Work, Energy and Power Review Package

1) Work: 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 $W = F\cos\theta \cdot d$)

2) Potential energy: stored energy. Measured in Joules, J.

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

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

3) Kinetic Energy: energy of motion. Measured in Joules, J.

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

4) Law of Conservation of Energy: 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) Power: 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) Efficiency: How much work or power output a machine has given the work or power input. All machines have an efficiency **less** that 100%.

$$\text{Efficiency} = \frac{\text{work out}}{\text{work in}} \times 100\%$$

$$\text{Efficiency} = \frac{\text{power out}}{\text{power in}} \times 100\%$$

7) Thermal Energy: the amount of heat in an object

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

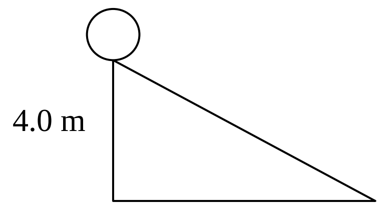
Work:

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?

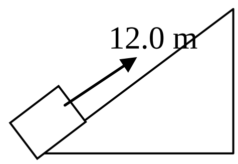
2) A block of wood is pushed at a constant velocity with a force of 25.0 N. How far did it travel if 100.0 J of work are done on it?

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?

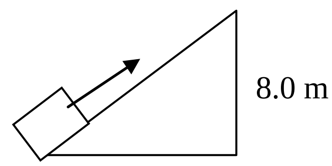
4) A 5.0 kg ball rolls down a ramp as shown.
How much work is done on the ball?



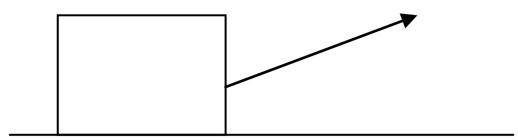
5) A 5.0 kg block of wood is pushed up a ramp as shown.
If a force of 16.0 N is needed to push it up the ramp at a constant velocity, how much work is done in the block?



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



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?



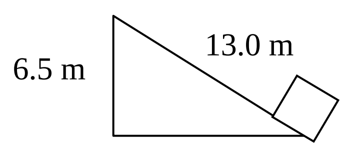
8) A 1200 kg car traveling at 60.0 km/h hits the brakes and comes to a stop in 32 m. How much work is done on the car?

Potential Energy:

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?



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!!!!)

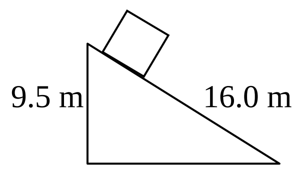
1) A 0.85 kg soccer ball is booted straight up in the air. If it left the soccer player's foot at a height of 1.0 m and reaches a height of 47.0 m, what was its kinetic energy immediately after it was kicked?

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

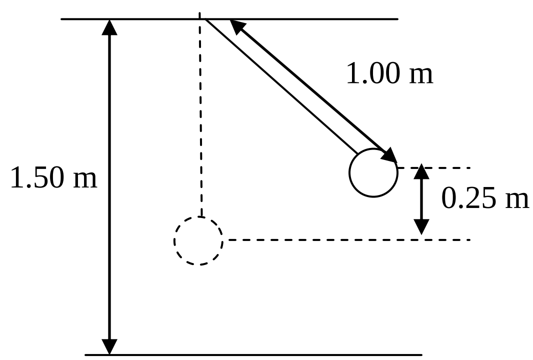
3) A 0.575 kg smurf is thrown straight down from a 10.0 m high toadstool. If his final speed is 18.0 m/s, how fast was he traveling initially?

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?



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?



Power and Efficiency

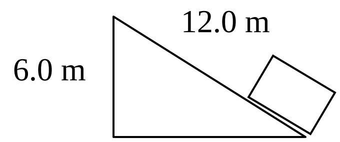
1) A 12.0 kg block is pushed up an 8.0 m ramp at a constant speed of 2.50 m/s with a force of 28.0 N. How much power does this require?

