Energy Equation Questions for GCSE Physics

1. A rock with a mass of 5 kg is lifted to a height of 10 meters. Calculate the gravitational potential energy gained by the rock. (Take g = 9.8 m/s^2)

$\Delta E_p = mg\Delta h$

$= 5 \times 9.8 \times 10$

$=$ **490J**

2. A car with a mass of 1,000 kg is traveling at 20 m/s. Calculate the car's kinetic energy.

$E_k = \frac{1}{2} mv^2$

$= \frac{1}{2} \times 1000 \times 20^2$

$=$ **200,000J**

3. A spring has a spring constant of 200 N/m and is stretched by 0.5 meters. Calculate the elastic potential energy stored in the spring.

$E_e = \frac{1}{2} ke^2$

$= \frac{1}{2} \times 200 \times (0.5)^2$

$=$ **25J**

4. A 2 kg ball is held 4 meters above the ground. What is the potential energy stored in the ball?

$\Delta E_p = mg\Delta h$

$= 2 \times 9.8 \times 4$

$=$ **78.4J**

5. A 0.2 kg ball is thrown at a speed of 15 m/s. Determine the kinetic energy of the ball.

$E_k = \frac{1}{2} mv^2$

$= \frac{1}{2} \times 0.2 \times 15^2$

$=$ **22.5J**

6. A rubber band is stretched by 0.1 meters and has a spring constant of 50 N/m. What is the elastic potential energy stored in the rubber band?

$E_e = ½ ke^2$

$= ½ \times 50 \times 0.1^2$

$=$ **0.25J**

7. A cliff diver has 2,940 J of potential energy before jumping off a cliff. If their mass is 75 kg, how high is the cliff?

$\Delta E_p = mg\Delta h$

$2940 = 75 \times 9.8 \times h$

$2940 = 735 \times h$ $2940/735 = h$ $=$ **4m**

8. A car has a kinetic energy of 50,000 J and is moving at 25 m/s. What is the mass of the car?

$E_k = ½ mv^2$

$50{,}000 = ½ \times m \times 25^2$

$50{,}000 = 312.5 \times m$ $50{,}000/312.5 = m$ $=$ **160kg**

9. A spring is stretched by 0.25 meters and stores 8 J of energy. What is the spring constant?

$E_e = ½ ke^2$

$8 = 0.5 \times k \times 0.25^2$

$8 = 0.03125 \times k$ $8/0.03125 = k$ $=$ **256N/m**

10. A book on a shelf has 147 J of gravitational potential energy. If the shelf is 3 meters high, what is the mass of the book?

$\Delta E_p = mg\Delta h$

$147 = m \times 9.8 \times 3$

$147 = 29.4\ m$

$147/29.4 = m$ $=$ **5kg**

11. A motorcycle with a mass of 200 kg has a kinetic energy of 18,000 J. How fast is it moving?

$E_k = ½ mv^2$

$18{,}000 = ½ \times 200 \times v^2$

$18{,}000 = 100\ v^2$ $18{,}000 / 100 = v^2$ $180 = v^2$ $\sqrt{180} = v$ = **13.4 m/s**

12. An elastic cord with a spring constant of 80 N/m stores 32 J of elastic potential energy. Determine the extension of the cord.

$E_e = ½ ke^2$

$32 = ½ \times 80 \times e^2$

$32 = 40 \times e^2$ $32/40 = e^2$ $0.8 = e^2$ $\sqrt{0.8} = e$ = **0.89 m**

The following questions require you to use more than one equation.

13. A 60kg diver jumps from a platform that is 8m above the surface of the water. What speed will they be doing as they hit the water?

Gravitational potential energy on the platform = kinetic energy at the water

$\cancel{m}\ g\ \Delta h = ½\ \cancel{m}\ v^2$

$9.8 \times 8 = ½ \times v^2$

$78.4 = ½ \times v^2$

$78.4 / ½ = v^2$ $156.8 = v^2$

$\sqrt{156.8} = v$ = **12.5 m/s**

14. A bow is drawn to fire an arrow that has a mass of 120g. The spring constant is 80N/m and the bow is stretched by 0.15m. What is the speed of the arrow as it is fired?

Elastic potential energy in the bow before = kinetic energy of the arrow after

$\cancel{½}\ k\ e^2 = \cancel{½}\ m\ v^2$

$80 \times 0.15^2 = 0.120 \times v^2$

$1.8 = 0.120 \times v^2$

$1.8 / 0.120 = v^2$ $15 = v^2$

$\sqrt{15} = v$ = **3.9 m/s**

15. A 70 kg skier starts from rest at the top of a hill that is 20 meters high. Assuming no friction, what is the skier's speed at the bottom of the hill?

Gravitational potential energy at the top = kinetic energy at the bottom

$\cancel{m}\ g\ \Delta h = \frac{1}{2}\ \cancel{m}\ v^2$

$9.8 \times 20 = \frac{1}{2} \times v^2$

$196 = \frac{1}{2} \times v^2$

$2 \times 196 = v^2$

$392 = v^2$

$\sqrt{392} = v$ = **19.8 m/s**

16. A slingshot has a spring constant of 100 N/m and is stretched by 0.2 meters. If the mass of the projectile is 0.3 kg, what is the speed of the projectile when fired?

Energy stored in the slingshot before = kinetic energy of projectile when fired

$\cancel{\frac{1}{2}}\ k\ e^2 = \cancel{\frac{1}{2}}\ m\ v^2$

$200 \times 0.2^2 = 0.3 \times v^2$

$4 = 0.3 \times v^2$

$4/0.3 = v^2$

$13.33 = v^2$ $\sqrt{13.33} = v$ = **3.7 m/s**

17. A diver with a mass of 65 kg jumps off a diving board that is 10 meters high. What will the diver's speed be just before hitting the water?

Gravitational potential energy at the top = kinetic energy at the bottom

$\cancel{m}\ g\ \Delta h = \frac{1}{2}\ \cancel{m}\ v^2$

$9.8 \times 10 = \frac{1}{2} \times v^2$

$9.8 = \frac{1}{2} \times v^2$

$2 \times 9.8 = v^2$

$196 = v^2$

$\sqrt{196} = v$ = **14m/s**

18. A mass of 0.4 kg is attached to a spring with a spring constant of 40 N/m. The spring is compressed by 0.1 meters. What is the velocity of the mass when the spring returns to its equilibrium position?

$\frac{1}{2}$ k e^2 = $\frac{1}{2}$ m v^2

40 x 0.1^2 = 0.4 x v^2

0.4 = 0.4 x v^2

1 = v^2

$\sqrt{1}$ = v = **1 m/s**

19. A spring with a constant of 200 N/m is stretched by 0.3 meters and is used to launch a 0.4 kg ball. What is the speed of the ball when the spring returns to its natural length?

$\frac{1}{2}$ k e^2 = $\frac{1}{2}$ m v^2

200 x 0.3^2 = 0.4 x v^2

18 = 0.4 x v^2

18/0.4 = v^2

45 = v^2 $\sqrt{45}$ = v = **6.7 m/s**

20. A 0.2 kg ball is dropped from a height of 5 meters. Ignoring air resistance, what is its speed when it has fallen halfway (2.5 meters)?

m g Δh = ½ m v^2

9.8 x 2.5 = ½ x v^2

24.5 = ½ x v^2

2 x 24.5 = v^2

49 = v^2

$\sqrt{49}$ = v = **7 m/s**