Energy and Work!!!

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Total points on test – 115....so 15 EC! Remember. Show your work. Identify knows & what you are trying to find. Write the formula first. Draw FBD & sketches as needed. Make it so we can see your thinking!

Short Questions (5 points each)

3600,000 − 900,000

1. Paulina is driving her 2000 kg Porsche wishes to pass a slow moving school bus on a 4 lane road. What is the average power in watts required to accelerate the sports car from 30 m/s to 60 m/s in 9 seconds?

$P = \frac{W}{t} \rightarrow \frac{\frac{1}{2}(2000)(60)^2 - \frac{1}{2}(2000)(30)^2}{9s} \rightarrow \frac{2,700,000}{9} = \boxed{300,000 \text{ watts}}$

$W_c = \Delta KE$

$m = 2000 \quad t = 9s$

$v_0 = 30 m/s \quad v_f = 60 m/s$

2. Justice applies a force of 20 N compresses a spring with a spring constant 50 N/m. How much energy is stored in the spring?

$F_{app} = 20N$

$Spring = 50 N/m$

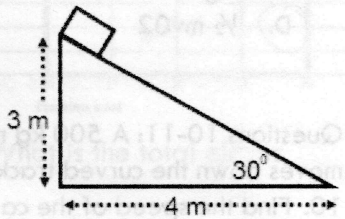
$PE_s = Fd = \frac{1}{2}kx^2$

$KE_0 + PE_0 = KE + PE$

3. Olive pushes a box across a horizontal surface at a constant speed of 0.6 m/s. The box has a mass of 40 kg, and the coefficient of kinetic friction is 0.5. The power supplied to the box by the person is:

$F_f = \mu F_n \rightarrow (0.5)(40)(9.8) = 196$

$P = F\bar{v} \rightarrow (196N)(0.6) = 117.6 \text{ watts}$



Questions 4-5: Jonathan releases a 2 kg block from rest from the top of an inclined plane, as shown in the diagram to the right. There is no friction between the block and the surface.

4. How much work is done by the gravitational force on the block?

$W = Fd = mgh \rightarrow (2)(9.8)(3) = 58.8J$

5. What is the speed of the block when it reaches the horizontal surface?

$KE = \frac{1}{2}mv^2 \rightarrow v = \sqrt{\frac{KE}{\frac{1}{2}m}}$

$v = \sqrt{\frac{58.8J}{\frac{1}{2}(2)}} = 7.67 m/s$

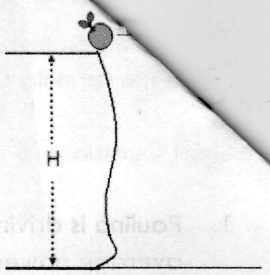
6. Ben is operating a crane which lifts a 300 kg load at a constant speed to the top of a building 60 m high in 15 s. The average power expended by the crane to overcome gravity is:

$W = Fd = mgh \rightarrow (300)(9.8)(60) = 176,400J$

$P = \frac{W}{t} \rightarrow \frac{176,400J}{15s} = 11,760 \text{ watts}$

Short Questions (5 points each)

7. Grant needs to move three identical couches from the first to the second floor of an apartment building. The first time, Grant and Liam 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 the third trip, Grant decides to put a ramp over the staircase and they both push the couch up the ramp to the second floor. During which trip did the boys perform the most work on the couch?

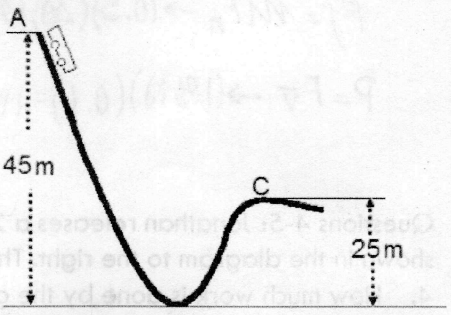


(A.) The first trip
B. The second trip
C. The third trip
D. The same work was performed for each trip.

Questions 8-9: Denton hurls an apple in a fit of Omnicron inspired rage horizontally from the edge of a cliff of height H, as shown to the right.

8. What is the total mechanical energy of the apple with respect to the ground when it is at the edge of the cliff?
   A. ½ mv02
   B. mgH
   (C.) mgH + ½ mv02
   D. ½ mv02- mgH
9. What is the kinetic energy of the apple just before it hits the ground?
   A. ½ mv02 + mgH
   B. ½ mv02 - mgH
   C. mgH
   (D.) ½ mv02

Questions 10-11: A 500 kg roller coaster car starts from rest at point A and moves down the curved track, as shown to the right. Assume the track is frictionless.

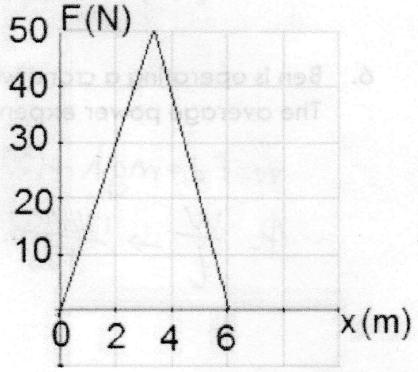


10. Find the speed of the car at the lowest point B.

$h = 45m$ $\quad KE_0 + PE_0 + W_{NC} + QE_0 = KE + PE + QE$
$m = 500kg$ $\quad PE_0 = KE_f$
$v_0 = 0$ $\quad mgh = \frac{1}{2}mv^2 \rightarrow v = \sqrt{\frac{mgh}{\frac{1}{2}m}} \rightarrow \sqrt{\frac{(500)(9.8)(45)}{\frac{1}{2}(500)}} = \sqrt{\frac{220500}{250}} = \sqrt{882} = 29.6\ m/s$
$v_f = ?$

(11.) Find the speed of the car when it reaches point C.