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?



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) 2.0×10^2 J 5) 192 J 6) 390 J 7) 2200 J   8) – 1.7×10^5 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

Work:

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?

No change in energy $\therefore W = \Delta E = 0\,J$

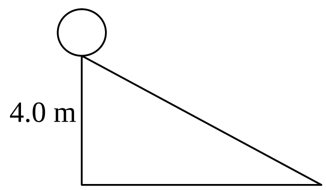
2) A block of wood is pushed at a constant velocity with a force of 25.0 N. How far did it travel if 100.0 J of work are done on it?

$W = Fd \quad d = \frac{W}{F} = \frac{100.0\,J}{25.0\,N} = 4.00\,m$

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?

$W = mg\Delta h = (2.0\,kg)(9.80\,m/s^2)(0.95\,m) = 19\,J$

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

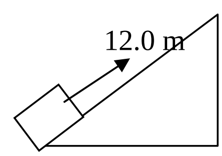


$W = \Delta E_p = E_{pf} - E_{pi}$

$= mgh_f - mgh_i$

$= 0 - 196 \quad = -2.0 \times 10^2\,J$

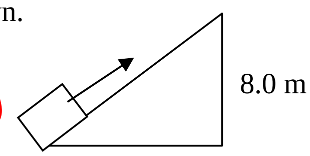
5) A 5.0 kg block of wood is pushed up a ramp as shown.
If a force of 16.0 N is needed to push it up the ramp at a constant velocity, how much work is done in the block?



$W = Fd = (16.0\,N)(12.0\,m)$

$= 192\,J$

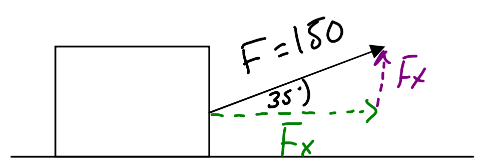
6) A 5.0 kg block of wood is pushed up a frictionless ramp as shown.
How much work is done on the block?



$W = \Delta E_p = mg\Delta h = (5.0\,kg)(9.80\,m/s^2)(8.0\,m)$

$= 4.0 \times 10^2\,J$

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?



$\cos 35° = \frac{F_x}{150}$

$F_x = 150\cos 35 = 122.9\,N$

$W = F_x d$

$= (122.9)(18) = 2200\,J$

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?

$\div 3.6 = 16.67\,m/s$

$v = 0$

$v_0 = 16.67$

$a =$

$d = 32\,m$

$t =$

$a = \frac{v^2 - v_0^2}{2d}$

$= -4.342\,m/s^2$

$F_{net} = F_f = ma = 5210\,N$

$W = F_f d$

$= -1.7 \times 10^5\,J$

because the car is losing energy!

Shortcut!

$W = \Delta E_K$

$= E_{kf} - E_{ki}$

$= 0 - \frac{1}{2}mv^2$

$= -1.7 \times 10^5\,J$

Potential Energy:

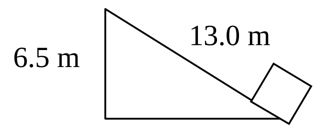
1) How much potential energy does a 12.0 kg bowling ball have if it is sitting on a 0.50 m high chair?

$E_p = mgh = (12.0\,kg)(9.80\,m/s^2)(0.50\,m) = 59\,J$

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?

$E_p = mgh = (7.5\,kg)(9.80\,m/s^2)(0.90\,m) = 66\,J$

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?



