<div align="center">Work, Energy and Power Review Package</div>

1) <u>Work</u>: change in energy. Measured in Joules, J.

$$\mathbf{W = Fd} \qquad \mathbf{W = \Delta E}$$

Work is scalar, but can be negative. To remember this, ask yourself either:
- Is the object is losing energy (i.e. ΔE is decreasing)?
- Is the force in the opposite direction of motion (recall that technically $W = F\cos\ominus \cdot d$)

2) <u>Potential energy</u>: stored energy. Measured in Joules, J.

$$\mathbf{E_p = mgh \text{ (gravitational)}}$$

$$\mathbf{E_p = Fd \text{ (springs etc)}}$$

3) <u>Kinetic Energy</u>: energy of motion. Measured in Joules, J.

$$\mathbf{E_k = \tfrac{1}{2}mv^2}$$

4) <u>Law of Conservation of Energy</u>: Energy cannot be created or destroyed, only transformed into one type or another. If there only conservative forces (such as gravity or elastic) then the total initial energy is equal to the total final energy:

$$\mathbf{E_{ki} + E_{pi} = E_{kf} + E_{pf}}$$

$$\mathbf{\tfrac{1}{2}mv^2_i + mgh_i = \tfrac{1}{2}mv^2_f + mgh_f}$$

Non-conservative forces (such as friction, applied force and tension) can be used to add or remove energy to/from an object.

5) <u>Power</u>: the amount of work done in a certain time. Measured in Watts, W.

$$\mathbf{P = W/t}$$
$$\mathbf{P = Fv} \text{ (at constant speed)}$$

6) <u>Efficiency</u>: How much work or power output a machine has given the work or power input. All machines have an efficiency **less** that 100%.

$$\textbf{Efficiency} = \underline{\textbf{work out}} \textbf{ x 100\%}$$
$$\textbf{work in}$$

$$\textbf{Efficiency} = \underline{\textbf{power out}} \textbf{ x 100\%}$$
$$\textbf{power in}$$

7) <u>Thermal Energy</u>: the amount of heat in an object

$$\mathbf{\Delta E_h = m\Delta tc}$$

<u>Work</u>:

1) A student holds a 15 kg bowling ball 1.5 m above the ground for 15 s. How much work is done on the ball?

2) A block of wood is pushed at a constant velocity with a force of 25.0 N. How far did it travel if 100.0 J of work are done on it?

3) A 2.0 kg textbook is picked up off the floor and placed on a 0.95 m high desk. How much work is down on the book?

4) A 5.0 kg ball rolls down a ramp as shown.
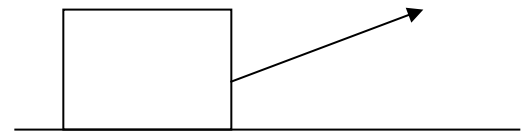How much work is done on the ball?

4.0 m
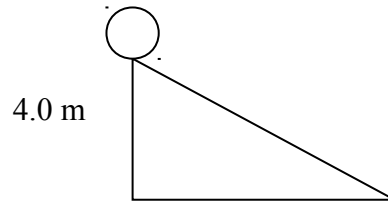
5) A 5.0 kg block of wood is pushed up a ramp as shown.
If a force of 16.0 N is needed to push it up the ramp at a constant velocity, how much work is done in the block?

12.0 m
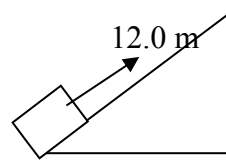
6) A 5.0 kg block of wood is pushed up a frictionless ramp as shown.
How much work is done on the block?

8.0 m
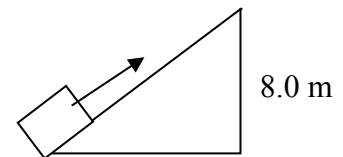
7) A box is pulled along a horizontal surface at a constant velocity. The tension in the rope is 150 N and the rope makes an angle of 35 ^{0} with the floor. How much work is done on the box if it is dragged 18 m?

8) A 1200 kg car traveling at 60.0 km/h hits the brakes and comes to a stop in 32 m. How much work is done on the car?

<u>Potential Energy</u>:

1) How much potential energy does a 12.0 kg bowling ball have if it is sitting on a 0.50 m high chair?

2) A 7.5 kg bowling ball sits on a 1.10 m desk. If a student lifts the ball 0.90 m above the desk, how much potential energy does it have with respect to the desk?

3) A 5.0 kg bock is pushed up a ramp as shown.
How much potential energy does it have when it reaches the top?

