of 1.0 MW when travelling at a constant speed of  $50 \text{ ms}^{-1}$ . The net resistive force acting on the train is

35. Engine X is stated to be more **powerful** than engine Y.  
Which of the following is the correct comparison of the engines?

- A. Engine X produces a larger force than engine Y.
- B. Engine X produces more useful energy than engine Y.
- C. Engine X produces more useful energy per unit time than engine Y.
- D. Engine X produces more power for a longer time than engine Y.

25.  $W = \Delta KE = 8 \times 10^6 \text{ J}$        $P = W/t = 8 \times 10^5 \text{ W}$   
 26.  $P = W/t = mgh/t = 20(60)(10)(5)/(60) = 1000 \text{ W}$   
 27.  $P = W/t = mgh/t = (51)(9.80)(5.0)/(5.0) = 0.50 \text{ kW}$   
 28.  $P = W/t = mgh/t = (49)(9.80)(5.0)/(20.0) = 120 \text{ W}$   
 29.  $F = mg \sin 30.0^\circ = 245 \text{ N}$        $P = Fv = (245)(1.00) = 245 \text{ W}$   
 30.  $P = Fv = mgv = (75)(9.8)(0.33) = 243 \text{ W}$   
 34.  $P = Fv$        $F = 20 \text{ kN}$   
 35. C