Movement and position

Model Answers 2

Level	IGCSE(9-1)
Subject	Physics
Exam Board	Edexcel IGCSE
Module	Double Award (Paper 1P)
Topic	Forces and motion
Sub-Topic	Movement and position
Booklet	Model Answers 2

Time Allowed: **68 minutes**

Score: **/56**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'75%	70%	60%	55%	50%	<50%

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)**

$Weight = mass \times g$

(ii) Calculate the weight of the skydiver and state the unit. **(2)**

Using the equation from part a, substitute in the values given

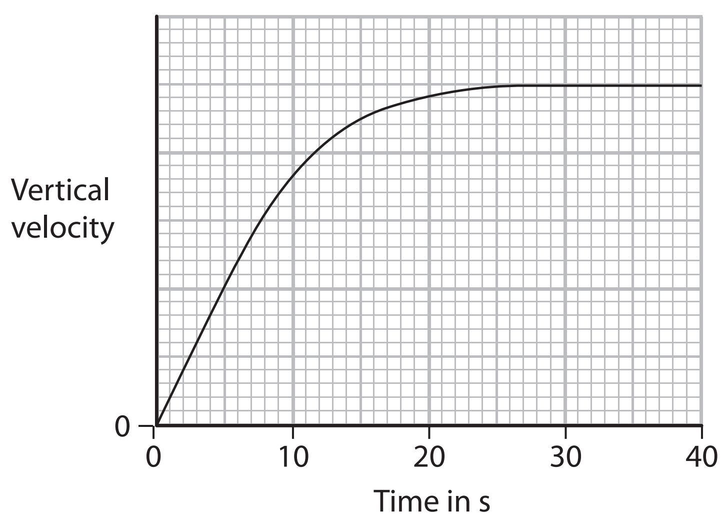
$Weight = 70kg \times 10m/s^2$

$Weight =$ 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, it is only the skydivers **weight** that is acting and so the skydiver will **accelerate** downwards.

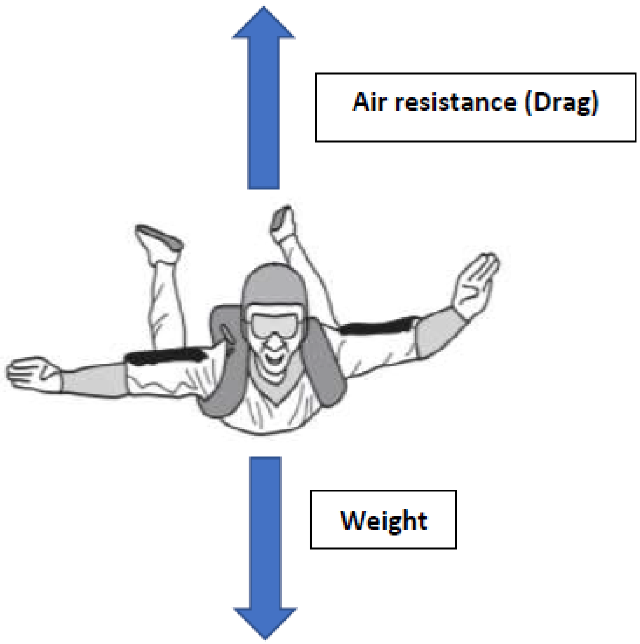
- **Air resistance increases** with velocity and so the **resultant downwards** force will **decrease** as the skydiver accelerates.

- This in turn will **reduce** the downwards **acceleration** until the point where the **forces are equal**. This **terminal velocity** occurs around 28s.

(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.