6.5 m   13.0 m
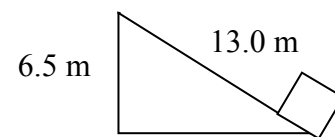
4) If the ramp in question #3 is frictionless, how much force is required to push the block up the ramp (think work!)?

Kinetic Energy:

1) How much kinetic energy does a 50.0 g bullet traveling at 365 m/s have?

2) If a 78 kg cheetah is running at a speed of 120 km/h, how much kinetic energy does it have?

3) A 3.91 N baseball has 775 J of kinetic energy. How fast is it moving?

4) A 0.425 kg water balloon is dropped from the top of a school gymnasium onto some unsuspecting physics students (those were the days…). If the gym is 8.50 m high how much kinetic energy does it have just before it hits the ground?

Law of Conservation of Energy: (Use Law of Con of En OR ELSE!!!!)

1) A 0.85 kg soccer ball is booted straight up in the air. If it left the soccer player's foot at a height of 1.0 m and reaches a height of 47.0 m, what was its kinetic energy immediately after it was kicked?

2) What was the speed of the ball in question #1 when it had reached a height of 24.0 m?

3) A 0.575 kg smurf is thrown straight down from a 10.0 m high toadstool. If his final speed is 18.0 m/s, how fast was he traveling initially?

4) Another 0.575 kg smurf (there are 99 of them…) is now thrown horizontally from a 50.0 m cliff at 8.00 m/s. how much kinetic energy does it have when it is 15.0 m from the ground?

5) A box slides down a frictionless ramp as shown. How fast is it traveling at the bottom?

9.5 m   16.0 m
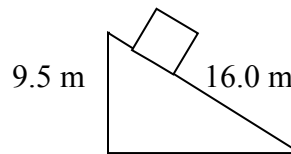
6) A pendulum if pulled aside as shown. The pendulum bob has a mass of 0.500 kg. If the pendulum is released from this point how fast will it be moving when it returns to the equilibrium point?

1.00 m

1.50 m

0.25 m
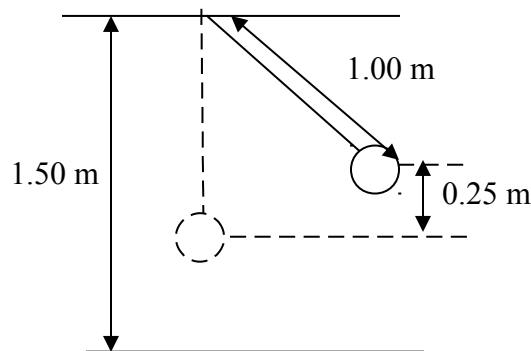
Power and Efficiency

1) A 12.0 kg block is pushed up an 8.0 m ramp at a constant speed of 2.50 m/s with a force of 28.0 N. How much power does this require?

2) A 25.0 kg crate it lifted on to a 2.0 m ledge by a worker that exerts 325 W of power. How long does it take to reach the ledge?

3) A 0.390 kg hockey puck is accelerated across a frictionless sheet of ice from rest to a speed of 15.0 m/s in 1.5 m. How much power is exerted on the puck?

4) A 5.0 kg box is sliding across the floor at 2.00 m/s when it is accelerated to 8.00 m/s in 1.80 s. If the coefficient of friction is 0.220 how much power is required to accelerate the box?

5) A 7.0 kg box is pushed up the ramp shown in 3.25 s. If it requires a force of 40.0 N to push at a constant velocity, what is the efficiency of the ramp?

12.0 m

6.0 m
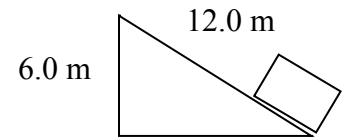
6) A 1250 W electric motor is used to lift an 80.0 kg weight to a height of 4.0 m in 3.00 s. What is the efficiency of the motor?

7) A pulley has an efficiency of 85.0%. If 475 J are exerted to lift a 16.0 kg weight, how high is the weight lifted?

Work
1) 0 J   2) 4.00 m 3) 19 J 4) 2.0 x10^2 J 5) 192 J 6) 390 J 7) 2200 J   8) – 1.7 x10^5 J

Potential Energy
1) 59 J   2) 66 J 3) 320 J 4) 25 N

Kinetic Energy
1) 3330 J 2) 43000 J 3) 62.4 m/s 4) 35.4 J

Law of Conservation of Energy
1) 380 J 2) 21 m/s 3) 11.3 m/s 4) 216 J 5) 14 m/s 6) 2.2 m/s

Power and Efficiency
1) 70.0 W 2) 1.5 s 3) 219 W 4) 140 W   5) 86% 6) 84% 7) 2.57 m