FOR CAMBRIDGE 2023 AND ONWARDS EXAMS

# O LEVEL 5054
# PHYSICS
## TOPICAL PAPER 2

- JUNE 2016 – JUNE 2023
- All Variants
- Arranged Sub-Topic Wise
- Mark Scheme
- Cambridge 2023 -2025 Syllabus


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## Content

# 1.1 Physical Quantities and Measurement Techniques

## 2020

**5054/21/O/N/20/Q2**

**1** Fig. 2.1 shows a satellite moving at a constant speed in a circular orbit around the Earth.

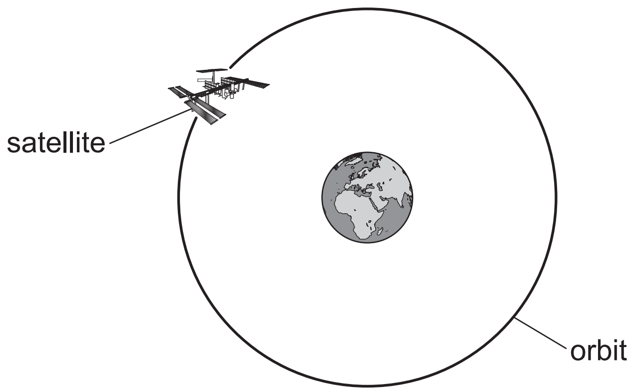


**Fig. 2.1** (not to scale)

Speed is a scalar quantity but velocity is a vector quantity.

**(a)** State how a scalar quantity differs from a vector quantity.

..............................................................................................................................................

.............................................................................................................................................. [1]

**(b)** Underline every vector quantity in the list.

**distance** **displacement** **force** **length** **mass** **time**

[1]

**(c)** There is a resultant force acting on the satellite in Fig. 2.1.

**(i)** Explain how the motion of the satellite shows that a resultant force is acting on it.

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..............................................................................................................................................

.............................................................................................................................................. [2]

**(ii)** State the cause of this force.

..............................................................................................................................................

.............................................................................................................................................. [1]

# 1.2 Motion

## 2023

**5054/22/M/J/23/Q1**

**1** Fig. 1.1 shows the speed–time graph for a car travelling on a straight horizontal road.

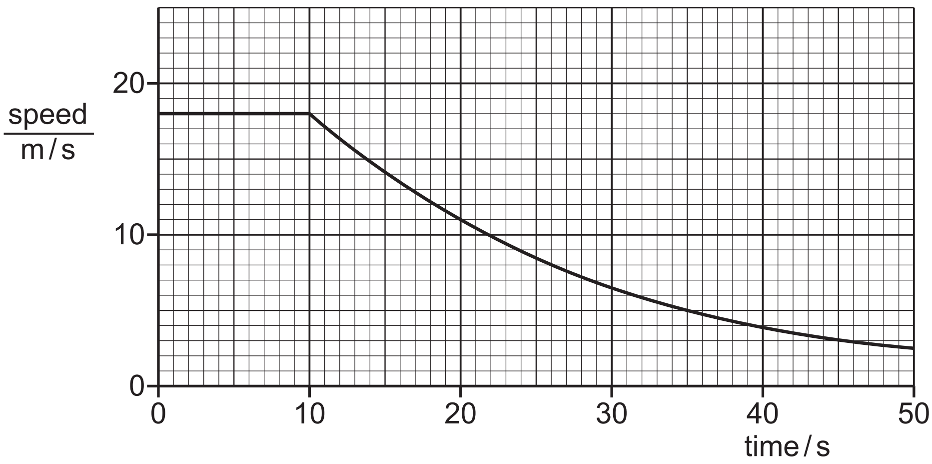


**Fig. 1.1**

**(a)** Describe the motion of the car shown in Fig. 1.1.

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..........................................................................................................................................

.......................................................................................................................................... [2]

**(b)** At time $t$ = 10 s the engine of the car is switched off. The brakes are not applied.

**(i)** Name **two** forces that act on the car to cause the change in motion after $t$ = 10 s.

1 ..........................................................................................................................

2 ..........................................................................................................................
[1]

**(ii)** Suggest why Fig. 1.1 is a curve after $t$ = 10 s.

..........................................................................................................................

..........................................................................................................................

