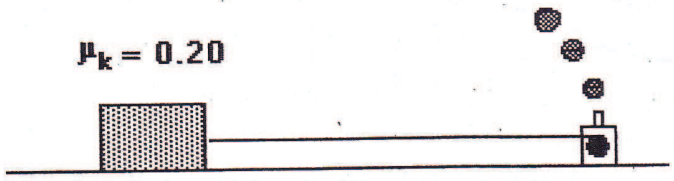
Name Dashan Ravi Chandar

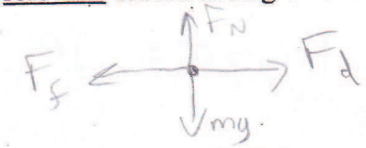
Date _____ Pd___

Work and Energy
Worksheet 1

1. A 200. kg box is pulled at constant speed by the little engine pictured below. The box moves a distance of 2.5 m across a horizontal surface.



a) Draw a force diagram of all relevant forces acting on the box.



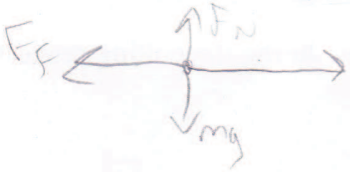
b) If the force of friction acting on the box is 400 N, how much energy is transferred by the engine?

If $F_f = 400$ then $F_d = 400$

So $W = Fd = 400(2.5)$

$= 1000$ J

c) What type of motion would occur if the engine pulled with a force of 500 N? Modify your force diagram and apply Newton's 2nd Law.



Acceleration

$F_d - F_f = ma$

$500 - 400 = 200a$

$a = \frac{100}{200} = 0.5\ m/s^2$

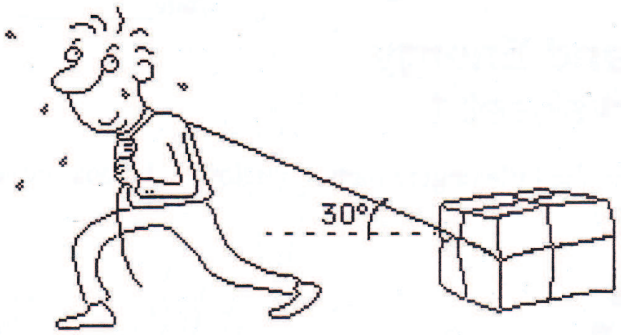
2. How far could the box in problem 1 be pulled *at constant velocity* with the expenditure of 8,000 J of energy?

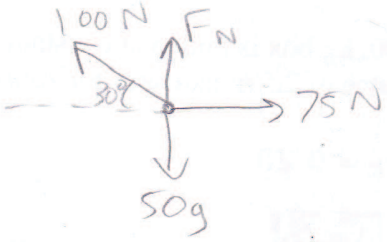
2.5 m → 1000 J

So $2.5 \times 8 = 20$ m

4. A person pulls a 50. kg box pictured below with a force of 100. N. The force of friction is 75 N.

a. Sketch a force diagram for the box.





b. How much of the force acts in the direction of motion? How much energy is transferred (via working) by the person who pulls the box a distance of 10.m?

$F_x = F\cos\theta = 100\cos 30 (= 86.6)$

$W = Fd = 100\cos 30 \times 10 = 866\,J$

c. Is the box moving at constant speed? Explain how you know. What does this tell you about the kinetic energy E_k of the system?

No, because the forces are not balanced.

86.6N > 75N

E_K must therefore be increasing

d. How much work is done by friction during the pulling process? What happens to this energy?

$W_f = F_f d = 75 \times 10 = 750\,J$

It is turned into heat

Name_____

Date _____ Pd____

Worksheet 2

Start each solution with a force diagram.

1. A baseball (m = 140 g) traveling at 30. m/s moves a fielder's glove backward 35 cm when the ball is caught.

What was the average force exerted by the ball on the glove?

OR

$KE = \frac{1}{2}mv^2 = \frac{1}{2}(0.14)(30^2)$

$KE = 63\ J$

$W = Fs$

$63 = Fs$

$F = \frac{63}{s} = \frac{63}{0.35} = 180\ N$

$v = 30,\ v_i = 0$

$a = ?,\ s = 0.3$

$\Rightarrow a$ then $F = ma \Rightarrow F$

2. A 60. kg student jumps from the 10. meter platform at UMD's swimming complex into the pool below.
   a. Determine her GPE at the top of the platform.

$GPE = mgh = 60(9.8)(10) = 6000\ J$

   b. How much KE does she possess at impact? What is her velocity at impact?

