1 A skydiver jumps from an aircraft.

(a) The mass of the skydiver is 70 kg.

(i) State the equation linking weight, mass and *g*.

(1)

Weight = mass * g

(ii) Calculate the weight of the skydiver and state the unit.

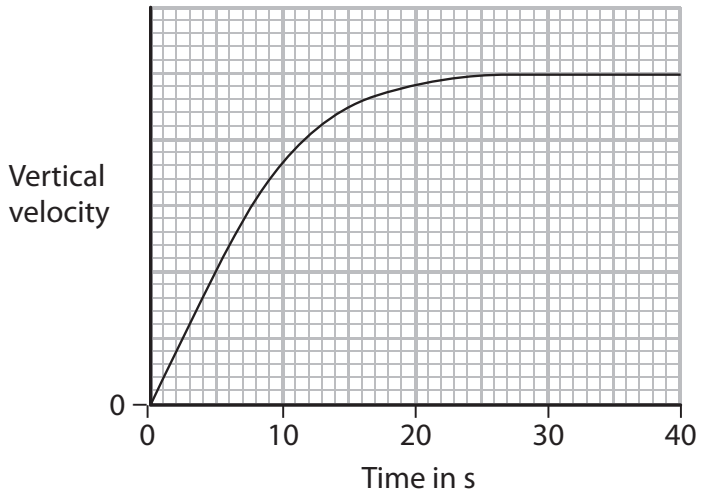
(2)

w = 70 * 10 = 700N

weight = **700** unit **N**

(b) The graph shows the vertical velocity of the skydiver during the first 40 s of the fall.

His parachute is not open during this time.



Explain the shape of the graph.

(4)

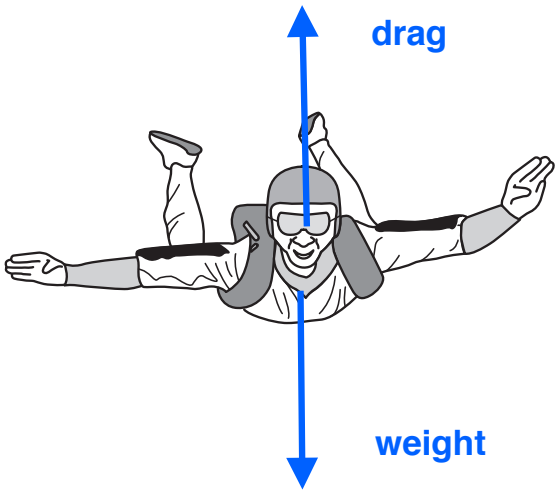
Initially the skydiver accelerates downwards because there is a net force downwards due to their weight. As their speed increases the drag increases so the net downward force decreases and their acceleration decreases causing the graph to flatten. Eventually the forces are balanced and the skydiver falls at terminal velocity.

(c) The diagram shows the skydiver falling at a constant velocity.

Add **two** labelled arrows to the diagram to represent the forces acting on the skydiver.

(3)

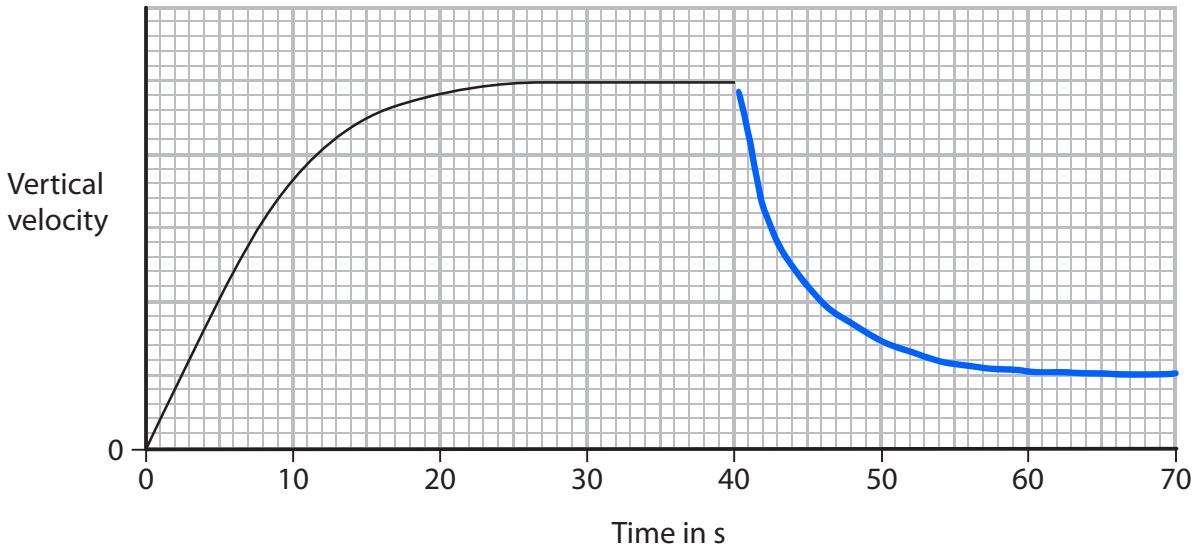
arows should be equal length, judged by eye



(d) The skydiver opens his parachute after 40 s.