.......................................................................................................................... [1]

**(c)** Between $t$ = 10 s and $t$ = 20 s the speed of the car changes from 18 m/s to 11 m/s.
The mass of the car is 1200 kg.

**(i)** Calculate the change in momentum of the car in this time.

Give the unit of your answer

momentum change = ...................................... unit ........... [2]

**(ii)** Calculate the average resultant force exerted on the car during this time.

average resultant force = ..................................................... N [2]

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**2** An aircraft pulls a glider along a runway as shown in Fig. 1.1. **5054/21/M/J/23/Q1**

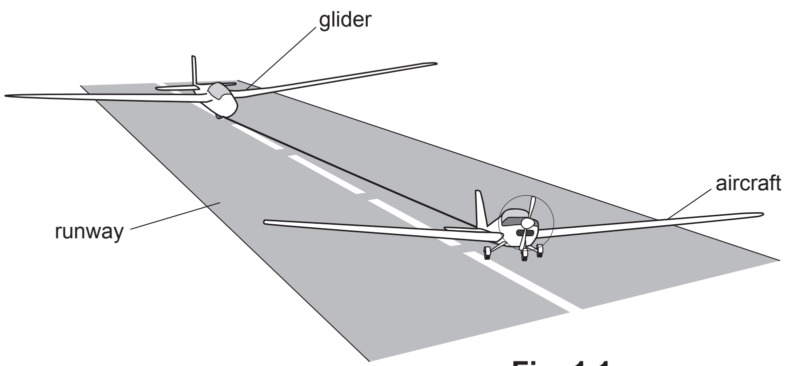


**Fig. 1.1**

Fig. 1.2 shows the speed of the glider during the first 12 s of the motion.

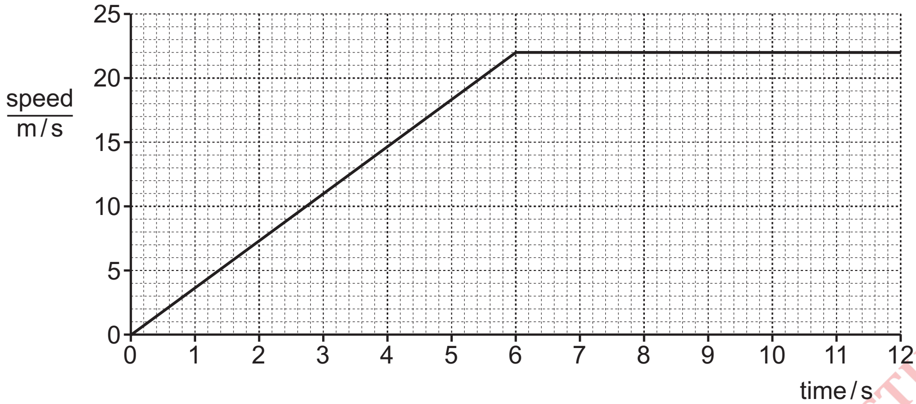


**Fig. 1.2**

**(a)** Describe the motion of the glider in the first 12 s.

..........................................................................................................................................

..........................................................................................................................................

.................................................................................................................................... [2]

**(b)** In the first 6.0 s of the motion, there is a resultant force of 1800 N on the glider.

Using the increase in speed in the first 6.0 s, calculate the mass of the glider.

mass = .................................................... kg [3]

**(c)** Determine the distance travelled by the glider in the first 6.0 s of its motion.

distance = .................................................... m [2]

**(d)** The glider has no engine and stays in the air with the use of convection currents.

**(i)** State what is meant by a 'convection current'.

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.................................................................................................................................... [1]

**(ii)** Suggest how the convection current that supports the glider is formed.

..........................................................................................................................................

..........................................................................................................................................

