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Mathematics 9709/42

Paper 4 Mechanics May/June 2023

Question No (1)

1 A particle of mass 1.6 kg is dropped from a height of 9 m above horizontal ground. The speed of the particle at the instant before hitting the ground is 12 m s^{-1} .

Find the work done against air resistance.

Solution:

Given data of particle

$u = 0 \text{ m s}^{-1}$ (due to rest)

$s = 9 \text{ m}$

$v = 12 \text{ m s}^{-1}$

$m = 1.6$

Diagram showing a particle falling from a height of 9 m. The initial velocity $u = 0 \text{ m s}^{-1}$ is shown pointing upwards, and the final velocity $v = 12 \text{ m s}^{-1}$ is shown pointing downwards. The mass $m = 1.6$ is indicated.

using the equation of motion

$$v^2 - u^2 = 2as$$

$$(12)^2 - (0)^2 = 2(a)(9)$$

$$144 = 18a$$

$$a = 8 \text{ m s}^{-2}$$

According to Newton's second law of motion

$$W - R = ma$$

$$1.6g - R = 1.6a$$

$$1.6 \times 10 - R = 1.6(8)$$

$$16 - R = 12.8$$

$\therefore F = ma$

(as the particle moving down $W > R$)

$W = mg$

HERO NOTES

$$R = 16 - 12.8$$

$$R = 3.2$$

work done against air resistance = force \times distance

$$\begin{aligned} \text{W.D.} &= R \times d \\ &= 3.2 \times 9 \end{aligned}$$

$$\boxed{\text{W.D.} = 28.8 \text{ J}}$$