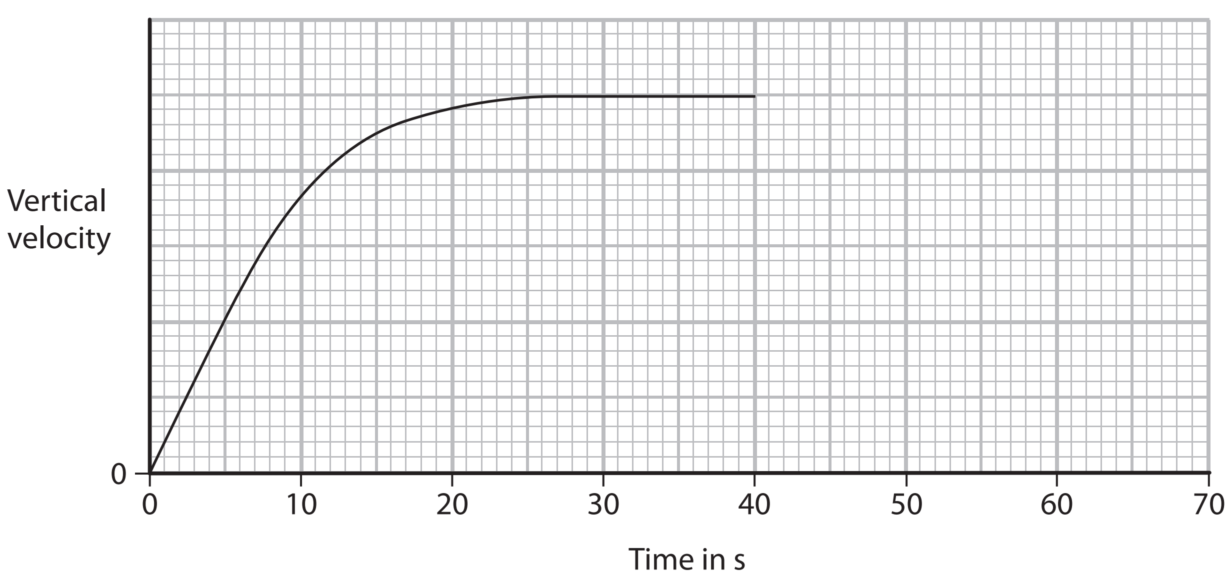
(3)

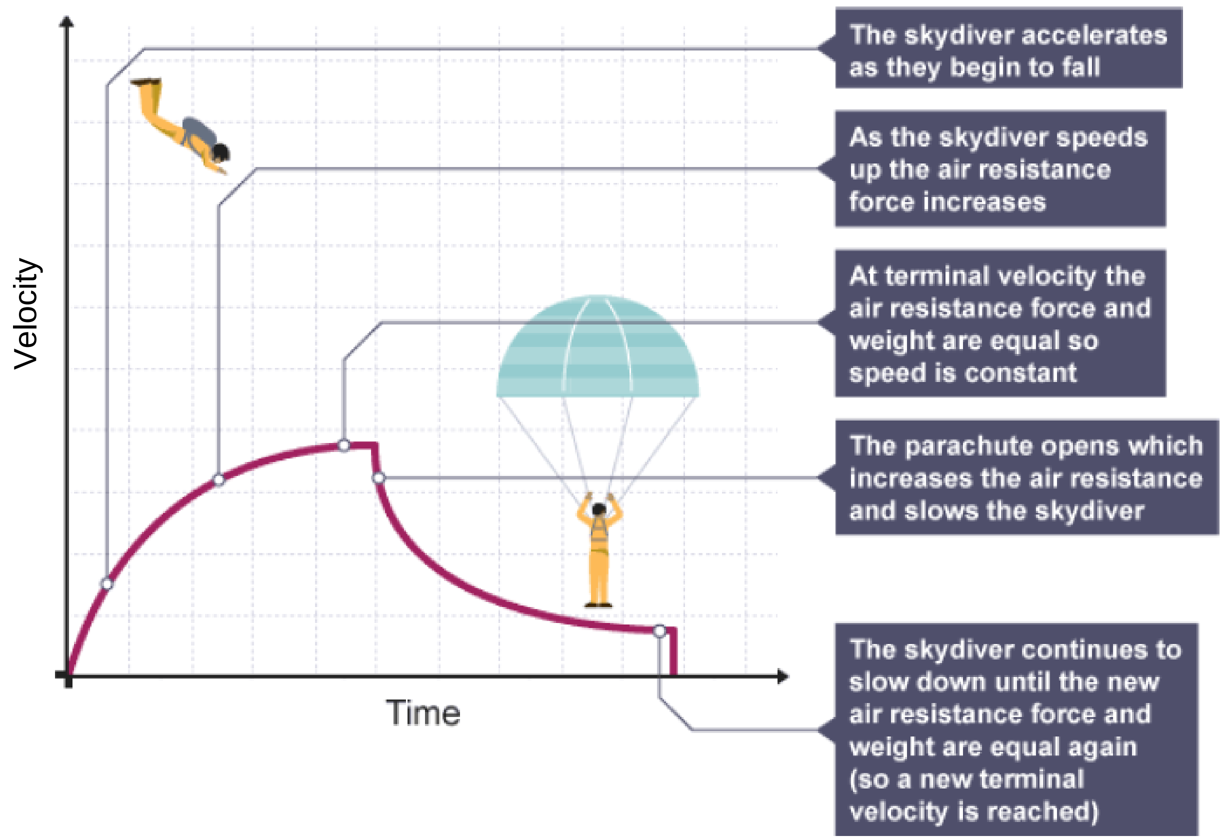


(d) The skydiver opens his parachute after 40 s.