.................................................................................................................................... [1]

**3** Fig. 1.1 is the speed-time graph for a stone as it falls to the ground. **5054/02/SP/23/Q1**

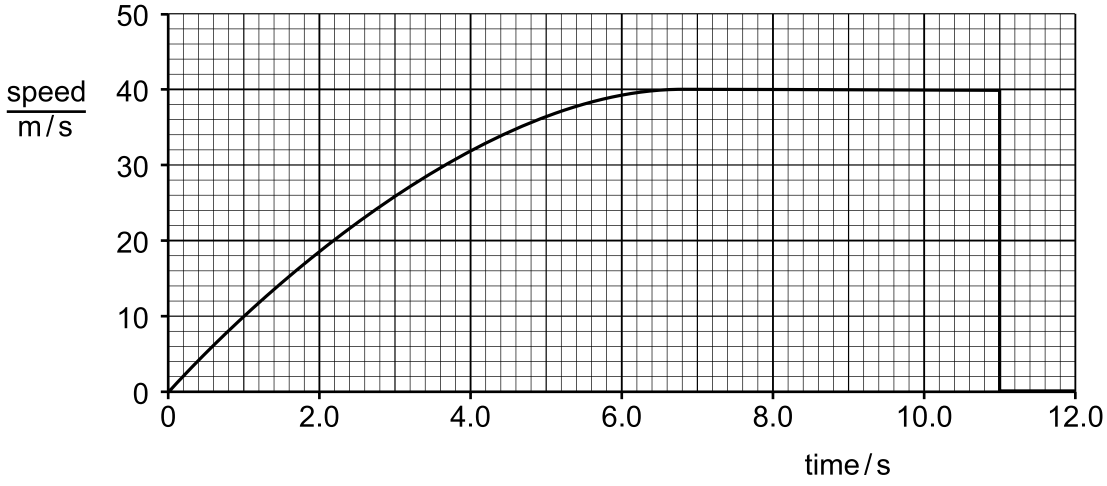


**Fig. 1.1**

**(a)** **(i)** On Fig. 1.1, mark:

- a letter **X** to indicate a point where the rock is moving with a constant speed
- a letter **Y** to indicate a point where the rock is decelerating.

[2]

**(ii)** At time $t$ = 0, the acceleration of the stone is equal to the acceleration of free fall.

Give the name of the force accelerating the stone at time $t$ = 0.

.............................................................................................................................. [1]

**(b)** The weight of the stone is 4.0 N.

As the stone falls, the force $F$ of air resistance acting on the rock changes.

**(i)** State the value of $F$ at time $t$ = 0.

$F$ = ...................................................... N [1]

**(ii)** State the value of $F$ at time $t$ = 10.0 s.

$F$ = ...................................................... N [1]

**(iii)** Suggest why $F$ changes between $t$ = 0 s and $t$ = 10.0 s

..............................................................................................................................

..............................................................................................................................

.............................................................................................................................. [1]

**(c)** **(i)** Using Fig. 1.1, determine the acceleration of the rock at time $t$ = 4.0 s. State the unit of your answer.

You will need to draw a tangent to the graph in Fig. 1.1 and show your working.

acceleration = .................................... unit = .......... [3]

**(ii)** The mass of the stone is 408 g.

Determine the force $F$ of air resistance acting on the rock at time $t$ = 4.0 s.

Show your working.

$F$ = ...................................................... N [2]

## 2022

**5054/22/O/N/22/Q1**

**4** A train travels along a straight horizontal track. At time $t$ = 0, the train passes through station P at constant speed without stopping.

The driver applies the brakes 70 s before reaching station Q. The train decelerates.

Fig. 1.1 is the speed–time graph for the train from $t$ = 0 until it stops at station Q.

