## Work, energy and power 2B

**1** **a** Kinetic energy $= \frac{1}{2}mv^2 = \frac{1}{2} \times 0.3 \times 15^2 = 33.8$ J (3 s.f.)

**b** Kinetic energy $= \frac{1}{2}mv^2 = \frac{1}{2} \times 3 \times 2^2 = 6$ J

**c** Kinetic energy $= \frac{1}{2}mv^2 = \frac{1}{2} \times 0.1 \times 100^2 = 500$ J

**d** Kinetic energy $= \frac{1}{2}mv^2 = \frac{1}{2} \times 25 \times 4^2 = 200$ J

**e** Kinetic energy $= \frac{1}{2}mv^2 = \frac{1}{2} \times 800 \times 20^2 = 160\,000$ J

In order, from the most kinetic energy to the least, will be **e**, **c**, **d**, **a**, **b**

**2** **a** Gain of P.E. $= mgh = 1.5 \times 9.8 \times 3 = 44.1$ J

**b** Gain of P.E. $= mgh = 55 \times 9.8 \times 15 = 8085$ J

**c** Loss of P.E. $= mgh = 75 \times 9.8 \times 30 = 22\,050$ J

**d** Loss of P.E. $= mgh = 580 \times 9.8 \times 6 = 34\,104$ J

**3** Decrease in K.E. $= \frac{1}{2}mu^2 - \frac{1}{2}mv^2$

$$= \frac{1}{2} \times 1.2 \times 12^2 - \frac{1}{2} \times 1.2 \times 4^2$$
$$= 76.8$$

The decrease in the particle's K.E. is 76.8 J

**4** Increase in K.E. $= \frac{1}{2}mv^2 - \frac{1}{2}mu^2$

$$= \frac{1}{2} \times 900 \times 20^2 - \frac{1}{2} \times 900 \times 5^2$$
$$= 168\,750$$

The increase in the van's K.E. is 168 750 J

**5** Increase in K.E. $= \frac{1}{2}mv^2 - \frac{1}{2}mu^2$

$$6 = \frac{1}{2} \times 0.2 \times v^2 - \frac{1}{2} \times 0.2 \times 2^2$$
$$6 = 0.1v^2 - 0.4$$
$$v^2 = \frac{6.4}{0.1} = 64$$
$$v = 8 \quad (v > 0)$$

Speed is positive.

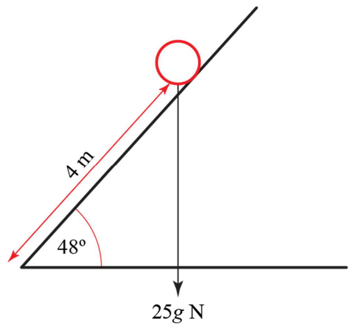
The value of $v$ is 8.

**6** Decrease in K.E. $= \frac{1}{2}mu^2 - \frac{1}{2}mv^2$

$$100 = \frac{1}{2} \times 45 \times 5^2 - \frac{1}{2} \times 45v^2$$
$$100 = 562.5 - 22.5v^2$$
$$v^2 = \frac{462.5}{22.5}$$
$$v = \pm 4.533\ldots$$
$$v = 4.533\ldots \quad (v > 0)$$

The skater's final speed is 4.53 m $s^{-1}$ (3 s.f.)

**7 a**




P.E. lost $= mgh$

$= 25 \times 9.8 \times (4 \sin 48°)$

$= 728.2\ldots$

The P.E. lost by the child is 728 J (3 s.f.)

Vertical distance moved is 4 sin 48°.

**b** You have assumed there to be no air resistance.
This would be valid for low speeds, but not for high speeds.

**8 a** $s = 2$ m, $a = 9.8$ m $s^{-2}$, $u = 0$, $v = ?$

$v^2 = u^2 + 2as$

$v^2 = 0 + 2 \times 9.8 \times 2$

$v^2 = 39.2$

K.E. $= \frac{1}{2}mv^2 = \frac{1}{2} \times 0.6 \times 39.2$

$= 11.76$

The K.E. of the ball as it hits the surface of the water is 11.8 J (3 s.f.)

Use $v^2 = u^2 + 2as$ to find the speed of the ball as it hits the water.

**b** K.E. lost $= \frac{1}{2}mu^2 - \frac{1}{2}mv^2$

$= 11.76 - \frac{1}{2} \times 0.6 \times 4.8^2$

$= 4.848$

The K.E. lost by the ball is 4.85 J (3 s.f.)

**9** $u = 35 \text{ m s}^{-1}$, $a = -1.2 \text{ m s}^{-2}$, $t = 5$ s, $v = ?$

$v = u + at$

$v = 35 - 1.2 \times 5$

$v = 29$

Use $v = u + at$ to find the final speed of the lorry.

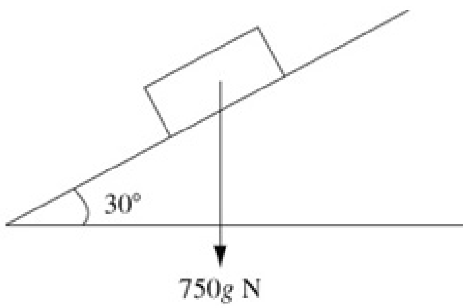
$\text{Loss of K.E.} = \frac{1}{2}mu^2 - \frac{1}{2}mv^2$

$= \frac{1}{2} \times 2000 \times 35^2 - \frac{1}{2} \times 2000 \times 29^2$

$= 384\,000$

The loss of K.E. of the lorry is 384 000 J

**10**




**a** $\text{Loss of K.E.} = \frac{1}{2}mu^2 - \frac{1}{2}mv^2$

$= \frac{1}{2} \times 750 \times 20^2 - \frac{1}{2} \times 750 \times 15^2$

$= 65\,625$

The loss of K.E of the car is 65 625 J

**b** $\text{Gain of P.E.} = mgh$

$= 750 \times 9.8 \times (500 \sin 30°)$

$= 1\,837\,500$

The gain of P.E. of the car is 1 837 500 J

**11** $\text{Increase of P.E.} = mgh$

1 kJ = 1000 J

$15.7 \times 1000 = 80 \times 9.8h$

$h = \frac{15.7 \times 1000}{80 \times 9.8}$

$h = 20.02$

The cliff is 20.0 m high (3 s.f.)

**Challenge**

**a** The ball is dropped from the top of a cliff, and falls freely under gravity.
Use the equation $v = u + at$
Using $u = 0$ and $a = g$, you have $v = gt$

$$\text{K.E.} = \tfrac{1}{2}mv^2 = \tfrac{1}{2} \times 1 \times (gt)^2 = \frac{g^2t^2}{2} = 48.0t^2$$

$s = ut + \frac{1}{2}at^2$. So using $s = h,\ u = 0$ and $a = g$, you have $h = \frac{1}{2}gt^2$

$$\text{P.E.} = -mgh = -1 \times g \times \left(\tfrac{1}{2}gt^2\right) = -\frac{g^2t^2}{2} = -48.0t^2$$

**b** Kinetic energy + potential energy $= \dfrac{g^2t^2}{2} + \left(-\dfrac{g^2t^2}{2}\right) = 0$

So kinetic energy + potential energy is constant.