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

(2)





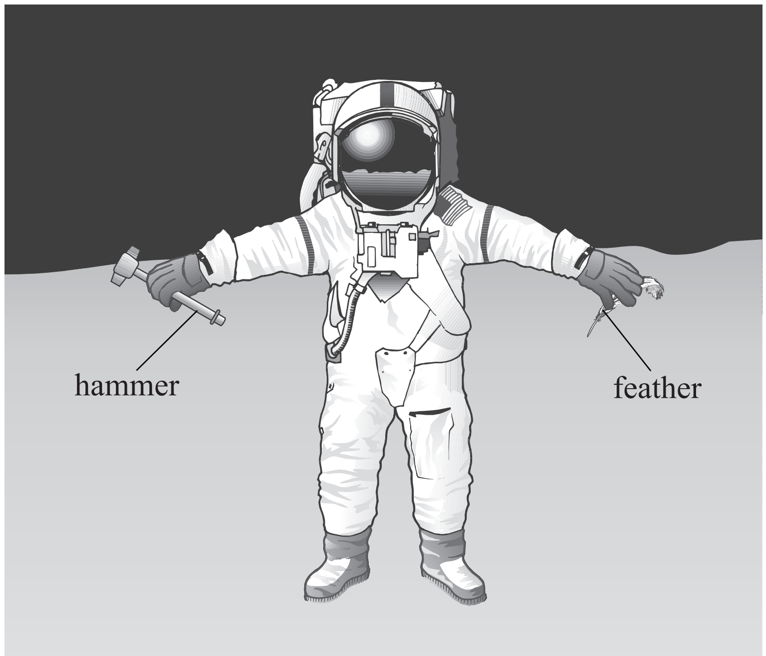
(Total for Question 1 = 12 marks)

2 The Apollo 15 mission landed on the Moon in 1971.

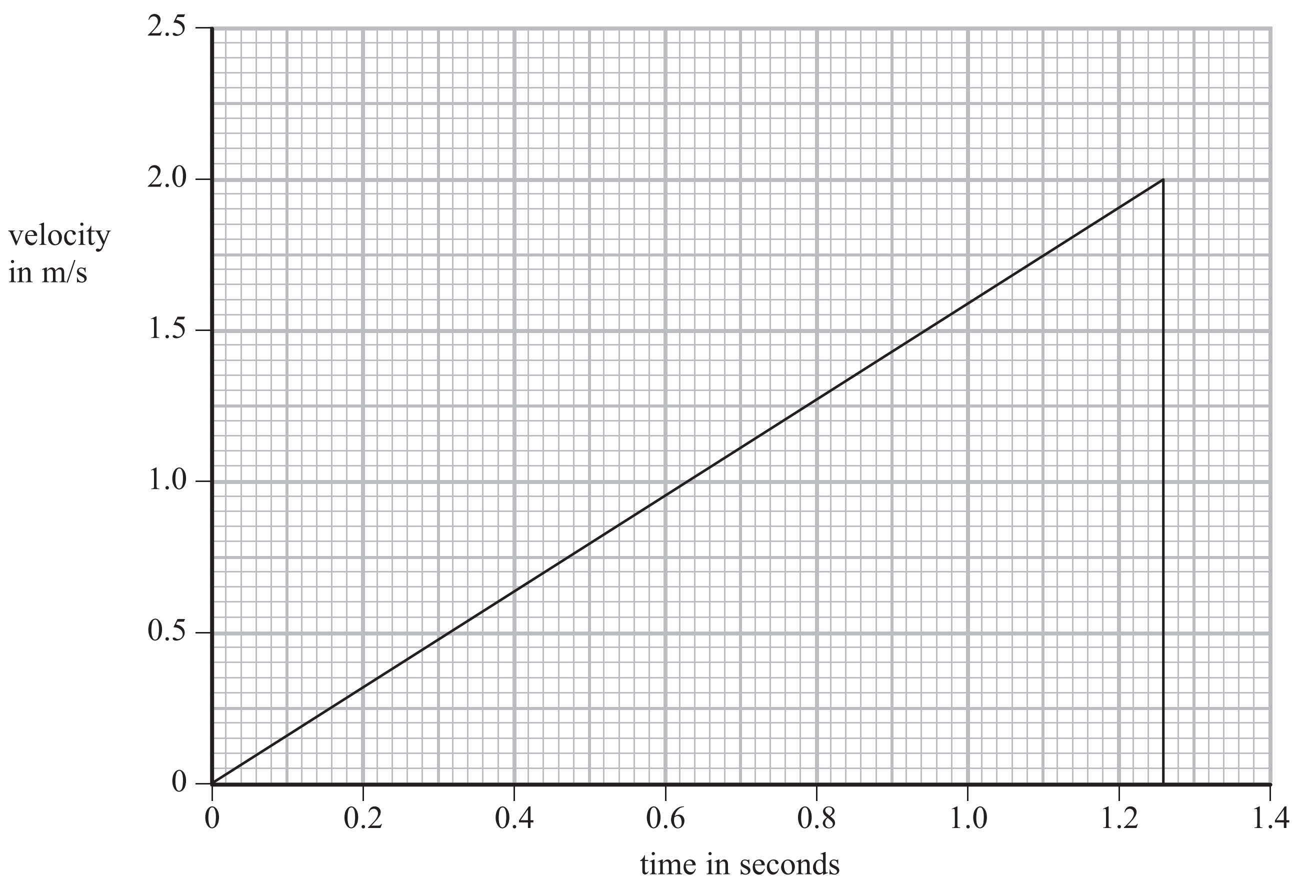
The astronaut David Scott dropped a hammer and a feather.