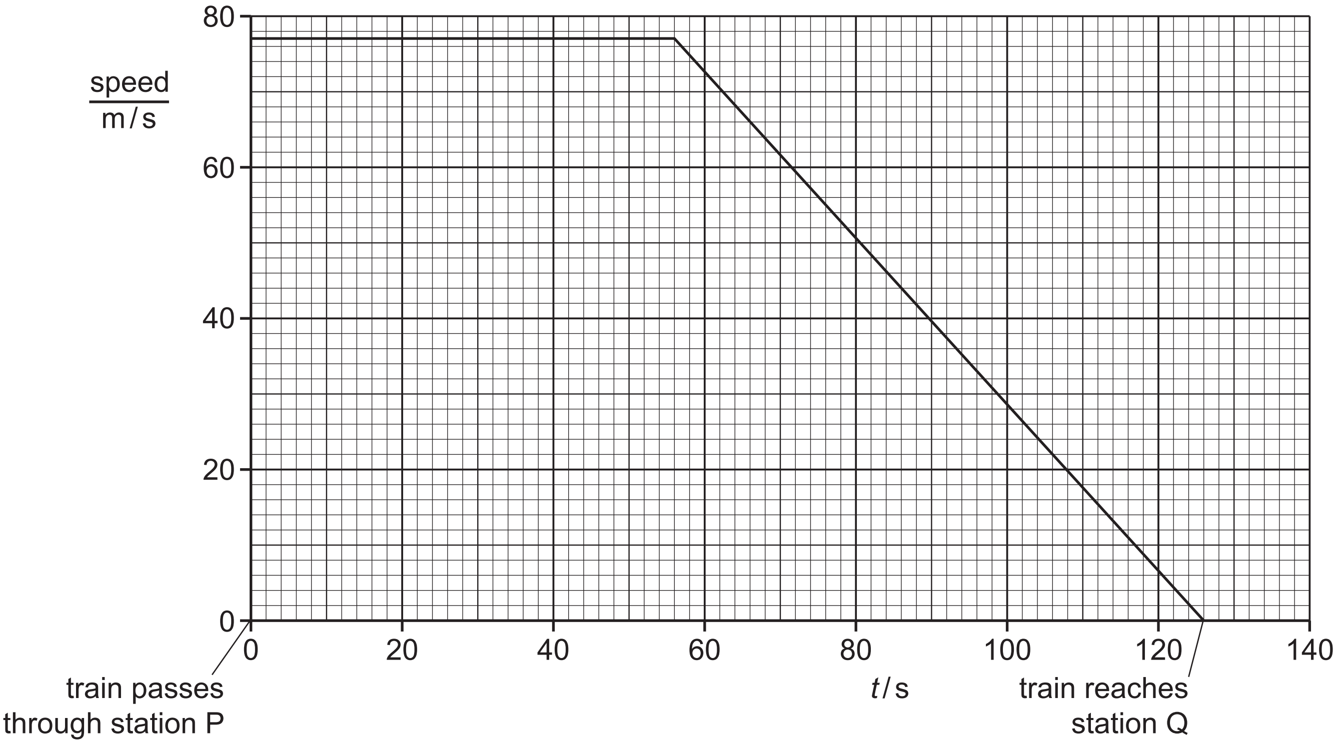


**Fig. 1.1**

**(a)** Using Fig. 1.1, determine the distance between station P and station Q.

distance = ........................................................ [3]

**(b)** The mass of the train is $3.8 \times 10^5$ kg.

**(i)** Determine the deceleration of the train in the 70 s before it stops at station Q.

deceleration = ........................................................ [2]

**(ii)** Calculate the resultant force on the train as it decelerates.

resultant force = ........................................................ [2]

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**5054/21/O/N/22/Q7**

**5** Fig. 7.1 shows a child sitting on a sledge on a snow-covered hill of constant slope.

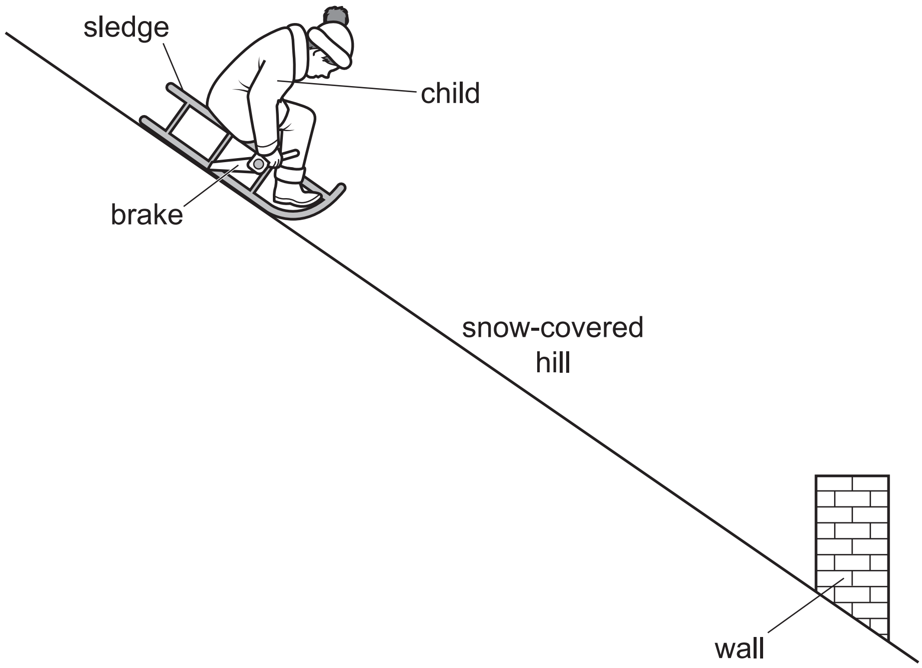


**Fig. 7.1** (not to scale)

At time $t = 0$, the child and the sledge begin to move down the hill in a straight line.

