**Energy Work Power Heat Review**

**Potential and Kinetic Energy**

1. Calculate the kinetic energy of a proton mass 1.67 x 10-27 kg, traveling at 5.20 x 107 m/s.
2. What is the kinetic energy of a 3.2 kg pike swimming at 2.7 km/h?
3. What is the kinetic energy of a 0.500 kg ball thrown at 30.0 m/s?
4. What is the mass of an object traveling at 20 m/s with kinetic energy of 4000 J?
5. A 0.50 kg rubber ball is thrown into the air. At a height of 20 m above the ground, it is traveling at 15.0 m/s.

(a)   What is the ball’s kinetic energy?

(b)  What is its gravitational potential energy relative to the ground?

1. A crane lifts a 1500 kg car 20 m straight up.
2. How much potential energy does the car gain?
3. How much potential energy does the crane transfer to the car?
4. A 4.00 kg rubber ball drops from a height of 5.00 m to the ground and bounces back to a height of      3.00 m.
5. How much potential energy does the ball lose on the trip down?
6. How much potential energy does the ball regain on the trip back up?
7. What is the net loss of potential energy during the bounce?
8. Each step of a ladder increases one’s vertical height 40. cm. If a 90.0 kg painter climbs 8 steps of the ladder, what is the increase in potential energy?

**Law of Conservation of Energy**

1. A 712 kg car is traveling at 5.6 m/s when a force acts on it for 8.4 s, changing its velocity to 10.2 m/s.

a.     What is the change in kinetic energy of the car?

b.     How far did the car move while the force acted?

c.     How large is the force?

1. A 0.25 kg ball is dropped from a height of 3.2 m and bounces to a height of 2.4 m. What is its loss in potential energy?
2. A 15.0 kg model plane flies horizontally at a constant speed of 12.5 m/s.
3. Calculate its kinetic energy.
4. The plane goes into a dive and levels off 20.4 m closer to Earth. How much, potential energy does it lose during the dive? Assume no additional drag.
5. How much kinetic energy does the plane gain during the dive?
6. What is its new kinetic energy?
7. What is its new horizontal velocity?
8. In an electronics factory, small cabinets slide down a 30.0° incline a distance of 16.0 m to reach the next assembly stage. The cabinets have a mass of 10.0 kg each
9. Calculate the speed each cabinet would acquire if the incline were frictionless.
10. What kinetic energy would a cabinet have under such circumstances?
11. A student lifts his 2.0 kg pet rock 2.8 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
12. half way down and
13. just before it hits the ground.
14. A 65 kg girl is running with a speed of 2.5 m/s. How much kinetic energy does she have? She 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 she swing?
15. How much kinetic energy will an 80.0 kg skier sliding down a frictionless slope (vertical height = 60.0 m) have when he 2/3 of the way down?
16. A golfer wishes to hit his drives further by increasing the kinetic energy of the golf club when it strikes the ball. Which would have the greater effect on the energy transferred to the ball by the driver --- doubling the mass of the club head or doubling the speed of the club head? Explain.
17. How much work must be done to increase the speed of a 12 kg bicycle ridden by a 68 kg rider from 8.2 m/s to 12.7 m/s?
18. A truck moving with a speed of 90 km/h 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.
19. A rubber ball falls from a height of 2.0 m, bounces off the floor and goes back up to a height of 1.6 m. What percentage of its initial gravitational potential energy has been lost? Where does this energy go? Has the Law of Conservation of Energy been ‘violated’?
20. An average force of 8.2 N is used to pull a 0.40 kg rock, stretching a sling shot 43 cm. The rock is shot downward from a bridge 18 m above a stream. What will be the velocity of the rock just before it enters the water?

**Work and Power**

1. How much work will you do if you push a block of concrete 4.3 m along a floor with a steady force of 25 N?
2. If your mass is 70.0 kg, how much work will you do climbing a flight of stairs 25.0 m high, moving at a steady pace?
3. Your car is stuck in the mud. You push on it with a force of 300.0 N for 10.0 s, but it will not budge. How much work have you done in 10.0 s
4. How much work is done by the Earth’s gravitational field on a 10.0 kg mass when the mass drops a distance of 5.0 m?
5. A girl uses a 3.0 m long ramp to push her 110 kg motorbike up to a trailer, the floor of which is 1.2 m above the ground. How much work is done n the motorbike?
6. A force was used to push a box along the floor for a distance of 8.0 m. If 160.0 J of work was done, what net force was applied?
7. A force of 50.0 N is used to do 480.0 J of work to move an object. What distance was the object moved?
8. A 2.0 kg puck accelerated at 5.0 m/s2 for 0.50 m across a frictionless air hockey table. How much work was done on the puck?
9. A bulldozer pushed a large rock with a force of 5000 N at 2.0 m/s for 20 s. How much work was done?
10. How much work is required to lift a 50 kg object straight up 10. m?
11. How much power does a crane develop doing 60 000 J of work in 5.00 minutes?
12. A 1200 kg car starts from rest and accelerates to 72 km/h in 20.0 s. Friction exerts an average force of 450 N on the car during this time;
13. What is the net work done on the car?
14. How far does the car move during its acceleration?
15. What is the net force exerted on the car during this time?
16. What is the forward force exerted on the car as a result of the engine, power train, and wheels pushing backward on the road?
17. How long does it take a 2.5 kW electric motor to do 75 000 J of work?
18. How much work can a 500 W electric mixer do in 2.5 minutes?

