EXERCISE 16

MECHANICS

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1 A pot plant falls off the balcony of an apartment. The balcony is 20 m above the ground and the pot plant has a mass of 2 kg. Ignore air resistance. Determine:

1.1 the pot plant's potential energy before it falls;

$E_P = mgh$

$= (2)(9,8)(20)$

$= 392\ J$

1.2 The pot plant's kinetic energy energy just before it hits the ground;

392 J

1.3 the speed with which the pot plant hits the ground;

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

$$392 = \frac{1}{2}(2)v^2$$

$$v = 19{,}8 \text{ m·s}^{-1}$$

1.4 The mechanical energy of the pot plant just before it falls.

$E_M = E_P + E_K$

$= 392 + 0$

$= 392\ J$

2 Hemali climbs on a stool and lifts her teddy bear (mass 0,4 kg) to a height h above the ground. She then drops her teddy bear from height h. Its speed just before it hits the ground is 4,7 $m \cdot s^{-1}$. Ignore air resistance.

2.1 What type of energy did the teddy bear gain when it was raised to height h?

Gravitational potential energy

2.2 What is the magnitude of the acceleration of the teddy bear the instant it starts to fall?

9,8 $m \cdot s^{-2}$

2.3 Calculate the kinetic energy of the teddy bear just before it hits the ground.

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

$= \frac{1}{2}(0,4)(4,7)^2$

$= 4,42$ J

2.4 Calculate the height from which the bear fell.

$E_P = mgh$

$4{,}42 = (0{,}4)(9{,}8)h$

$4{,}42 = 3{,}92\ h$

$h = 1{,}13\ m$

3 Ashleigh, with a mass of 45 kg, skis from rest down a frictionless slope. She has a potential energy of 84 000 J at the top.

3.1 Calculate the vertical height of the slope.

$E_P = mgh$

$84\,000 = 45 \times 9{,}8 \times h$

$h = 190{,}48\ m$

3.2 Calculate the magnitude of Ashleigh's mechanical energy halfway down the slope.

$E_M = 84\,000\ J$

4 A hailstone has a mass of 8,5 g. At a height of 30 m the velocity of the hailstone is 3,5 $m \cdot s^{-1}$.
Calculate the hailstone's:

4.1 potential energy;

$E_P = mgh$

$E_P = 0{,}0085 \times 9{,}8 \times 30$

$E_P = 2{,}5\ J$

4.2 kinetic energy;

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

$E_K = \frac{1}{2}(0{,}0085)(3{,}5)^2$

$E_K = 0{,}052\ J$

4.3 mechanical energy;

$E_M = E_P + E_K$

$= 2,5 + 0,052$

$= 2,552\ J$

4.4 velocity with which it hits the ground.

$E_M = E_P + E_K$

$2,552 = 0 + E_K$

$E_K = 2,552\ J$

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

$2,552 = \frac{1}{2}(0,0085)v^2$

$v^2 = 600,49$

$v = 24,5\ m \cdot s^{-1}$ downwards