When the child sees a wall ahead, he applies the brake.

The child and sledge continue to travel in a straight line until they come to a stop before hitting the wall.

Fig. 7.2 is the speed-time graph for the journey.

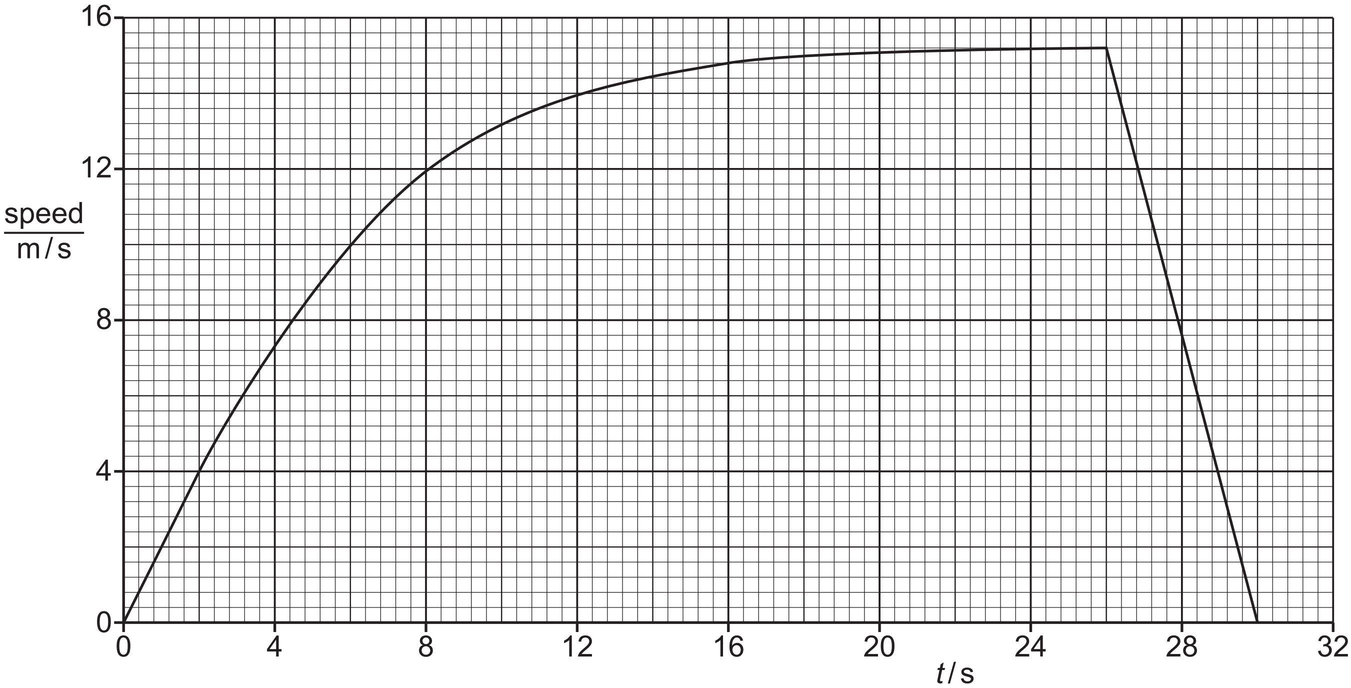


**Fig. 7.2**

The brake is applied at $t$ = 26 s.

**(a)** Fig 7.2 shows how the speed of the child and sledge varies over the whole of the journey.

Explain why, between $t$ = 0 and $t$ = 26 s, the speed varies in the way shown by the graph.

