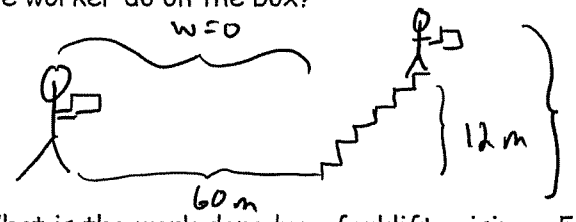
PHYSICS 11

NAME: _____

Work, Energy, Power

Section I

1. A worker carries a box of mass 20 kg in a warehouse. The worker walks 60 m then carries the box to the third floor of the warehouse, a total height of 12 m. How much work does the worker do on the box?



$W = F \cdot d$

$= F_g \cdot d$

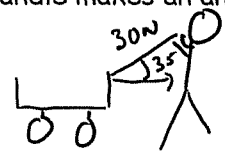
$= (20)(9.8)(12) = 2352$ J Joules

2. What is the work done by a forklift raising a 5200 N crate 2.3 m?

$W = F \cdot d$

$= (5200\text{N})(2.3) = 11960\text{ J} \approx 12000\text{ J}$

3. A child pulls a 15 kg wagon 25m. If she pulls the handle with a force of 30 N and the handle makes an angle of 35°, determine the work done on the wagon by the child.



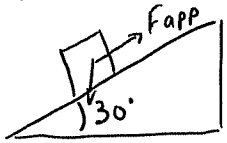
$F_{app} = 30\text{N}(\cos 35°)$

$= 24.6\text{N}$

$W = F \cdot d$

$= (24.6)(25\text{m}) = 614\text{ J}$

4. A 400 kg piano is slid up a frictionless plank that is 3.5 m long. If the plank is on an angle of 30°, calculate the work done.



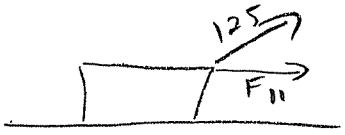
$W = F_{app} \cdot d$

$= F_g \sin\theta \cdot d$

$= (400)(9.8)\sin 30°(3.5\text{m})$

$= 6860\text{ J}$

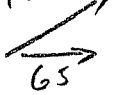
5. An 845-N sled is pulled a distance of 185 m. If the sled was pulled with a force of 125 N and 1.2×10^4 J of work was done calculate the angle the rope was held.



$W = F_{11} \cdot d$

$12000 = (64.9)(185)$

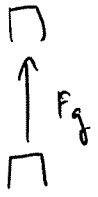
$F_{11} = 64.9$



$\cos\theta = \frac{65}{125}$

$\theta = 59°$

6. What power is required to lift a 25 kg box a distance of 20 m straight up in 15 s?



$P = \frac{W}{t} = \frac{F \cdot d}{t} = \frac{(25)(9.8)(20\text{m})}{15\text{s}} = 327\text{ W}$

7. An electric motor produces 30 kW of power as it lifts a 20000 N load in 4 s. How high was the load lifted?

$30\ kW = 30\,000 W$ $\quad P = \frac{W}{t}$ $\quad 30\,000 = \frac{20000N\,(d)}{4s}$, $d = 6m$

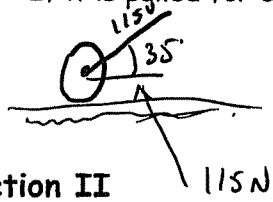
$P = \frac{F \cdot d}{t}$

8. A force of 300 N is used to push a 145 kg mass 30 m horizontal in 3.0 s. Calculate the work done on the mass and the power required.

$W = F \cdot d$
$= (300)(30)$
$= 9000\ J$

$P = \frac{W}{t} = \frac{9000\ J}{3} = 3000\ W$

9. A lawn roller is pulled across a lawn with a force of 115 N along the handle which is at 35°. If it is pulled for 60.0 s and 65 W of power is required, how far was the roller pulled?



$P = 65W$ $\quad t = 60.0$ $\quad P = \frac{W}{t}$, $W = P \cdot t$ $\quad W = F \cdot d$

$= (65W)(60s) = 3900J = 94.2(d)$

$d = 41.4m$

$115N(\cos 35^\circ) = 94.2N$

Section II

1. How much work must be done to slow a car travelling at 20 m/s to 10 m/s? (2000 kg)

$W = \Delta E = E_{K_f} - E_{K_0}$
$= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_0^2$

$\frac{1}{2}(2000)(10\ m/s)^2 - \frac{1}{2}(2000)(20)^2$
$100\,000\ J - 400\,000 J = -300\,000\ J$

2. Determine the kinetic energy of a .250 kg puck travelling at 40 m/s. How much work is done on the puck if it starts from rest? If the work is done over a distance of 0.4 m, what is the average force on the puck?