Continue the line on the graph to show how the skydiver's vertical velocity changes and reaches terminal velocity.

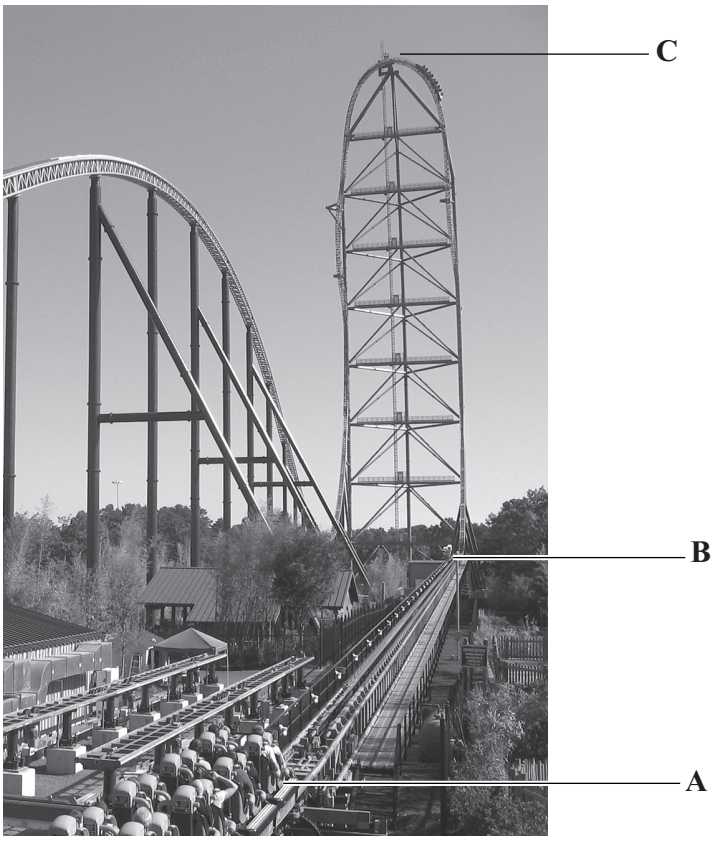
(2)



(Total for Question 1 = 12 marks)

6 The photograph shows a type of rollercoaster.

The car is launched from point **A** in the photograph, accelerates to point **B** and then rises over point **C**.



(a) Each loaded car has a mass of 2000 kg.

C is 128 m above **B**.

(i) State the equation linking gravitational potential energy, mass, height and gravitational field strength.

gpe = mass * gravitational field strength * change in height

don't say 'gravity'

(1)

(ii) Show that the gravitational potential energy gained by the car when it rises from **B** to **C** is about 2.6 MJ.

(2)

gpe = m*g*h = 2000 * 10 * 128 = 2,560,000 J
= 2.6MJ (2 s.f)

(b) The car gains kinetic energy when work is done on it by the launching system between **A** and **B**.

Assume there are no energy losses.

(i) State the minimum kinetic energy that the car must have at **B** for it to reach **C**.

(1)

2.56MJ

(ii) How is the kinetic energy gained related to the work done?

(1)

ke gained = work done

(iii) Write down the equation linking work done, force and distance.

(1)

work = force * distance

(iv) The launching system provides a force of 32 kN.

Calculate the minimum length of track needed between **A** and **B** for the car to reach **C**.

(2)

w = f * d
2,560,000 = 32,000 * d
d = 2560000/32000 = 80m

Length of track = **80m** m

(c) Sometimes the car does not reach **C**, but rolls backwards to the start.

This can happen when it becomes windy or the track becomes wet.

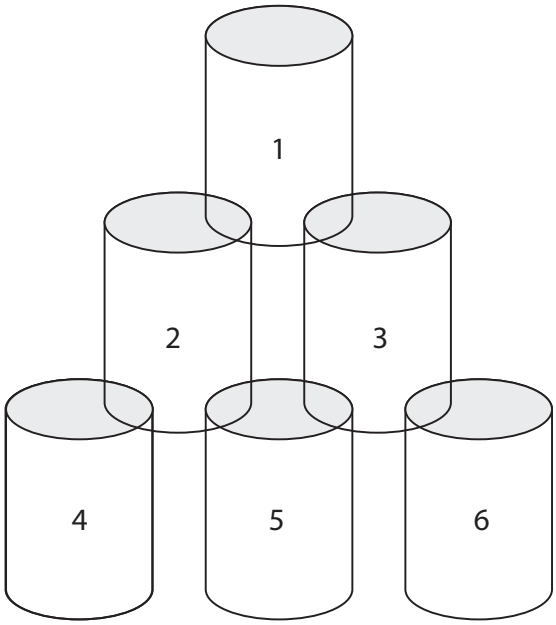
Explain why these conditions could cause the car to stop before it reaches **C**.