They were released from rest at the same time and from the same height.

The hammer and the feather landed at the same time.



(a) The graph shows how the velocity of the hammer changed with time.

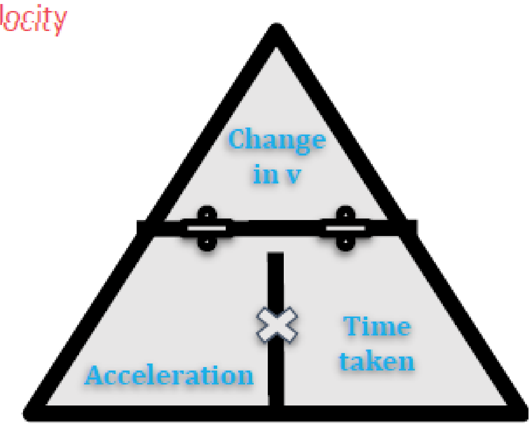


(i) Use the graph to calculate the acceleration due to gravity on the Moon.

Give the unit. **(3)**

Acceleration = Change in velocity/Time taken for change in velocity
Gradient of initial straight line = acceleration

$Acceleration = \frac{2}{1.26} = 1.6ms^{-2}$



Acceleration = ...1.6.......... Unit ....ms^{-2}..........

(ii) Use the graph to calculate the height the hammer was dropped from. **(2)**

Distance = Velocity * Time

- Area under the graph = Distance travels
- Area under graph = area of triangle
- Area $= \frac{1}{2} \times 1.26 \times 2 = 1.26m$

Height = ...1.26.......... m

(b) The gravitational field strength is smaller on the Moon than on the Earth.

Suggest why. **(1)**

The **mass of the Earth is larger than the mass of the Moon**, therefore the **gravitational field strength at earth is stronger**.

(c) If the same experiment is carried out on Earth, air resistance affects both objects.

