0 1

A group of friends are doing some archery.

When Brian fully stretches the bow, it stores 10 J of energy.

0 1 . 1

Describe the energy transfer that occurs as Brian stretches the bow.

Chemical potential energy [1] to elastic potential energy [1]

TOP TIP: You could mention kinetic energy here (the kinetic energy in his arms as Brian stretches the bow) but the marks are only given here for chemical and elastic potential energy. Ensure that you always include the *initial* (chemical) and *final* (elastic potential) energy stores in any questions like this.

0 1 . 2

When Brian releases the bow, an arrow of mass 50 g is projected horizontally towards the target.

Show that the arrow leaves the bow at a speed of **20 m/s**.

Elastic potential energy stored in bow = kinetic energy given to arrow [1]
($E_e = E_k$)

$10 = ½ \times 0.05 \times v^2$
$v^2 = 400$
v = **20 m/s**

Don't forget to convert the mass into kilograms here (50 g = 0.05 kg)

0 1 . 3

By using a slow-motion video system, Daniela measures the speed of the arrow as it strikes the target to be approximately **18 m/s**.

Calculate the **decrease** in the **kinetic energy** of the arrow as it travelled between Brian and the target.

Initial $E_k = ½ \times 0.05 \times 20^2 = 10$ J
Final $E_k = ½ \times 0.05 \times 18^2 = 8.1$ J
Decrease = 10 – 8.1 = **1.9 J**

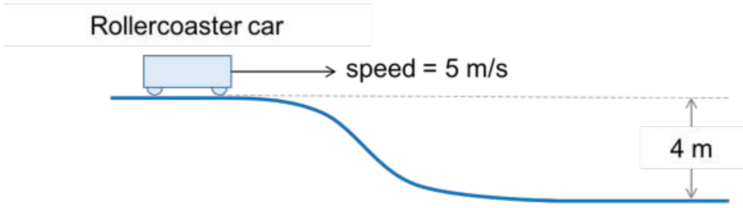
0 1 . 4

Explain why the speed at which the arrow struck the target was lower than the speed at which it left the bow.

Because some of the kinetic energy of the arrow was transferred [1] to the thermal energy store of the surrounding air [1]

0 2

An empty rollercoaster car of mass 200 kg is travelling horizontally at a speed of 5 m/s as it approaches a downwards section in the track, as shown below



0 2 . 1

Calculate the initial kinetic energy of the car.

$E_k = ½\ m\ v^2$
Initial $E_k = ½ \times 200 \times 5^2 =$ **2500 J**

0 2 . 2

Calculate the amount of gravitational potential energy lost by the car as it completes the downwards section of track. Take g = 9.8 N/kg.

$E_p = m\ g\ h$
E_p lost $= 200 \times 9.8 \times 4 =$ **7840 J**

0 2 . 3

Hence, assuming the rollercoaster car to be a closed system, calculate its speed at the bottom of the hill.

Total kinetic energy at bottom of hill = 2500 + 7840 = 10,340 J [1]

$10{,}340 = ½ \times 200 \times v^2$
$v^2 = 103.4$
v = **10.2 m/s**

TOP TIP: Remember here that, because this is a *closed* system, the total amount of energy of the rollercoaster car is constant. The gravitational potential energy which it had at the top of the hill is converted to kinetic energy as it travels down the hill.