(2)

If the wind blows against the car there will be more air resistance. If the track is wet the car has less grip so it gains less kinetic energy.

(Total for Question 6 = 10 marks)

3 A student is playing a game with some empty tins.



(a) He throws a wet cloth of mass 0.15 kg at the tins.

The wet cloth moves at a velocity of 6.0 m/s.

(i) State the equation linking momentum, mass and velocity.

(1)

momentum = mass * velocity

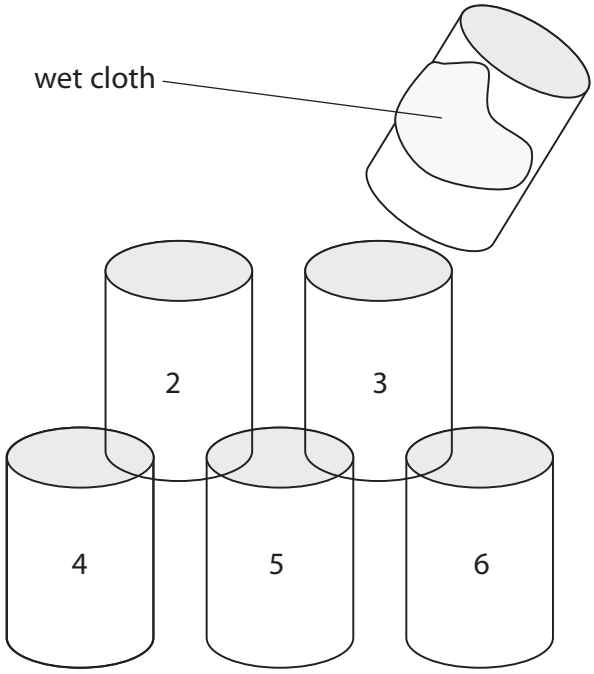
(ii) Calculate the momentum of the wet cloth and give the unit.

(3)

p = mv = 0.15 * 6 = 0.9 kg m/s

Momentum = 0.9 unit kg m/s

(iii)The wet cloth sticks to tin 1.



The mass of tin 1 is 0.050 kg.

The cloth and tin 1 move away together.

Calculate their velocity.

(2)

p=mv = 0.9kh m/s

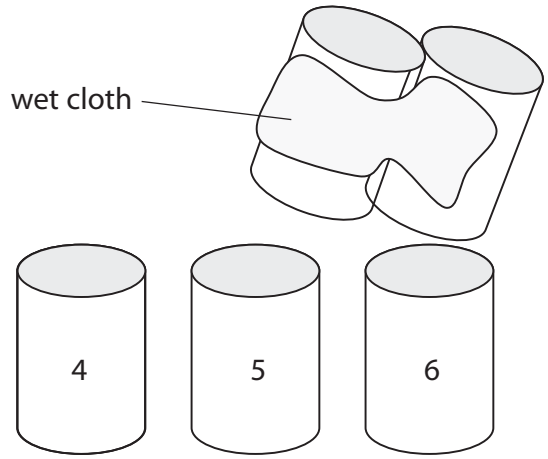
v = p/m = 0.9 / (0.15 + 0.05)

v = 4.5m/s

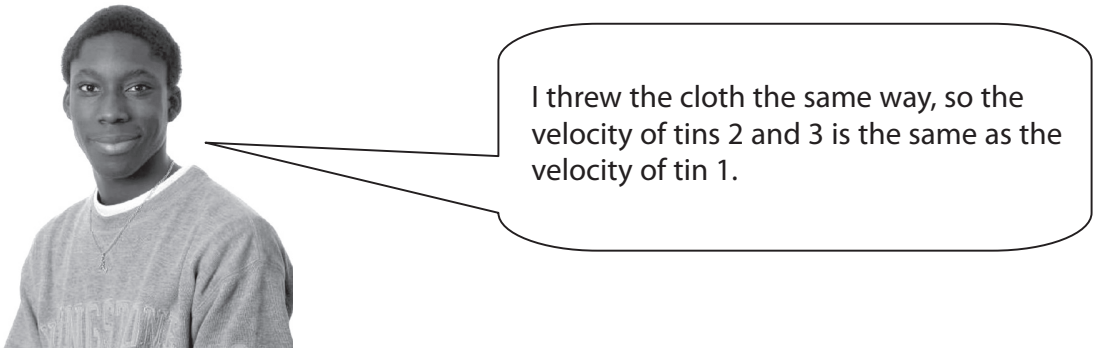
Velocity = **4.5** m/s

(b) The student throws a bigger wet cloth at the remaining tins.

This wet cloth sticks to tins 2 and 3 and they move away together.



The student concludes



Do you agree with this conclusion?

Explain why.

(2)

The student is wrong because we don't know the mass of the new cloth. If it has exactly double the momentum of the first cloth and tins 2 and 3 have masses equal to tin 1 then he would be right.

(Total for Question 3 = 8 marks)