

## Kinetic, potential and mechanical energy worksheet

1. A car travels at a speed of 60.0 km/h and has a mass of 1 005 kg. What is its kinetic energy?

$$\frac{60 \text{ km}}{\text{hr}} \times \frac{1 \text{ hr}}{3600 \text{ s}} \times \frac{1000 \text{ m}}{1 \text{ km}} = 16.67 \text{ m/s}$$

$$KE = \frac{1}{2}(1005)(16.667 \text{ m/s})^2 = 139583 \text{ J}$$

$$\boxed{1.40 \times 10^5 \text{ J}}$$

2. A quarterback throws a football weighing 205 g at a speed of 10.0 km/h at a height of 20.0 m. What is the football's mechanical energy?

$$ME = KE + PE$$

$$KE = \frac{1}{2}(0.205) \left( \frac{10.0 \text{ km}}{\text{hr}} \times \frac{1000 \text{ m}}{1 \text{ km}} \times \frac{1 \text{ hr}}{3600 \text{ s}} \right)^2 = 0.79 \text{ J}$$

$$PE = (0.205)(9.8)(20) = 40.2 \text{ J}$$

$$\boxed{ME = 41.0 \text{ J}}$$

3. A truck weighing 12 000 kg has 91 000 J of kinetic energy. What speed is it travelling at?

$$v = \sqrt{\frac{2E_k}{m}} = \sqrt{\frac{2(91,000)}{12,000}} = 3.9 \text{ m/s}$$

4. A van travels at a speed of 40.0 km/h with a kinetic energy of 7 600 J. What is the van's mass?

$$\frac{40 \text{ km}}{\text{hr}} \times \frac{1 \text{ hr}}{3600 \text{ s}} \times \frac{1000 \text{ m}}{1 \text{ km}} = 11.11 \text{ m/s}$$

$$m = \frac{2E_k}{v^2} = \frac{2(7600)}{(11.11)^2} = 120 \text{ kg}$$

5. A hammer weighing 200.0 g is raised 3.0 m above the ground. What is its potential energy?

$$E_g = (0.2000)(9.8)(3) = 5.9 \text{ J}$$

6. A four cylinder Toyota can reach a maximum of 150.0 km/h while a six cylinder Toyota can reach a maximum of 180 km/h. If they both weigh 1 500 kg, what is the maximum kinetic energy each car can have?

Toyota  
4-cyl

$$\frac{150 \text{ km}}{\text{hr}} \times \frac{1 \text{ hr}}{3600 \text{ s}} \times \frac{1000 \text{ m}}{1 \text{ km}} = 41.67 \text{ m/s}$$

$$KE = \frac{1}{2}(1500)(41.67)^2 = 1,300,000 \text{ J}$$

6-cyl

$$\frac{180 \text{ km}}{\text{hr}} \times \frac{1 \text{ hr}}{3600 \text{ s}} \times \frac{1000 \text{ m}}{1 \text{ km}} = 50 \text{ m/s}$$

$$KE = \frac{1}{2}(1500)(50)^2 = 1,900,000 \text{ J}$$

7. A ball is raised 5.0 m off the ground and weighs 750 g. What is its potential energy?

$$E_g = (0.75)(9.8)(5) = 37 \text{ J}$$

8. An electric toy car weighs 150.0 g and travels at 0.50 km/h. What is its kinetic energy?

$$\frac{0.50 \frac{\text{km}}{\text{hr}} \left| \frac{1000 \text{ m}}{1 \text{ km}} \right| \frac{1 \text{ hr}}{3600 \text{ s}}}{1 \text{ hr}} = 0.138 \text{ m/s}$$

$$KE = \frac{1}{2}(0.15)(0.138)^2 = 0.0014 \text{ J}$$

9. A javelin is raised 10.0 m off the ground and has a potential energy of 501 J. What is the mass of the javelin?

$$m = \frac{E_g}{gh} = \frac{501}{(10)(9.8)} = 5.11 \text{ kg}$$

10. Which will cause more damage, a truck weighing 700 kg travelling at a speed of 60 km/h or a truck weighing 300 kg travelling at a speed of 100 km/h?

Big:  $\frac{60 \text{ km}}{\text{hr}} \left| \frac{1000 \text{ m}}{1 \text{ km}} \right| \frac{1 \text{ hr}}{3600 \text{ s}} = 16.67 \text{ m/s}$   $KE = \frac{1}{2}(700)(16.67)^2 = 10,000 \text{ J}$

Small:  $\frac{100 \text{ km}}{\text{hr}} \left| \frac{1000 \text{ m}}{1 \text{ km}} \right| \frac{1 \text{ hr}}{3600 \text{ s}} = 27.78 \text{ m/s}$   $KE = \frac{1}{2}(300)(27.78)^2 = 100,000 \text{ J}$   
(with sig figs — SAME!)

