Name: KEY

Energy Review

1. Work is required to lift a barbell. How many times more work is required to lift the barbell three times as high?

   3x the distance, so **3x the work**

2. Which requires more work – lifting a 10-kg sack a height of 2 meters, or lifting a 5-kg sack a height of 4 meters?

   W → PE so mgh (10)(10)(2) = 200J   (5)(10)(4) = 200J   **The same!**

3. How many Joules of work are done on an object when a force of 10 N pushes it a distance of 10 m?

   $W = Fd = (10)(10) =$ **100 J**

4. a. How much power is required to do 100 J of work in a time of 2 seconds?

   $P = \frac{W}{t} = \frac{100}{2} =$ **50 W**

   b. How much power is required to do 100 J of work in a time of 4 seconds?

   $P = \frac{W}{t} = \frac{100}{4} =$ **25 W**

   c. How much power is required to do 100 J of work in a time of 0.5 seconds?

   $P = \frac{W}{t} = \frac{100}{.5} =$ **200 W**

5. If you do 100 J of work to lift a bucket of water, how much potential energy do you give the bucket?

   100J !

6. A 1 kg rock is held above the ground and has 250 J of potential energy. It is then dropped.

   a. What is its kinetic energy while it is still being held? **0J** (it's not moving)

   b. What is the total energy of the rock? 0 + 250 = **250 J**

   c. What is its potential energy just as it hits the ground? $PE = mgh = (1)(10)(0) =$ **0J**

   d. What is its kinetic energy just as it hits the ground? PE → KE **250 J**

   e. While it is falling, if it has only 100 J of potential energy at some point, how much kinetic energy does it have?

   KE + PE = 250 → KE + 100 = 250 **KE = 150 J**

   f. How high above the ground is the rock when it has 100 J of PE?

   $PE = mgh$ $100 = (1)(10)h$ **h = 10 m**

   g. How fast is the rock moving when it has 100 J of PE?

   From e, KE = 150 J → $KE = \frac{1}{2}mv^2$ $150 = \frac{1}{2}(1)v^2$ $v^2 = 300$ **v = 17.3 m/s**

   h. While it is falling, if it has only 50 J of kinetic energy at some point, what is its potential energy?

   KE + PE = 250   50 + PE = 250   **PE = 200J**

Energy Review

7. Suppose a car has a kinetic energy of 2000 J.
   a. If it moves with twice the speed, what will be its kinetic energy?

   Since $KE = \frac{1}{2}mv^2 \dots \rightarrow \frac{1}{2}m(2v)^2 = 4(\frac{1}{2}mv^2)$ so 4x the KE so **8000 J**

   b. If it moves with three times the speed, what will be its kinetic energy?

   3x the speed = 9x the KE so **18,000 J**

8. A certain engine can make a car go from 0 to 100 km/h in 10 seconds. All other things being equal, if the engine has twice the power, how many seconds would it take to go from 0 to 100 km/h?

   Since $P = \frac{W}{t}$ 2x the Power = $\frac{1}{2}$ the time (if the same work)

9. A car traveling at 60 km/h skids 20 m when its brakes are locked. How far will it skid if it is traveling at 120 km/h?

   2x the speed = 4x the KE so need 4x the work to stop it
   so 4x the distance so **80 m**

10. A hammer falls off a roof and hits the ground with 75 J of kinetic energy. If it fell from a roof twice as high, how much kinetic energy would it have when it hit the ground?

   2x the height means 2x the PE so **150 J**

11. Does a car use more gas when the air conditioner is on? How about the headlights or radio?

   Yes! Yes & Yes! All the energy in the car comes from the chemical potential of the gas!

12. A car has 2500 J of kinetic energy and it skids to a stop, losing all its kinetic energy. Where did this energy go?

   Thermal Energy! (And a little sound energy)

13. Peter, Paul and Mary are lifting weights. Peter lifts 135 kg 0.8 m in 1 second. Paul lifts 150 kg 1.3 m in 1.4 seconds. Mary lifts 124 kg 0.9 m in 1.3 seconds. Since the work turns into PE…
   a. Who does the most work?

   Peter: mgh = $(135)(10)(.8)$ = 1080 J

   Paul: mgh = $(150)(10)(1.3)$ = 1950 J

   Mary: mgh = $(124)(10)(.9)$ = 1116 J

   b. Who is most powerful?

   Peter: $P = \frac{W}{t} = \frac{1080}{1}$, $P = 1080$ W

   Paul: $P = \frac{W}{t} = \frac{1950}{1.4}$, $P = 1393$ W

   Mary: $P = \frac{W}{t} = \frac{1116}{1.3}$ = 858 W

Energy Review

14. A 25 g bullet with a horizontal velocity of 500 m/s, comes to a stop 12 cm within a solid wall.

$m = 25$ gram $= 0.025$ kg
$v_i = 500$ m/s
$v_f = 0$ m/s
$d = 12$ cm $= .12$ m

a. What is the initial KE of the bullet?

