GCSE Physics: Energy Calculations

Priority Learning

Worksheet

Name: _____ **Date**: _____

Question:	1	2	3	4	5	Total
Marks:	9	8	7	2	11	37
Score:						

Aims of this worksheet:

- Practicing energy calculations.
- Practicing rearranging formulae.

1. (a) State the kinetic energy equation and state what each term means. (2 marks)

Solution: $KE = \frac{1}{2}mv^2$

(b) State the gravitational potential energy equation and state what each term means. (1 mark)

Solution: $GPE = mg\Delta h$

(c) State the elastic potential energy equation and state what each term means. (1 mark)

Solution: $EPE = \frac{1}{2}kx^2$

(a) A car of mass 900kg travels at 22ms^{-1}. Calculate the kinetic energy of the car. (2 marks)

Solution:

$$\begin{aligned} KE &= \frac{1}{2}mv^2 \\ &= \frac{1}{2} \times 900 \times 22^2 \\ &= 217800J \end{aligned}$$

(b) A ball of mass 650g travels at 2ms^{-1}. Calculate the kinetic energy of the ball. (2 marks)

Solution:

$$\begin{aligned} KE &= \frac{1}{2}mv^2 \\ &= \frac{1}{2} \times 0.65 \times 2^2 \\ &= 1.3J \end{aligned}$$

(c) Suppose an object of mass 20kg has 3610J of kinetic energy, what is its velocity? (3 marks)

Solution:

$$\begin{aligned} KE &= \frac{1}{2}mv^2 \\ 3610 &= \frac{1}{2} \times 20v^2 \\ 3610 &= 10v^2 \\ 361 &= v^2 \\ v &= 19\text{ms}^{-1} \end{aligned}$$

2. (a) A bird has mass 3kg flies to the top of a tree 15m tall. How much gravitational potential energy does the bird have at the top of the tree? (2 marks)

Solution:

$$\begin{aligned} GPE &= mg\Delta h \\ &= 3 \times 9.8 \times 15 \\ &= 441J \end{aligned}$$

(b) A person of mass 80kg gets into a lift of mass 1200kg. Each floor in this building is 5m above the previous floor, if the person in the lift goes from the third floor to the ninth floor how much gravitational potential energy will be gained by the person and lift combined? (3 marks)

Solution: Total mass = 1280kg. 6 floors = 6x5 = 30m so $\Delta h = 30$

$$\begin{aligned} GPE &= mg\Delta h \\ &= 1280 \times 9.8 \times 30 \\ &= 376320J \end{aligned}$$

(c) If an object of mass 23g has 4000J of gravitational potential energy, how high above the ground is it? (3 marks)

Solution:

$$\begin{aligned} GPE &= mg\Delta h \\ 4000 &= 0.023 \times 9.8h \\ 4000 &= 0.2254h \\ h &= \frac{4000}{0.2254} \\ h &= 17746.2m = 17.7km \end{aligned}$$

3. (a) A spring with spring constant 40N/m is extended 2m. What is the elastic potential energy stored? (2 marks)

Solution:

$$\begin{aligned} EPE &= \frac{1}{2}kx^2 \\ &= \frac{1}{2} \times 40 \times 2^2 \\ &= 80J \end{aligned}$$

(b) A spring with spring constant 120N/m is extended 35cm. What is the elastic potential energy stored? (2 marks)

Solution:

$$\begin{aligned} EPE &= \frac{1}{2}kx^2 \\ &= \frac{1}{2} \times 120 \times 0.35^2 \\ &= 7.35J \end{aligned}$$

(c) If a spring has elastic potential energy 30J and is extended 50cm, what is the spring constant of the spring? (3 marks)

Solution:

$$\begin{aligned} EPE &= \frac{1}{2}kx^2 \\ 30 &= \frac{1}{2}k \times 0.5^2 \\ 30 &= 0.125k \\ k &= 240\text{N/m} \end{aligned}$$

4. State the law of the total conservation of energy. (2 marks)

Solution: Energy cannot be created or destroyed (**1 mark**), only transferred from one form to another (**1 mark**).

5. (a) A ball is dropped from a height of 15m. Calculate it's velocity as it hits the ground. (3 marks)

Solution:

(b) A mass of 600g is attached to a spring of spring constant 24N/m. How far does it extend? (4 marks)

Solution:

$$GPE = EPE$$
$$mg\Delta h = \frac{1}{2}kx^2$$

Note that the extension here is equal to the change in height.

$$\begin{aligned} mg\Delta h &= \frac{1}{2}k(\Delta h)^2 \\ mg &= \frac{1}{2}k(\Delta h) \\ \frac{2mg}{k} &= \Delta h \\ \Delta h &= \frac{2 \times 9.8 \times 0.6}{24} \\ &= 0.49 \end{aligned}$$

(c) A spring of spring constant k is held vertically with a mass of mass m attached to it, the spring is then released and the trajectory of the mass is directly upwards for a distance of h. Write an equation for the extension of the spring and mass before it was released.

Solution: Let the point of extension be the point of 0 GPE. Then Δh is just h.

$$\begin{aligned} mgh &= \frac{1}{2}kx^2 \\ \frac{2gh}{k} &= x^2 \\ x &= \sqrt{\frac{2gh}{k}} \end{aligned}$$