Calculating Energy

Solve the following problems and show your work!

$$KE = \frac{\text{mass} \times \text{velocity}^2}{2} \quad \text{GPE} = \text{WEIGHT (N)} \times \text{HEIGHT (m)} \quad ME = \text{PE} + \text{KE}$$

1. A car has a mass of 2,000 kg and is traveling at 28 meters per second North. What is the car's kinetic energy (KE)?

$$KE = \frac{2000 \text{ kg} \times 28^2}{2} = 784,000 \text{ J}$$

2. When a golf ball is hit, it travels at 41 m/s. The mass of the golf ball is 0.045 kg. What is the kinetic energy of the golf ball?

$$KE = \frac{0.045 \text{ kg} \times 41^2}{2} = 37.8 \text{ J}$$

3. **MATH REVIEW!** The newly developed F-22 Raptor Jet Fighter is approximately 100,000 kg and can travel up to 600 meters per second. If the Kinetic Energy is 18,000,000,000 what is the KE in scientific notation?

$$18,000,000,000 = 1.8 \times 10^{10} \text{ Joules}$$

4. **MATH REVIEW!** If the jet fighter in #3 has a GPE = 9,000,000,000, what is the GPE in scientific notation?

$$9,000,000,000 = 9.0 \times 10^9 \text{ Joules}$$

5. A bullet from a sniper's gun travels at 200 m/s and has a mass of 0.02 kg. What is the bullet's kinetic energy?

$$KE = \frac{m \text{V}^2}{2} = \frac{0.02 \text{ kg} \times 200^2}{2} = 400 \text{ J}$$

6. If the bullet in #5 travels 2 meters above the ground, what would the potential energy of the bullet be? (Weight = mass x 9.8 m/s/s)

$$\text{GPE} = m \times g \times h = 0.02 \text{ kg} \times 9.8 \times 2 = 0.392 \text{ J}$$

7. Former San Francisco 49ers Quarterback Joe Montana throws a football at a speed of 35 meters per second. If the football is 0.4 kg, what would the kinetic energy of Joe Montana's pass be?

$$\frac{mv^2}{2} = 0.4 \times 35^2 = 245 \text{ J}$$

8. What is the potential energy of a squirrel standing on the ground?

$$0 \text{ J}$$
9. Give the units for each (shorthand notation):
   a. Mass: \[ \text{kg} \]  
   b. Velocity: \[ \text{m/s} \]  
   c. Energy (PE, KE, ME): \[ \text{J} \]  
   d. Weight: \[ \text{N} \]  

10. Qu decides to go sky-diving for his 18th birthday. At 13,000 meters, what is Qu’s potential energy right before he jumps if he weighs 50 N?

   \[
   \text{PE} = 50 \text{N} \times 13,000 \text{ m} \\
   = 650,000 \text{ J}
   \]

11. The diagram below represents a ski jumper. Use it to answer the following questions:
   
   a. What is the mechanical energy of the ski jumper at each point?
      A: \[ 50,000 \text{ J} \]  
      B: \[ 50,000 \text{ J} \]  
      C: \[ 50,000 \text{ J} \]  
      D: \[ 50,000 \text{ J} \]  
      E: \[ 50,000 \text{ J} \]  
   
   b. What can you say about mechanical energy based on your answers above?

12. Based on your answers to #11, answer the following: If an object moves and total mechanical energy is conserved, then ____________.
   
   a. The amount of kinetic energy remains the same throughout its motion
   b. The amount of potential energy remains the same throughout its motion
   c. The sum of kinetic and potential energy remains the same throughout its motion

13. A toy car moves along with 4 joules of kinetic energy. If its speed is doubled, then its new kinetic energy will be ____________.
   a. Doubled  
   b. Quadrupled  
   c. the same

14. Ray’s paper plane is soaring through the air, possessing 8 Joules of potential energy. If its speed is doubled and its height is doubled, then the new potential energy will be ____________.
   a. Doubled  
   b. Quadrupled  
   c. the same

15. Shown to the right is the motion of a pendulum. Determine the missing components assuming total mechanical energy is conserved:
   a. When the pendulum is in position “2”, what is the KE? \[ 2 \text{ J} \]  
   b. At position “3”, the pendulum is at its lowest point. What is the:
      \[
      \begin{align*}
      \text{PE} &= 0 \text{ J} \\
      \text{KE} &= 7 \text{ J}
      \end{align*}
      \]
   c. At position “4”, the pendulum has 3J of kinetic energy. What is the PE? \[ 4 \text{ J} \]  

   \[ \text{ME} = 7 \text{ J} \] everywhere
Energy Scenarios!

Directions for each scenario:
1. CIRCLE where there is maximum potential energy and no kinetic energy.
2. DRAW A SQUARE where the subject has kinetic energy.

1. Bow and Arrow

Does the arrow at “2” have potential energy? Yes - still above ground!

2. Swing

Does the girl at “B” have gravitational potential energy? Technically yes (she’s still above ground)

3. Slingshot

Does the rock at “2” have both PE and KE? Yes

4. Rollercoaster

Which letter represents the part of the rollercoaster that has BOTH PE and KE? B or D

ENERGY REVIEW

Nuclear Chemical Radiant Heat Electrical Kinetic Sound Potential

5. Give an energy transformation for a rollercoaster cart in #4 above:
   Gravitational potential energy is converted to kinetic energy, which is converted to thermal energy and sound.

6. When cooking a slice of bread in a toaster, electrical energy from the outlet is converted to heat energy in the coils, which transfers to the bread. The coils also light up, which means that radiant energy is transferred as well. The bread turns brown, which means that chemical energy is cooking the bread. When the toaster is done, the bread pops up, which is an example of kinetic energy and because you can hear it pop, sound energy.