$E_p = mgh = 290\,J$

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

$W = Fd = \Delta E_p \qquad F = \frac{E_p}{d} = \frac{294\,J}{13.0\,m} = 23\,N$

Kinetic Energy:

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

$E_k = \frac{1}{2}mv^2 = \frac{1}{2}(0.0500\,kg)(365\,m/s)^2 = 3.33 \times 10^3\,J$

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

$E_k = \frac{1}{2}mv^2 = \frac{1}{2}(78\,kg)(33.3\,m/s)^2 = 43000\,J$

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

$F_g = mg \qquad m = \frac{F_g}{g} = \frac{3.91\,N}{9.80\,m/s^2} = 0.399\,kg \qquad E_k = \frac{1}{2}mv^2 \qquad v = \sqrt{\frac{2E_k}{m}} = \sqrt{\frac{2(775)}{0.399}} = 62\,m/s$

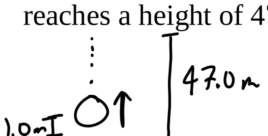
4) A 0.425 kg water balloon is dropped from the top of a school gymnasium onto some unsuspecting physics students (those were the days…). If the gym is 8.50 m high how much kinetic energy does it have just before it hits the ground?

$E_{kf} = E_{pi} = mgh = (0.425)(9.80)(8.50) = 35\,J$

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?

← assuming initial $h = 0$



$E_{ki} = E_{pf} = mgh_f = (0.85\,kg)(9.80\,m/s^2)(46.0\,m) = 380\,J$

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

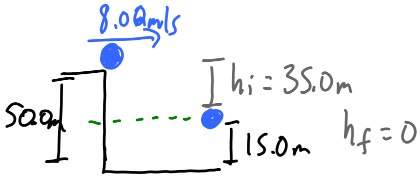
$E_{ki} = E_{kf} + E_{pf} \qquad E_{kf} = E_{ki} - E_{pf} \qquad \frac{1}{2}mv_f^2 = E_{ki} - mgh_f \qquad v_f = \sqrt{\frac{2(E_{ki} - mgh_f)}{m}} = 21\,m/s$

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?

$E_{ki} + E_{pi} = E_{kf}$

$\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2$

$v_i = \sqrt{v_f^2 - 2gh_i} = \sqrt{(18.0)^2 - 2(9.80)(10.0)} = 11\,m/s$



$$E_{Ki} + E_{Pi} = E_{Kf} + E_{Pf}^{\,0}$$

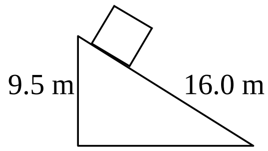
$$E_{Kf} = E_{Ki} + E_{Pi} = \tfrac{1}{2}mv_i^2 + mgh_i$$

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?

$$= \tfrac{1}{2}(0.575\text{kg})(8.00\text{m/s})^2 + (0.575\text{kg})(9.80\text{m/s}^2)(35.0\text{m})$$

$$= 215\text{ J}$$

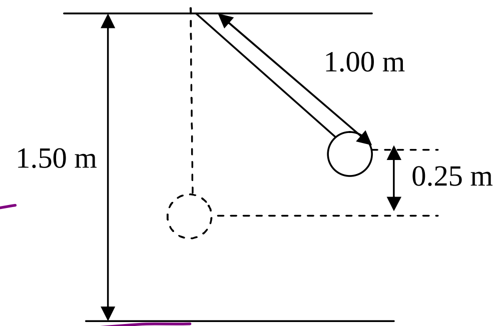
5) A box slides down a frictionless ramp as shown.
How fast is it traveling at the bottom?



$$E_{Pi} = E_{Kf} \qquad v = \sqrt{2gh_i} = 14\text{ m/s}$$

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

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?



$$E_{Pi} = E_{Kf} \qquad v = \sqrt{2gh_i}$$

$$mgh_i = \tfrac{1}{2}mv_f^2$$

$$= \sqrt{2(9.80\text{m/s}^2)(0.25\text{m})} = 2.2\text{ m/s}$$

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?

$$P = \frac{W}{t} = \frac{Fd}{t} = Fv = (28.0\text{N})(2.50\text{m/s}) = 70.\text{ W}$$

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?

$$P = \frac{W}{t} = \frac{\Delta E_P}{t} = \frac{mgh}{t} \qquad t = \frac{mgh}{P} = \frac{(25.0\text{kg})(9.80\text{m/s}^2)(2.0\text{m})}{325\text{W}}$$

$$= 1.5\text{ s}$$

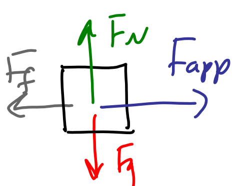
3) A 0.390 kg hockey puck is accelerated across a frictionless sheet of ice from rest to a speed of 15.0 m/s in 1.5 m. How much power is exerted on the puck?