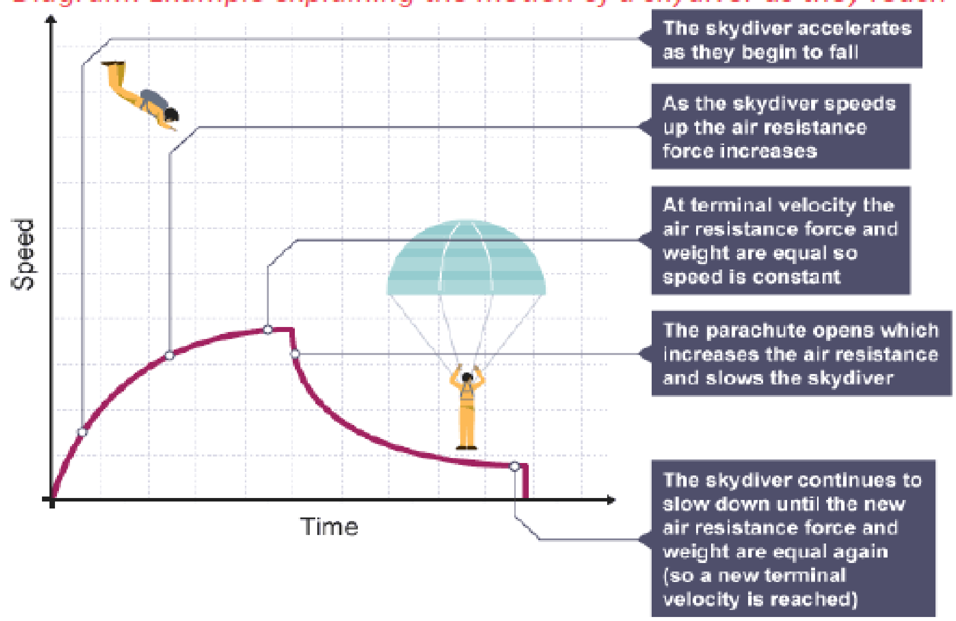
The feather reaches the ground after the hammer, even though the force of air resistance is smaller on the feather than on the hammer.

Explain why the feather reaches the ground after the hammer.

(4)

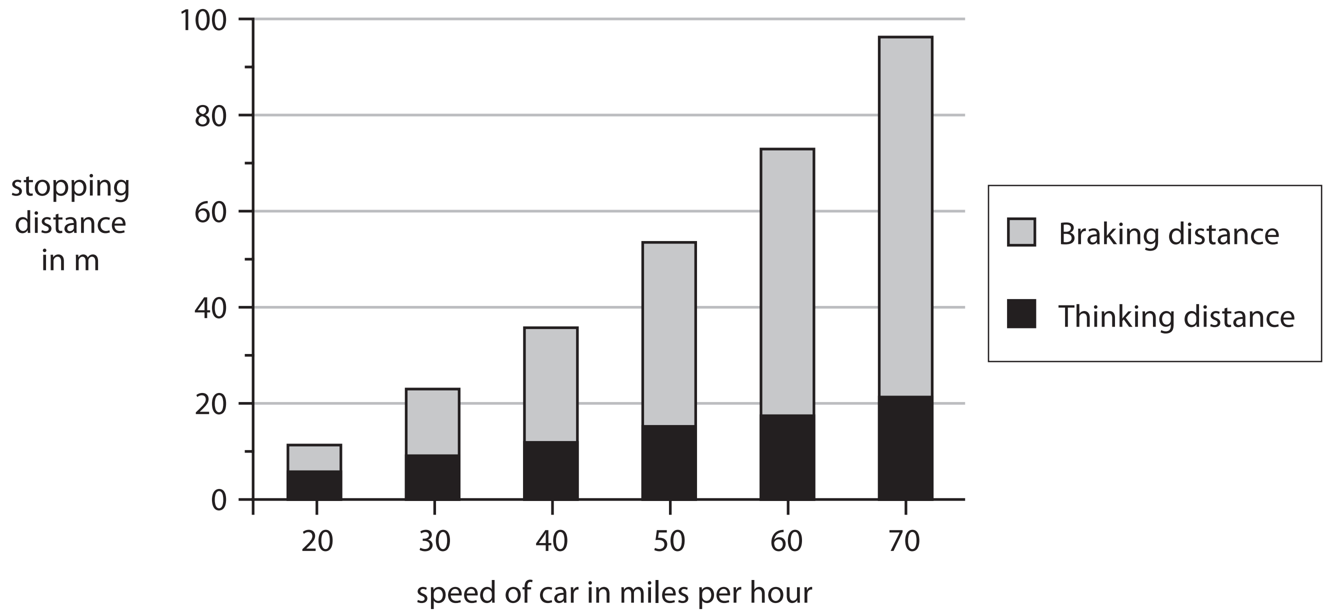
- The feather has a **lower weight** than the hammer
- As both objects are released from rest at the same time, they accelerate due to gravity at the same rate.
-The **air resistance force increases with their velocity**.
- But since the **feather has a lower weight than the hammer a lower air resistance is required to equal out the weight** and to cause no resultant force I.e. no acceleration.
-The point when the air resistance force = weight is known as terminal velocity.
- The hammer spends **more time accelerating** as a larger air resistance needs to be built up
-The hammer **reaches a higher terminal velocity than the feather** because of the extra time spent accelerating. The larger terminal velocity as well as the extra acceleration time means that the hammer covers the distance to the ground faster.
-Hence the **feather falls after.**