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.................................................................................................................................... [3]

**(b)** At $t$ = 26 s, the front of the sledge is 35 m from the wall.

Determine the distance between the front of the sledge and the wall when the sledge stops.



distance = ........................................................ [3]

**(c)** At $t$ = 26 s, the child and sledge begin to decelerate.

**(i)** Determine the size of the deceleration.

deceleration = ........................................................ [3]

**(ii)** The mass of the child is 46 kg and the mass of the sledge is 9.0 kg.

Calculate the resultant force on the child and sledge as they decelerate.

resultant force = ........................................................ [2]

**(iii)** State the energy transfer that is taking place as the child and sledge decelerate.

...........................................................................................................................

...........................................................................................................................

........................................................................................................................... [2]

**(d)** At $t$ = 26 s, when the brake is first applied, the child jerks forwards on the sledge.

Explain why.

...........................................................................................................................

...........................................................................................................................

........................................................................................................................... [2]

**5054/22/M/J/22/Q7**

**6** Fig. 7.1 shows the speed–time graph for a car travelling on a straight horizontal road.

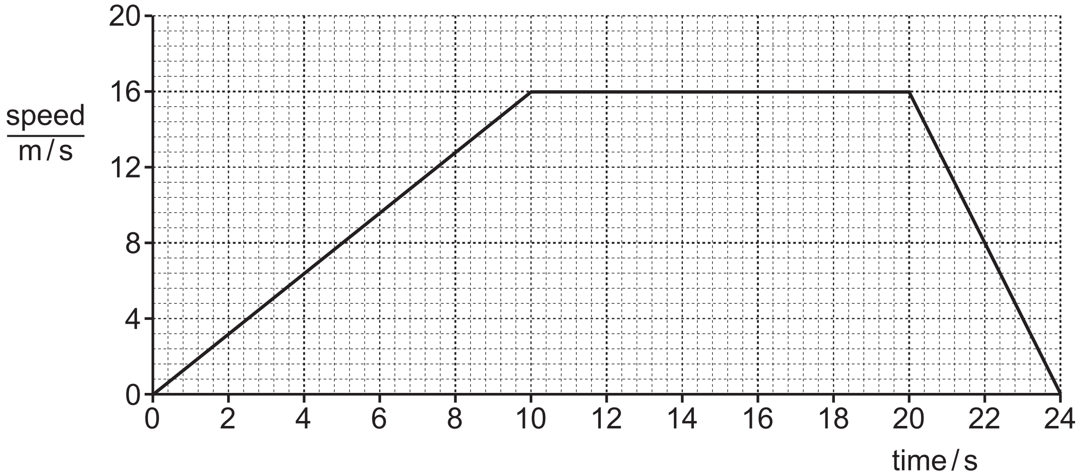


**Fig. 7.1**

**(a)** **(i)** Describe the motion of the car.

..........................................................................................................................................

..........................................................................................................................................

..........................................................................................................................................

..........................................................................................................................................

.................................................................................................................................... [3]

**(ii)** Using Fig. 7.1, calculate the distance travelled by the car during the 24 s of its motion.

Show your working.

distance = ....................................................... [3]

**(iii)** Calculate the average speed of the car during its motion.

average speed = ....................................................... [2]

**(iv)** A second car travels at a steady speed. It travels the same distance as the first car in the 24 s of the journey.

On Fig. 7.1, draw the speed–time graph for the second car. [2]

**(b)** The thinking distance is the distance travelled by a car between the time that a hazard is seen and the time that the brakes are applied.

The braking distance is the distance travelled while the car slows down to rest.

Table 7.1 shows the thinking and braking distances for an alert driver when the car travels at different speeds.

**Table 7.1**

| $\frac{\text{speed}}{\text{km/h}}$ | thinking distance / m | braking distance / m |
|---|---|---|
| 20 | 9 | 2 |
| 40 | 18 | 9 |
| 60 | | 20 |
| 80 | 36 | 36 |
| 100 | 45 | 56 |

**(i)** Complete Table 7.1. [1]

**(ii)** The time it takes for the driver to react to the hazard is constant at different speeds.

Explain how the table shows this.

.....................................................................................................................

.....................................................................................................................

.....................................................................................................................