$v = 15.0$ m/s, $v_0 = 0$, $a = ?$, $d = 1.5$ m, $t = ?$

$$a = \frac{v^2 - v_0^2}{2d} = 75\text{ m/s}^2 \qquad t = \frac{v - v_0}{a} = 0.20\text{ s}$$

$$P = \frac{W}{t} = \frac{\Delta E_K}{t} = \frac{\tfrac{1}{2}mv^2}{t} = \frac{\tfrac{1}{2}(0.390\text{kg})(15.0\text{m/s})^2}{0.20\text{s}} = \boxed{220\text{ W}}$$

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?



$v = 8.00$ m/s, $v_0 = 2.00$ m/s, $a = ?$, $d = ?$, $t = 1.80$ s

① $a = \frac{v - v_0}{t} = 3.333\text{ m/s}^2$

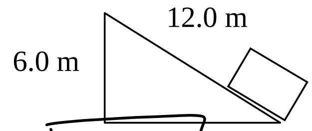
② $d = \frac{v^2 - v_0^2}{2a} = 9.00\text{ m}$

③ $F_f = \mu F_N = \mu mg = 10.78\text{ N}$

④ $F_{net} = F_{app} - F_f = ma \qquad F_{app} = ma + F_f = (5.0)(3.333) + 10.78 = 27.45\text{ N}$

⑤ $P = \frac{W}{t} = \frac{F_{app}d}{t} = \frac{(27.45)(9.00)}{1.80} = \boxed{137\text{ W}}$

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?



$W_{out} = mgh = (7.0)(9.80)(6.0) = 411.6\,J$

$W_{in} = Fd = (40.0)(12.0) = 480\,J$

$Eff = \frac{W_{out}}{W_{in}} \times 100\% = \frac{411.6\,J}{480\,J} \times 100\% = 86\%$

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?

P_{in}

$P_{out} = \frac{W}{t} = \frac{\Delta E_p}{t} = \frac{mgh}{t} = \frac{(80.0)(9.80)(4.0)}{3.00} = 1045\,W$

$Eff = \frac{P_{out}}{P_{in}} \times 100\% = \frac{1045\,W}{1250\,W} \times 100\% = 84\%$

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?

$\to W_{in}$

$Eff = \frac{W_{out}}{W_{in}} \times 100\%$

$W_{out} = \frac{Eff}{100\%} \times W_{in} = \frac{85\%}{100\%} \times 475\,J = 403.75\,J$

$W_{out} = \Delta E_p = mgh$

$h = \frac{W_{out}}{mg} = \frac{403.75\,J}{(16.0\,kg)(9.80\,m/s^2)} = 2.57\,m$

Physics 11

Work, Energy, & Thermal Energy Review WS

1. A 23 kg boulder is pushed a distance of 4.5 m by a horizontal force of 35 N. How much work was done on the boulder? *(2 marks)*

2. A 650 kg pile-driver is lifted a height of 4.0 m before being dropped onto a pile. The pile is pushed into the ground a distance of 0.050 m every time the pile-driver is dropped.
   a. How many times must the pile-driver be dropped to push the pile 3.0 m into the ground? *(3 marks)*
   b. What is the ground resistance force on the pile? *(3 marks)*

3. A 2300 kg car whose motor is rated at 45000 W completes a 200 km road race in 8280 s. How much work is done during the race? *(4 marks)*