Diagram: Example explaining the motion of a skydiver as they reach terminal velocity:



(Total for Question 2 = 10 marks)

3 The graph shows the minimum stopping distances, in metres, for a car travelling at different speeds on a dry road.



(a) Complete the equation to show the link between stopping distance, thinking distance and braking distance. **(1)**

Stopping distance = *Thinking distance + Braking distance*

(b) Describe the patterns shown in the graph. **(2)**

- As the **speed increases, stopping distance increases** as both **thinking** and **braking distances increase**.
- **Thinking distance** increases **linearly** with **speed**.
- **Braking distance** increases **non-linearly** with **speed**; the **greater** the **speed**, the **greater** the **increase** in **braking distance**.
- The **overall stopping distance** is **not proportional** to the **speed** because of the **non-linear** relationship between **braking distance** and **speed**.

(c) Use the graph to estimate the stopping distance for a car travelling at 35 miles per hour.

(1)

The **stopping distance** will be **between** the stopping distances at **30 mph** and **40 mph**. A good **estimate** might be **30 m**.

Stopping distance = **30 m** m

(d) To find the minimum stopping distance, several different cars were tested.

Suggest how the data from the different cars should be used to give the values in the graph. **(1)**

To find the **minimum stopping distance**, the **smallest values** obtained from the cars should be used for the graph.

(e) The tests were carried out on a dry road.

If the road is icy, describe and explain what change there would be, if any, to

(i) the thinking distance **(2)**

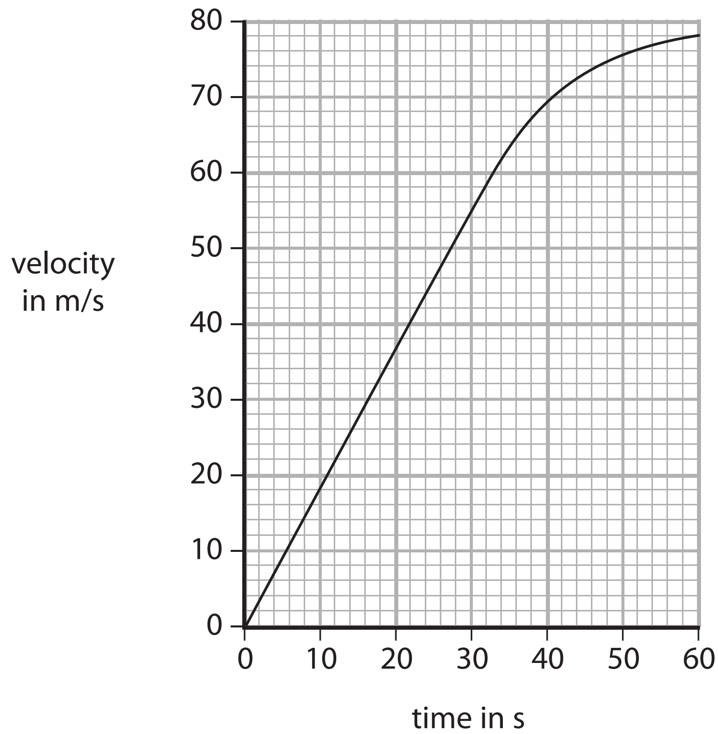
The **thinking distance** does **not** depend on **road conditions** but on the **alertness** of the driver and the **speed** of the car, so there would be **no change**.

(ii) the braking distance **(2)**

The **braking distance** may **increase**, as there is **less friction** between the tyres and the road, so the car will **travel further** in the **same time**.