**Thermal Energy**

1. Define or explain the three ways heat is exchanged/transferred
2. Explain why:
   1. Heat conduction does not work well in fluids
   2. Convection of heat does not work well in solids
   3. Neither conduction nor convection works in space.
3. Which has more heat: a small 100ml cappuccino coffee at 70oC or a large 2.5L pot of coffee at 65oC? Explain your answer.
4. How much heat is required to raise the temperature of 1.00 kg of aluminum (specific heat = 903 J/kgoC) from 20oC to 65oC?
5. How much heat is lost in cooling 0.600 kg of water (sp. heat = 4180J/kgoC) from 90oC to 40 oC?
6. A thermos bottle contains 0.150 kg of water at 4.0 oC. When 0.090 kg of metal, initially at 100 oC, is put into the water, the temperature of the water/metal rises to 21 oC. Calculate the specific heat of the metal.
7. A 700 W submersible heater is used to heat a beaker containing 1200g of water (specific heat = 4180 J/kgoC). How long will it take to heat the water from 15 oC to 95 oC?
8. A 2000W kettle heats 2.0kg of water from 22 oC to 42 oC in 120 secs.
   1. What is the amount of input energy?
   2. What is the amount of output energy?
   3. What is the % efficiency of the heater?
9. A Troll wishes to cook a 80 kg Weirdo in a cauldron. To do this he must bring the cauldron to a boil (100 oC) How much time does the Weirdo have to escape if the Troll uses a 2500 W heater? The Water is originally 20 oC. (sp. heat = 4180J/kgoC)

**Answer Key**

**1**. 2.26 x 10-12 J **2.** 0.75 m/s therefore 0.90 J**-** **3.** 225 J **4**. 20 kg **5.** A)56.3 J b) 98 J **6**. A)294 000 J b) 294000J **7.** a) 196 J b) 117.6 J c) 78.4 J **8**. 2800 J **9.** a) 25874 J b) a = 0.55 m/s2; 68 m c) 390 N **10.** ∆Ep = 7.84 J – 5.88 J = 1.96 J **11.**.a) 1170 J b) Ep = 3000 J c) Ek = 3000 J (total energy is conserved so a loss of potential must equal a gain in kinetic energy) d) Ekold  + Eknew = 1172 + 3000 J =4172 J e) vnew = 23.63 m/s **12.** A) Find height using trig. which is 8.0 m. Then Ep = 784 J, as this cabinet slides down all the PE is converted to KE. Therefore, Ek = 784 J and the speed is 12.5 m/s. B) Ek = 784 J 15. Use ∆Ep = ∆Ek  **13.** a) 5.2 m/s  b) 7.4 m/s   **14**. Use ∆Ep = ∆Ek     Ek = 203 J, Ep = 203 J therefore h = 0.32 m c) Fnet = Fapplied – Ffr ; Fapplied  = 1650 N **15**. Use ∆Ep = ∆Ek   ∆Ep = 31 360 J, therefore Ek = 31 360 J and velocity is 28 m/s **16.** Doubling the mass only doubles the kinetic energy while doubling the velocity quadruples the kinetic energy. **17**. Total mass is 80.0 kg. Use W = ∆Ek then ∆Ek = 3760 J and hence work equals 3760 J **18**. 25 m/s , Use ∆Ep = ∆Ek which means mgh = 0.5mv2. Note that the masses cancel out with gh = 0.5v2 !! Therefore h = (0.5v2)/g = 31.9 m. If friction were to be taken into account, we would expect that the height would be less since some energy would be lost (probably as heat or sound) **19**. 20% , Lost as heat or sound , Absolutely not. **20**. DALP. The kinetic energy the sum of the KE supplied by the slingshot (equal to work done on the slingshot) and the KE supplied by gravity (as gravitational PE is converted to KE). Ek = 3.5 J + 70.6 J = 74.1 J; this relates to a velocity of 19.2 m/s **21**. 110 J **22.**. 1.72 x 104 J **23**. ? 0 J **24**. 4.9 x 102 J **25**. 1.3 x 103 J **26**. 20 N **27**. 9.6 m **28**. F must calculated first, F = 10.N then calculate work W= 5.0 J **29**. Find distance = 40. m then W = 2.0 x 105 J **30**. W = 4.9 x 103 J **31**. 200 W **32**. (20. m/s) ,a) Wnet = ∆Ek = Ek final – Ek initial = 240 000 J – 0 J = 240 000 J b) Use kinematics; a= 1.0 m/s2 then d = 200 m c) Wnet = Fnet x d so Fnet  = Wnet/d = 1200 N **33**. 30. S **34**. 75 000 J **38.** 4.06x 104 J **39.** 1.25 x 105J **40.** 1500 J/kgoC **41.** 573s **42. a)**2.4 x 105J **b)** 1.67 x 105J **c)** 70% **43.**  2.97hrs