4. Tim lifts a 34 kg weight to a maximum height of 2.3 m and then **slowly lowers** the mass to the floor. He repeats this motion 15 times to build up his muscles.
   a. What total work is being done? *(3 marks)*
   b. Tim does this motion in 46s. What power does Tim generate? *(3 marks)*

5. An oil pump delivers 450 kg of oil up to a platform 35 m above the ground in a time of 23 s.
   a. Calculate the work done on the oil? *(2 marks)*
   b. Calculate the power produced by the pump? *(2 marks)*

6. A boat is pushed through the water at a constant speed of 16 m/s while the motor generates a constant force of 7.0×10^3 N. What power does the motor develop? *(3 marks)*

7. A 45 kg climber is able to lift her body to a vertical height of 450 m. The she lowers herself down to a height of 250m.
   a. How much potential energy does she gain in climbing 450 m? *(2 marks)*
   b. How potential energy does she lose on the way down to the 250 m mark? *(2 marks)*

8. A 2300 kg car is travelling at 18.0 m/s. What is the car's kinetic energy? *(2 marks)*

9. A 25 kg cart is moving with a speed of 6.4 m/s down a level hallway. A constant force of **–10.0 N** acts on the car slowly it to 2.2 m/s.
   a. What is the change in kinetic energy of the cart? *(3 marks)*
   b. How much work is done on the car? *(1 mark)*
   c. How far did the cart move while the force acted? *(2 marks)*

10. Tarzan swings from the top of cliff using a long rope-vine. The 15 m long vine is horizontal when Tarzan jumps off the cliff. What is the speed of Tarzan at the bottom of the swing? *(4 marks)*

11. A 450 kg roller coaster reaches the top of the first 78 m high hill with a speed of 11 m/s. (Assume no friction)
    a. What is the speed of the hill at the bottom of this hill? *(4 marks)*
    b. The car then climbs up the next hill and reaches its peak with a speed of 19 m/s. How high is this hill? *(4 marks)*

12. A 0.0025 kg bullet travelling at 450 m/s strikes and embeds itself into a 6.7 kg sand bag.
    a. What is the kinetic energy of the bullet before it hits the sand bag? *(2 marks)*
    b. What kind of collision is this? *(1 mark)*
    c. What happened to the "missing" energy? *(1 mark)*
    d. What is the speed of the sand bag & bullet after collision? *(3 marks)*
    e. What is the kinetic energy after the collision? *(2 marks)*
    f. How much energy was "lost"? *(2 marks)*

13. Which of these objects contains the most heat energy. ***Explain your answer***.
    a. 120 kg of water at 20 ^oC *(2 marks)*
    b. 9.0 kg of water at 80 ^oC
    c. 50 kg of copper at 47 ^oC

14. Convert: *(4 marks)*
    a. 230 K to ^oC
    b. –67 ^oC to K
    c. 670 ^oC to K
    d. 980 K to ^oC

15. A 23 kg piece of iron is heated up from 150 ^oC to 750 ^oC. How much thermal energy does this take? *(2 marks)*

16. A 2.3 kg piece of brass is heated to 67 ^oC and is then immersed into some water initially at 20 ^oC. The brass cools down to 29 ^oC. What was the mass of the water was used in this process? *(3 marks)*

17. A 400 W electric immersion heater is used to heat a 250 g of water. The water is initially at 20 ^oC. This process takes 120 s. What is the final temperature of the water? *(4 marks)*

18. A 45 kg piece of iron is heated to 95 ^oC and is then placed into 120 kg of water initially at 20 ^oC. What is the final temperature of the water? *(4 marks)*

19. A soft drink from Canada is labelled "Low Joule Cola". The label says 100 mL yields 1.9 kJ. The can contains 375 mL. Jennifer drinks the whole can of cola and then wants to "burn off" the energy from the drink by climbing stairs. How high must she climb if she has a mass of 65 kg to "burn off" all of this energy? (Assume 1.0 mL of Cola has a mass of 1.0 g) *(4 marks)*