(Total for Question 3 = 9 marks)

4 The graph shows how the velocity of an aircraft changes as it accelerates along a runway.



(a) Use the graph to find the average acceleration of the aircraft. **(3)**

The **average acceleration** is the **average rate** at which the **initial velocity** changes to the **final velocity**.

$$Acceleration = \frac{(Final\ velocity - Initial\ velocity)}{Time} = \frac{78}{60} = 1.3\ m/s^2$$

Acceleration = $1.3\ m/s^2$ m/s²

(b) Explain why the acceleration is not constant, even though the engines produce a constant force. **(3)**

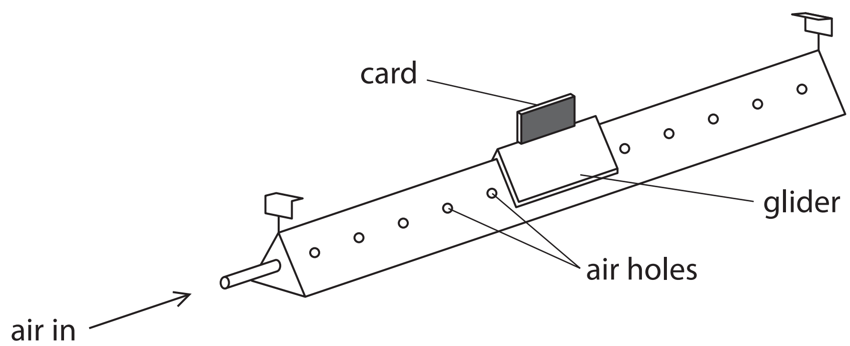
- As the aircraft **accelerates**, its **velocity increases**.
- An increased velocity leads to a **greater air resistance**.
- The **force** on the aircraft due to **air resistance** acts in the **opposite direction** to the **force** produced by the **engines**, so the **resultant force** on the aircraft **decreases** as air **resistance increases**.
- A **reduced resultant force** means that the **forward acceleration** of the aircraft is **reduced**.

(Total for Question 4 = 6 marks)

5 The diagram shows an air track that can be used to investigate motion.

Air comes out through a series of small holes in the air track.

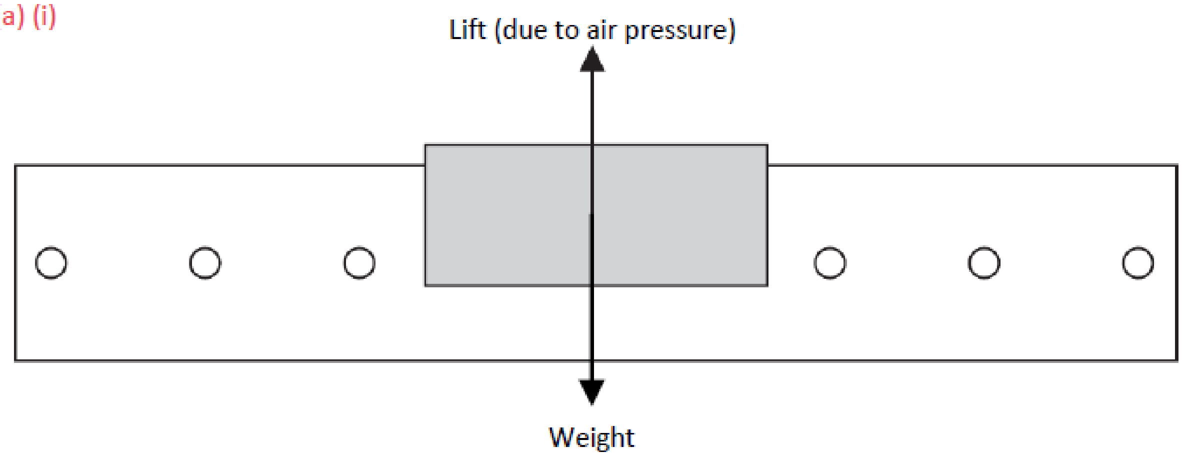
A small glider floats on a cushion of air.



(a) (i) The diagram below shows the glider at rest on the air track.

Complete the diagram to show the forces acting on the glider.
Label the forces.
One force arrow has been drawn for you. **(3)**

(a) (i)

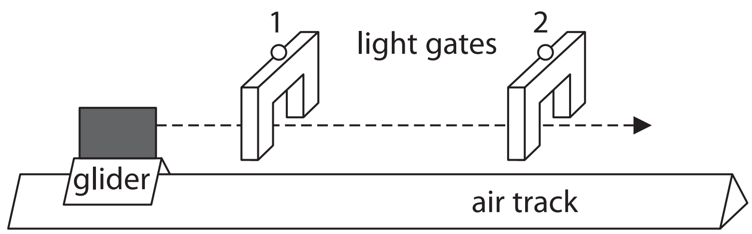


(ii) Explain what effect the cushion of air has on the movement of the glider. **(2)**

The **cushion of air lifts** the **glider**, which greatly **reduces the friction** it experiences when it moves. This means that the glider will keep moving at an **almost constant speed**.