Questions 12-13: An object with a mass of 2.0 kg is initially at rest at a position x = 0. A F is applied to the object over a displacement of 6.0 m, as shown in the graph to the rig



12. What is the total work done on the object at the end of 6.0 m?

$m = 2kg$
$d = 6m$
$\frac{1}{2}bh \rightarrow \frac{1}{2}(6)(50) = 150J$

13. What is the velocity of the object at x = 6.0 m?

$W = KE = \frac{1}{2}mv^2 \rightarrow \sqrt{\frac{W}{\frac{1}{2}m}} = v$

$v = \sqrt{\frac{150J}{\frac{1}{2}(2)}} = 12.25\ m/s$

estions (5 points each)

4. Grady's car is stuck on the ice. Sam pushes down on the car to provide more friction for the tires (by way of increasing the normal force), allowing the car's tires to propel it forward 5 meters onto the less slippery ground. How much work does Sam do? DON'T need coefficient of friction

$W = Fd \rightarrow (9.8)(5) = 49\,J$

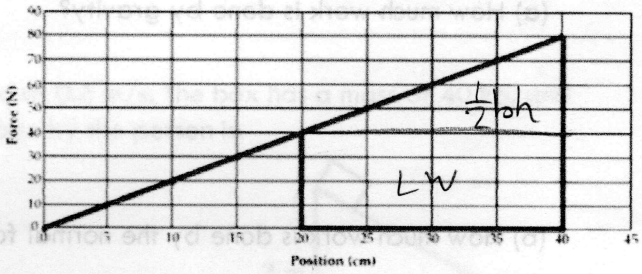
15. Tamir push a crate up a ramp with a force of 10 N. Despite his pushing, the crate slides down the ramp 4 m. How much work did Tamir do?

$W = Fd = mgh \rightarrow (10)(9.8)(4) = 392\,J$

16. Nounn tweaks a spring so that it exerts a force as shown on the graph below. How much work is done as the spring stretches from 20 to 40 cm?

$W = \frac{1}{2}bh + (b)(h)$

$\frac{1}{2}(20)(40) + (20)(40) = 400 + 800 = 1{,}200\,J$



17. A spring with a spring constant (k = 4.0 N/m) is compressed by a force of 1.2 N. What is the total elastic potential energy stored in the compressed spring?

$PE = Fd = \frac{1}{2}kx^2 \rightarrow \frac{1}{2}(4)(0.3)^2 = 0.18\,J$

$|F| = k|x|$

$\frac{F}{k} = x \rightarrow \frac{1.2}{4} = 0.3\,m$

Multipart Questions(3 points each)

18. A 15-kg crate is moved along a horizontal floor by Andrej who is pulling on it with a rope that makes a 30° angle with the horizontal. The tension in the rope is 69 N, and the crate slides a distance of 10 m.

A) How much work is done on the crate by Andrej?

$m = 15\,kg$
$\theta = 30°$
$F_t = 69\,N$
$d = 10\,m$

$W = Fd\cos\theta \rightarrow (69\,N)(10\,m)(\cos 30°) = 106.43\,J$

B) assume the coefficient of kinetic friction between the crate and the floor is 0.4. How much work is done by the normal force?

$\mu = 0.4$
$F_t = 69\,N$
$m = 15\,kg$
$\theta = 30°$
$d = 10\,m$

$F_f = \mu F_n \rightarrow (0.4)(15)(9.8) = 58.8\,N$

$W_{net} = W_{nc} + W_c \rightarrow 127.8 + 147 = 274.8\,J$

$W = Fd\cos\theta \rightarrow (147\,N)(10\,m)(\cos 30) = 226.75\,J$

C). How much work is done by the friction force?

$W = Fd\cos\theta \rightarrow (58.8\,N)(10)\cos(30) = 90.71\,J$

Multipart Questions(3 points each)

20. A 2 kg block starts at rest and is slides down a ramp from a height of 3 meters above the ground and reaches the ground with a kinetic energy of 50 J.

A) Determine the total work done by friction on the block as it slides down the ramp

$m = 2\,Kg$ | $F_f = \mu F_N / \mu mg$
$h = 3m$ | $W_g = Fd = mgh$
$V_0 = 0$ | $KE_0 + PE_0 + W_{nc} = KE + PE$
$KE_f = 50J$ |

21.

B) Explain what has happened to some of the gravitational potential energy.

22. Ansh and Peter watch a box slide down an inclined plane 37° above the horizontal. The mass of the block, m, is 35 kg, the coefficient of kinetic friction is 0.3 and the length of the ramp, d, is 8 m.

(a) How much work is done by gravity?

(b) How much work is done by the normal force?

(c) How much work is done by friction?

(d) What is the total work done?

(e) If it starts from rest at the top, with what speed does it reach the bottom?