$KE = \frac{1}{2}mv^2 = \frac{1}{2}(.025)(500)^2 = 3125\ J$

b. What is the final KE of the bullet?

$KE = \frac{1}{2}mv^2 = \frac{1}{2}(.025)(0)^2 = 0\ J$

c. What was the average force stopping the bullet?

So the bullet "lost" 3125 J of KE so that is the work needed to stop it

$W = Fd$
$-3125 = F(.12)$
$F = -26{,}042\ N$

15. An apple falls 3.5 m from the branch of a tree to the ground below.

$h = 3.5$ m

a. How fast is the apple moving when it hits the ground? Use conservation of energy.

$\Sigma E_i = \Sigma E_f$
$PE + 0 = 0 + KE$
So $mgh + 0 = 0 + \frac{1}{2}mv^2$
$m(10)(3.5) = \frac{1}{2}mv^2$
$v^2 = 70$
$v = 8.4$ m/s

b. At what point is KE = PE?

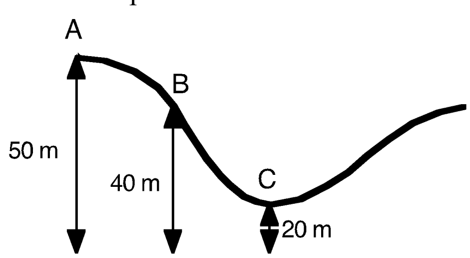
$\frac{1}{2}$ way down

hey! The mass canceled out! :)

c. How fast is the apple moving when it is 1 m off the ground?

$\Sigma E_i = \Sigma E_f$
$PE_i + 0 = PE + KE$
$m(10)(3.5) + 0 = m(10)(1) + \frac{1}{2}mv^2$
$35m = 10m + \frac{1}{2}mv^2$
$v^2 = 50$
$v = 7.07$ m/s

16. A frictionless roller coaster with a mass of 200 kg is at rest at point A. What is speed of the cart at point B and point C?



$\Sigma E_A = \Sigma E_B$
$PE + 0 = PE + KE$
$(200)(10)(50) = (200)(10)(40) + \frac{1}{2}(200)v^2$
$v^2 = 200$
$v = 14.1$ m/s ← @ B

Likewise
$(200)(10)(50) = (200)(10)(20) + \frac{1}{2}(200)v^2$
$v^2 = 600$
$v = 24.5$ m/s ← @ C

17. A force of 200 N is applied to a 50 kg crate to slide it across the floor a distance of 70 m.

a. How much work is required to slide the crate along the floor?

$W = Fd = (200)(70) = 14{,}000\ J$

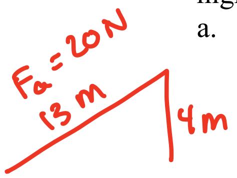
b. How much work would be required to lift the crate to a height of 70 m?

To lift it we give it PE, so

$PE = mgh = (50)(10)(70) = 35{,}000\ J$

Energy Review

18. An applied force of 20 N is required to push a 5 kg object up an incline that is 13 m long and 4 m high.



a. How much work is done by the applied force?

$W = Fd = (20)(13) = \boxed{260\ J}$

b. How much work would be needed to lift the 5kg object straight up to a height of 4 m?

So W → PE = mgh

$= (5)(10)(4) = \boxed{200\ J}$

c. Why does it take more work to use the incline?

Friction on the incline. (If it was frictionless, it would have taken only 200J to lift up the ramp – the same as lifting straight up.)

Answers: 1) 3x 2) same! 3) 100 J 4. a) 50 W b) 25 W c) 200 W
5) 100 J 6. a) 0 J b) 250 J c) 0 J d) 250 J e) 150 J
f) 10 m g) 17.3 m/s h) 200 J 7. a) 8000 J b) 18,000 J 8) 5 s
9) 80 m 10) 150 J 11) Yes, yes, yes 12) brakes are hotter (KE became thermal energy)
13. a) Peter = 1080 J, Paul = 1950 J, Mary = 1116 J b) Peter = 1080 W, Paul = 1393 W, Mary = 858 W
14. a) 3125 J b) 0 J c) 26,000 N HINT: 25 g = 0.025 kg & 12 cm = 0.12 m
15. a) 8.4 m/s b) 1/2 way down c) 7.1 m/s 16) B = 14.1 m/s & C = 24.5 m/s
17. a) 14,000 J b) 35,000 J HINT: how much force does it take to lift up?
18. a) 260 J b) 200 J c) because there is (probably) friction on the incline