(b) Two light gates connected to a data logger are placed above the air track so that the card will pass through them.

The glider moves at a constant speed to the right.



The length of the card is 8.3 cm.

The card takes 314 ms to pass through the first light gate.

(i) State the relationship between average speed, distance moved and time taken. **(1)**

$$Average\ speed = \frac{Distance\ moved}{Time\ taken}$$

(ii) Calculate the average speed of the card as it passes through the first light gate. **(2)**

The distance moved as the card passes through the light gate is equal to the length of the card:

$$Average\ speed = \frac{8.3}{0.314} = 26\ cm/s$$

Remember to convert the time of 314 ms to 0.314 s. The length does not need to be converted to metres as the units given for the answer are cm/s. The answer has been rounded to 2 significant figures.

average speed = 26 cm/s

(iii) State the time taken for the card to pass through the second light gate. **(1)**

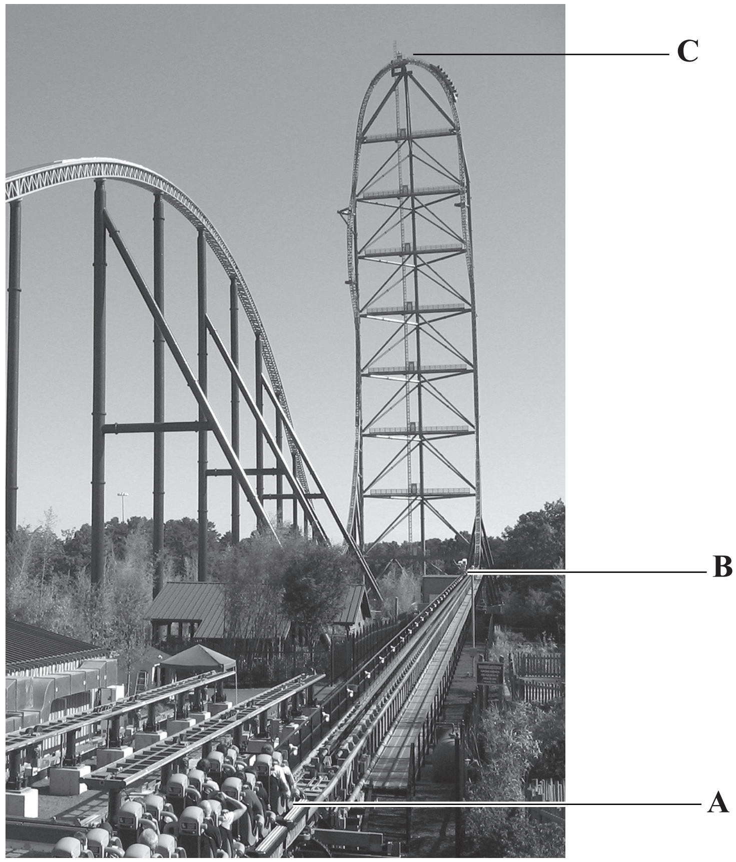
The **time taken** for the card to pass through the **second** light gate will be the **same** as the time taken to pass the **first**; **314 ms.** This is because, as stated in (a)(ii), the **reduced friction** of the track caused by the air cushion will cause the glider to move at a near **constant speed**, and since the **length does not change**, the **time** must also remain **constant**.

time taken = **314** ms

(Total for Question 5 = 9 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. **(1)**

GPE = mass* gravitational field strength*height

(ii) Show that the gravitational potential energy gained by the car when it rises from **B** to **C** is about 2.6 MJ. **(2)**

Using the equation given in the previous question:

$$GPE = 2000 \times 10 \times 128 = 2560000J = 2.6MJ(2sf)$$

(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)**

Kinetic energy gained = work done because all the kinetic energy will be converted into GPE when the car reaches C

(iii) Write down the equation linking work done, force and distance. **(1)**

Recall that

$Work = Force \times Distance$

(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)**

Use the equation shown above to calculate the force it would take to put 2.6MJ of energy into the car.

$32 \times 10^3 * Distance = 2.56 \times 10^6$

$Distance = 80m.$

Length of track = 80 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)**

When it is windy the resultant force on the car is not the full 32Kn, this is because there is a **drag force opposing the force the launch system provides** so part of the **energy is wasted overcoming the drag**. When the conditions are wet there is **less friction so the wheels might not be able to grip** the tracks properly.

(Total for Question 6 = 10 marks)