$KE = 6000\ J$

$6000 = \frac{1}{2}mv^2 = \frac{1}{2}(60)v^2$

$v = \sqrt{\frac{2(6000)}{60}} = 14.1\ m/s$

   c. If she jumped from a platform that was twice as high, how many times greater would be her velocity at impact?

$GPE = 12000\ J$

$v = \sqrt{\frac{2(12000)}{60}} = 20\ m/s$

   d. How much higher would the platform have to be in order for her velocity to be twice as great?

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

$h = \frac{v^2}{2g} = \frac{(28.2)^2}{2(9.8)} = 39.8\ m$

4 × original height

3. A 24 kg child descends a 5.0 m high slide and reaches the ground with a speed of 2.8 m/s.

How much energy was dissipated due to friction in the process?

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

$E_f = \frac{1}{2}mv^2 - mgh = \frac{1}{2}(24)(2.8^2) - 24(9.8)(5)$

$E_f = 94.08 - 1200 = -1105.92\ J$

Worksheet 3

1. A 60 kg box is lifted by a rope a distance of 10 meters straight up at constant speed. How much power is required to complete this task in 5 seconds?

$$P = \frac{W}{t} = \frac{Fd}{t} = \frac{mgd}{t} = \frac{60(9.8)(10)}{5} = 120\ W$$

2. Hulky and Bulky are two workers being considered for a job at the UPS loading dock. Hulky boasts that he can lift a 100 kg box 2.0 meters vertically, in 3.0 seconds. Bulky counters with his claim of lifting a 200 kg box 5.0 meters vertically, in 20 seconds.
Which worker can produce more power?

$$P = \frac{mgh}{t} = \frac{100(9.8)(2)}{3} = 666.7\ W$$

$$P = \frac{200(9.8)(5)}{20} = 500\ W$$

3. A 1994 Ford Mustang is driving down a road with a constant speed of 30 m/s. The engine must exert a 5000 N force to maintain this speed.

   a. What is the power output of the engine?

$$P = Fv = 5000(30) = 150{,}000\ W$$

4. An 82 kg hiker climbs Sugarloaf mountain. During a two hour period, the hiker's vertical elevation increases by 540 meters.

   a. Calculate the climber's ΔGPE.

$$\Delta GPE = mgh = 82(9.8)(540$$

$$= 442{,}800\ J$$

   b. Find the power generated to increase the hiker's GPE.

$$P = \frac{W}{t} = \frac{442\,800}{2 \times 60 \times 60}$$

$$P = 61.5\ W$$

5. How long would it take a 7.5 KW motor to raise a 500 kg piano to an apartment window 10 meters above the ground?

$P = \frac{mgh}{t}$

$t = \frac{mgh}{P} = \frac{500(9.8)(10)}{7500}$ $t = 6.7s$

6. The trains on a roller coaster are raised from 10 m above ground at the loading platform to a height of 60 m at the top of the first hill in 45 s. Assume that the train (including passengers) has a mass of 2500 kg. Ignoring frictional losses, what power motor would be required to accomplish this task?

$P = \frac{W}{t} = \frac{mgh}{t} = \frac{2500(9.8)50}{45}$

$= 27777.7W$

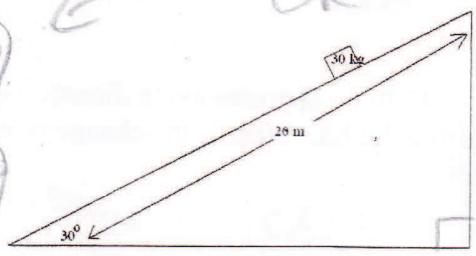
$P = 27.8\ kW$

7. How many joules does your 1600W blow drier transfer if you dry your hair in 5.0 min?

$P = \frac{W}{t}$ $W = Pxt = 1600(5x60)$

$W = 480{,}000J$

8. A 30 kg box slides down a ramp that makes an angle of 30° with the horizontal. If the force of friction is 78 N, what is the KE of the box at the bottom of the ramp?



OR

$\Delta PE = \Delta KE - W_{friction}$

So $\Delta KE = mgh - F_s d$.

$\sin 30 = \frac{h}{20}$

$\Delta KE = mg\ 20 \sin 30 - 78(20)$

$= 30(9.8)(20)\sin 30 - 78(20)$

$= 3000 - 1560$

$= 1440\ J$

$F_{net} = mg\sin 30 - 78$

$F_{net} = 30(9.8)\sin 30 - 78$

$F_{net} = 72\ N$

$W = Fd = 72(20)$

$W = 1440\ J$

So $\Delta KE = 1440\ J$

How fast is the box going at the bottom of the ramp?

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

$1440 = \frac{1}{2}mv^2$

$v = \sqrt{\frac{2(1440)}{30}} = 9.80\ m/s$