11. A car has a speed of 90 km/h and a mass of 7 000 kg. What is its kinetic energy?

$$\frac{90 \text{ km}}{\text{hr}} \left| \frac{1000 \text{ m}}{1 \text{ km}} \right| \frac{1 \text{ hr}}{3600 \text{ s}} = 25 \text{ m/s}$$

$$\frac{1}{2}(7000)(25)^2 = 2,000,000 \text{ J}$$

12. A shot-put is raised 4.00 m off the ground and has a potential energy of 7 050 J. What is the mass of the shot-put?

$$m = \frac{E_g}{gh} = \frac{7050}{(4)(9.8)} = 1.80 \times 10^2 \text{ kg}$$

13. A truck weighing 17 000 kg has 9 100 J of kinetic energy. What is the speed it is travelling at?

$$v = \sqrt{\frac{2KE}{m}} = \sqrt{\frac{2(9100)}{17000}} = 1.0 \text{ m/s}$$

14. A bow and arrow weighing 3.00 kg is raised 9.00 m. What is its potential energy?

$$E_g = (3)(9.8)(9) = 264.6 \text{ J} = 265 \text{ J}$$

15. A van travels at a speed of 70 km/h with a kinetic energy of 9 600 J. What is the van's mass?

$$\frac{70 \text{ km}}{\text{hr}} \left| \frac{1000 \text{ m}}{1 \text{ km}} \right| \frac{1 \text{ hr}}{3600 \text{ s}} = 19.44 \text{ m/s}$$

$$m = \frac{2KE}{v^2} = 50 \text{ kg}$$

16. A rock weighs 4 kg and has a potential energy of 120 J. What height is it found at?

$$h = \frac{E_p}{mg} = \frac{120}{(4)(9.8)} = 3.0 \text{ m}$$

17. A crane carries a metal tube weighing 95 kg 9.0 m above ground at a speed of 2.0 km/h. What is metal tube's mechanical energy?

$$\frac{2.0 \text{ km/hr}}{1 \text{ hr}} \cdot \frac{1000 \text{ m}}{1 \text{ km}} \cdot \frac{1}{3600 \text{ s}} = 5.56 \text{ m/s}$$

$$KE = \frac{1}{2}(95)(5.56)^2 = 1466$$

$$E_g = (95)(9.8)(9) = 7938$$

$$ME = 9400 \text{ J}$$

18. A rock weighs 9.0 kg and has a potential energy of 1200 J. What height is it found at?

$$h = \frac{E_p}{mg} = \frac{1200}{(9)(9.8)} = 14 \text{ m}$$

19. Tiger Woods is very upset about all his personal problems and he decides to go golfing to release his pent up anger. He hits a golf ball weighing 400.0 g at a speed of 4.0 km/h and reaches a height of 30.0 m. What is the ball's mechanical energy?

$$\frac{4.0 \text{ km/hr}}{1 \text{ hr}} \cdot \frac{1000 \text{ m}}{1 \text{ km}} \cdot \frac{1}{3600 \text{ s}} = 1.11 \text{ m/s}$$

$$E_k = \frac{1}{2}(0.400)(1.11)^2 = 0.247 \text{ J}$$

$$E_g = (0.4)(30)(9.8) = 117.6 \text{ J}$$

$$ME = 120 \text{ J}$$

20. Which has more potential energy?

a- A hammer weighing 700.0 g raised to 3.0 m.

b- A rock weighing 1800 g raised to 2.0 m.

c- A nail weighing 0.05 kg raised to 5.0 m

**Sample kinetic energy questions**

1. A marble weighing 4.0 kg, travels at a speed of 7.0 km/h. What is its kinetic energy?

$$\frac{1}{2}(4)\left(\frac{7\text{ km}}{1\text{ hr}} \cdot \frac{1\text{ hr}}{3600\text{ s}} \cdot \frac{1000\text{ m}}{1\text{ km}}\right)^2 = 7.56\text{ J}$$

7.6 J

2. What is the mass of a truck if its kinetic energy is 5500 J and travels at a speed of 65 km/h.

$$m = \frac{2KE}{v^2} = \frac{11000}{\left(\frac{65\text{ km}}{1\text{ hr}} \cdot \frac{1\text{ hr}}{3600\text{ s}} \cdot \frac{1000\text{ m}}{1\text{ km}}\right)^2} = 34\text{ kg}$$

3. A car having 75 000 J of kinetic energy and a mass of 330 kg, travels at what speed?

$$v = \sqrt{\frac{2KE}{m}} = \sqrt{\frac{150,000}{330}} = 21\text{ m/s}$$

**Example potential energy questions**

1. A bar weighing 550 g is raised 3.0 m off the ground. What is its potential energy?

16,000 J

2. What is the mass of a girl if she was raised 2.00 m off the ground and has a potential energy of 555 J?

$$m = \frac{E_g}{gh} = \frac{555}{(9.8)(2)} = 28.3\text{ kg}$$

3. A rock weighs 700 g and has a potential energy of 1 500 J. What height is it found at?

$$h = \frac{E_g}{gm} = \frac{1500}{(0.7)(9.8)} = 220\text{ m}$$

**Example mechanical energy questions**

1. A car weighing 5 500 kg, travels at a speed of 55 km/h up a 15 m hill. What is its mechanical energy?

$$KE = \frac{1}{2}(5500)\left(\frac{55\text{ km}}{1\text{ hr}} \cdot \frac{1\text{ hr}}{3600\text{ s}} \cdot \frac{1000\text{ m}}{1\text{ km}}\right)^2 = 641878.85$$

$$PE = (5500)(9.8)(15) = 808500$$

$$ME = 1450378 = 1500000$$