..................................................................................................................... [2]

**(iii)** State what happens to the thinking distance and the braking distance when the driver is tired.

thinking distance .....................................................................................

braking distance ..................................................................................... [2]

7 Fig. 7.1 shows a toy helicopter. It can hover and travel through the air. **5054/21/M/J/22/Q7**

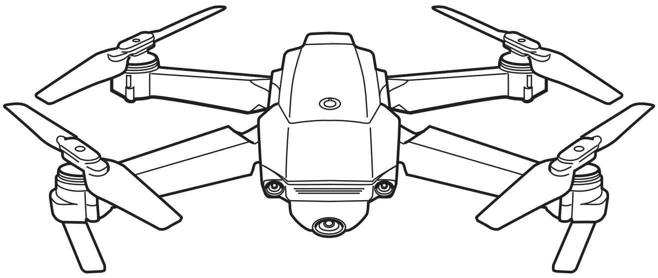

**Fig. 7.1**

A student flies the toy helicopter on a journey from A to B to C to D at a constant height.

Fig. 7.2 is a scale drawing of the path of the helicopter, viewed from above.

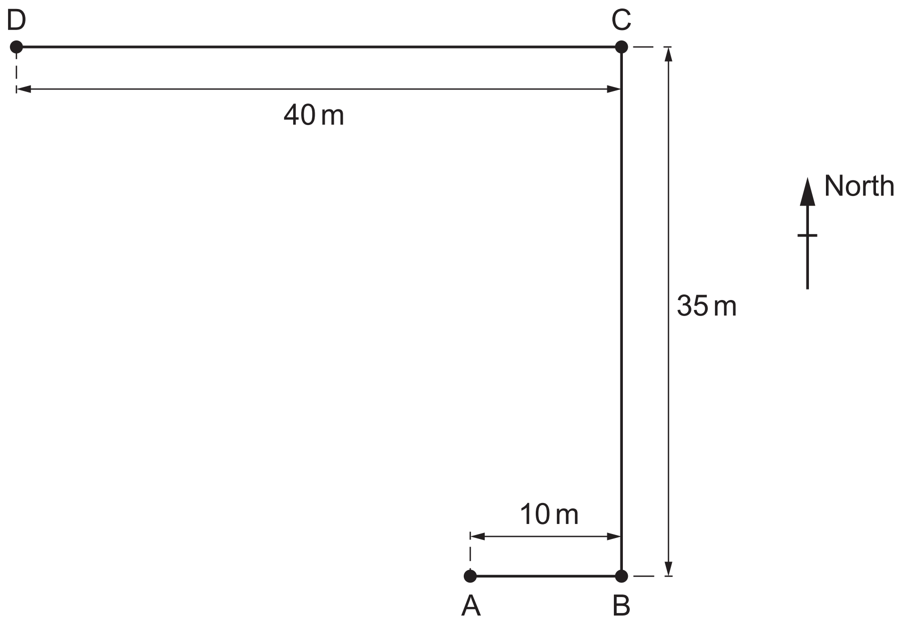


**Fig. 7.2** (to scale)

**(a)** **(i)** Determine the total distance travelled by the toy helicopter.

.............................................................................................................................. [1]

**(ii)** The toy helicopter makes the journey in 40 s.

Calculate its average speed during the journey.

speed = ........................................................ [2]

**(b)** **(i)** State the difference between distance and displacement.

..........................................................................................................................................

.......................................................................................................................................... [1]

**(ii)** Determine the scale used to construct Fig. 7.2 and complete the sentence.

1 cm on the diagram represents .............................. on the path. [1]

**(iii)** Using Fig. 7.2, determine the size of the displacement of point D from point A.

Show your working.

size of displacement = ........................................................ [2]

**(iv)** Determine the angle between North and the direction of the displacement of point D from point A.

angle = ........................................................ [1]

**(v)** State what is meant by velocity.

.......................................................................................................................................... [1]

**(vi)** Another toy helicopter flies directly from point A to point D in 40 s.

Explain why the magnitude of the velocity of this toy helicopter is smaller than the answer in **(a)(ii)**.

..........................................................................................................................................

.......................................................................................................................................... [1]

**(c)** When the toy helicopter hovers at D, its motor fails and it falls. It reaches terminal velocity as it falls.

Explain, in terms of the forces and acceleration, what happens as the helicopter falls and reaches terminal velocity.

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.................................................................................................................................... [5]

## 2021

**8** An aircraft flies at a constant height. **5054/21/M/J/21/Q1(b)**

Air drag and the force from the aircraft's engines together produce a force on the aircraft of 36 kN due north, as shown in Fig. 1.1.