$E_K = \frac{1}{2}(.25)(40)^2$
$= 200\ J$

$W = \Delta E = 200\ J$

$W = F \cdot d$
$\frac{200J}{.4} = \frac{F(.4m)}{.4}$, $F = 500N$

3. How much work is done if the puck in the above question is only travelling at 20 m/s?

50 J

4. A 50 kg boy on a deck 2.5 m off the ground climbs a ladder 3 m vertically to get on the roof of the house. Determine the boy gravitational potential energy with respect to the a) roof, b) deck, c) ground.

0 J 1470 J 2700 J

$E_p = mgh$ b) $E_p = (50)(9.8)(2.5) = 1470\text{ J}$

5. A 1500 kg car travelling at 16 m/s hits a tree and comes to a rest. a) What is the change in kinetic energy of the car. b) If the front end of the car is compressed 0.40 m what is the size of the force. c) Determine the force on the car if it is only compressed 0.10 m.

a) $\frac{1}{2}(1500)(16)^2$ b) $W = F \cdot d$ c) $1.92 \times 10^6\text{ N}$

192000 J $192000 = F(.4)$

$4.8 \times 10^5\text{ N}$

Section III

1. How much heat is required to heat 4 kg of glass from -15° C to 30° C?

$E_h = mc \cdot \Delta T$

$= (4\text{kg})(664)(45^\circ\text{C}) = 120000\text{ J} = 120\text{ kJ}$

2. What is the change in temperature when 200 g of water is warmed from 6 kJ of heat energy?

$E_h = mc\Delta T$

$6000 = (0.2\text{kg})(4180)(\Delta T) =$

$\Delta T = 7.2^\circ\text{C}$

3. A 500 g block of metal absorbs 4250 J of heat energy when its temperature changes from 35° C to 48° C. What is its specific heat capacity? 654 J/kg°C

$E_h = mc\Delta T$ $C = \nearrow$

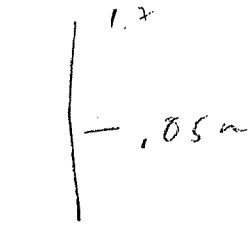
$4250\text{ J} = (.5\text{kg})c(13)$

4. How much heat is required to melt 3 kg of ice at 0° C to water at 0° C?

5. How much heat is required to turn 300 g of water at 30°C to steam at 120° C

Section IV

1. A student lifts his 1.5 kg pet rock 1.7 m straight up. He then lets it drop to the ground. Use the Law of Conservation of Energy to calculate how fast the rock will be moving (a) half way down and (b) just before it hits the ground.

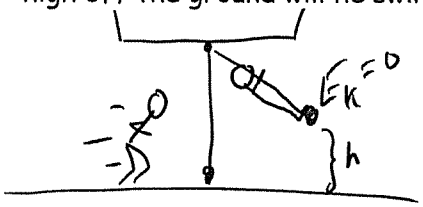


$E_p = E_k$

$(1.5)(9.8)(.85) = \frac{1}{2}(1.5)v^2$

$v = 4.1 m/s$ $\quad v = 5.8 m/s$

2. A 80 kg boy is running with a speed of 4.8 m/s. How much kinetic energy does he have? He grabs on to a rope that is hanging from the ceiling, and swings from the end of the rope. How high off the ground will he swing?

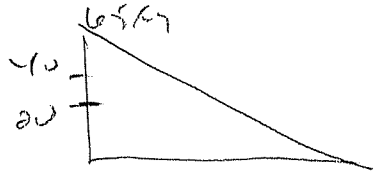


$E_b = E_a$ $\quad \frac{1}{2}(80)(4.8)^2 = 80(9.8)h$

$E_K = E_P$ $\quad h = 1.18 m$

$\frac{1}{2}mv^2 = mgh$ $\quad 1.18 m$

3. How much kinetic energy will an 65.0 kg skier sliding down a frictionless slope (vertical height = 60.0 m) have when he 2/3 of the way down?



$E_p = E_k$

$mgh = \frac{1}{2}mv^2$

$2(9.8)(40) = v^2$ $\quad v = 28 m/s$

4. A truck moving with a speed of 110 km/h 30.6 m/s loses it brakes but sees a "runaway" hill near the highway. If the driver steers his vehicle into the runaway hill, how far up the hill (vertically) will the vehicle travel before it comes to a stop? (Ignore friction.) If friction is taken into account, will the vertical distance the vehicle moves be less or greater than the 'ideal' distance you just solved for, neglecting friction? Explain.

Less.

$\frac{1}{2}v^2 = gh$

$h = \frac{v^2}{2g}$ $\quad h = 47.6 m$