Physics 11

Work, Energy, & Thermal Energy Review Worksheet – Answers

1. 160 J
2. a) 60 times b) 5.10×10^5 N
3. 3.7×10^8 J
4. a) 23000 J b) 500 W
5. a) 154000 J b) 6710 W
6. 112000 W
7. a) 198000 J b) 88200 J
8. 373000 J
9. a) -450 J b) -450 J c) 45 m
10. 17 m/s
11. a) 41 m/s b) 66 m
12. a) 243 J b) inelastic collision c) converted to heat d) 0.168 m/a e) 0.095 J
    f) Almost all of it: 253 J
13. a)
14. a) -43^{o}C b) 206 K c) 947 K d) 707^{o}C
15. 6.21×10^6 J
16. 0.873 kg
17. 66^{o}C
18. 23^{o}C
19. 11 m

U06L04 Assignment

Exercises

1. (a) Explain the difference between **temperature**, **thermal energy** and **heat.**
   (b) Why is it strictly incorrect to say that a body 'contains heat'?

2. A sample of helium gas has a temperature of 20^{o}C.
   (a) What is its temperature in kelvins (K)?
   (b) In another helium sample, the atoms have *twice* the average translational kinetic energy.
   What is the temperature of this sample in (i) kelvins? (ii) ^{o}C?
3. A large pot of near-boiling water has a small, red-hot nail dropped into it.
   (a) Which has more thermal energy to begin with — the pot of water or the nail?
   (b) Which has the higher average kinetic energy to begin with?
   (c) Which will lose heat, and which will gain heat when the nail is dropped into the pot of boiling water?
   (d) After five minutes, which will have (i) more thermal energy? (ii) higher average kinetic energy?

Exercises

1. How much heat is needed to raise the temperature of 90.0 kg of water from 18^{o}C to 80^{o}C?
2. If 1.0 MJ (megajoule) of heat is transferred to 10.0 kg of water initially at 15^{o}C, what will its final temperature be?
3. If 12 kg of water cools from 100^{o}C down to room temperature (20^{o}C), how much heat will it release to the environment?
4. Why is water such a desirable material to use as a coolant in a car engine?
5. If it takes 1200 J to raise the temperature of 0.500 kg of brass from 20.0^{o}C to 26.2^{o}C, what is the specific heat capacity of brass?
6. How much heat would be needed to warm 1.6 kg of ice from –15^{o}C up to its melting point of 0^{o}C?
7. A 5.0 kg block of lead at 250^{o}C cools down to 20^{o}C. How much heat does it give off in doing so?

Exercises

1. If you must do 500 J of work to operate a pulley system, and the pulley system lifts a 150 N load to a height of 3.0 m, how efficient is the pulley system?

2. A kettle that is 80% efficient is rated 1200 W. At what rate does the water in the kettle absorb energy (in watts)?

3. If a light bulb has an efficiency of 5.0%, at what rate does a 60 W bulb produce light energy?

4. For every megajoule of chemical potential energy in the fuel used to run a certain truck, only
120 kJ of useful work is done by the truck in making itself move. How efficient is the truck? Where are some of the places that the energy from the fuel is wasted?

ANS.

2. (a) 293 K (b) (i) 586 K (ii) 313^{o}C
3. (a) water (b) nail (c) Nail loses heat to water
   (d) (i) water (ii) neither

1. 2.3×10^{7} J, or 23 MJ
2. 39°C
3. 4.0×10^{6} J, or 4.0 MJ
4. Water has a very high heat capacity.
5. $c = 3.9 \times 10^{2}$ J/kg/C^{o}
6. 5.0×10^{4} J, or 50. kJ
7. 1.5×10^{5} J, or 150 kJ

1. 90%
2. 960 W
3. 5% of 60 W is 3.0 W.
4. 12% efficient