The wind produces a force of 12 kN towards the east.

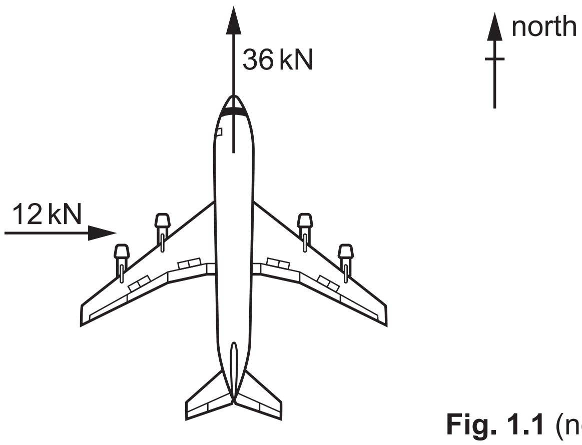


**Fig. 1.1** (not to scale)

**(b)** The acceleration of the aircraft is uniform.

**(i)** Describe how a uniform acceleration differs from a non-uniform acceleration.

..........................................................................................................................................

..........................................................................................................................................

..........................................................................................................................................

.................................................................................................................................... [2]

**(ii)** The mass of the aircraft is 60 000 kg.

Calculate the acceleration of the aircraft.

acceleration = ........................................................ [2]

---

**9** Fig. 8.1 shows a stationary horse and its rider, about to jump over two fences. **5054/21/M/J/21/Q8**

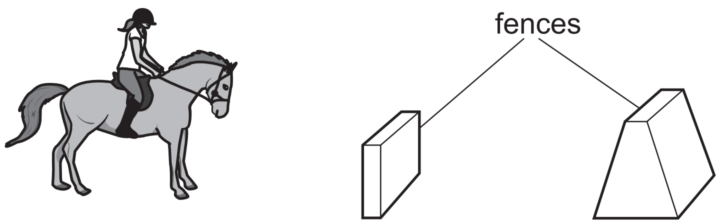


**Fig. 8.1**

**(a)** Fig. 8.2 shows a side view of the horse.

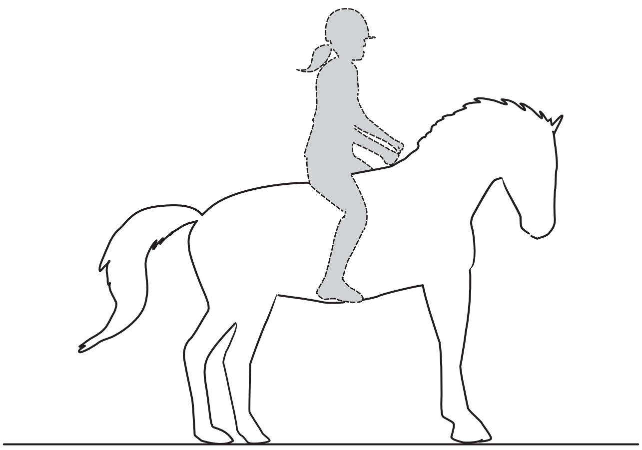

**Fig. 8.2**

**(i)** On Fig. 8.2, draw and label the forces acting on the horse.

Include the force that the rider exerts on the horse. Label this force *F*. [3]

**(ii)** Explain how Newton's third law applies to force *F*.

..........................................................................................................................................

..........................................................................................................................................

.................................................................................................................................... [2]

**(b)** Fig. 8.3 shows a side view of the two fences. They both have the same height and a uniform density.

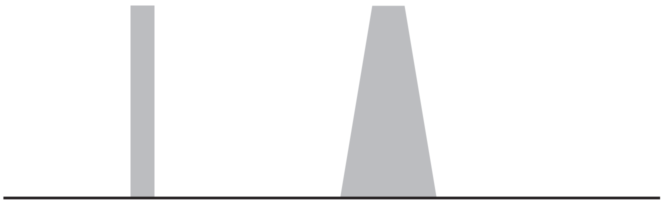

**Fig. 8.3**

**(i)** On each fence in Fig. 8.3, mark with a cross the centre of mass. [2]

**(ii)** Explain why a wider base makes the fence more stable.

..........................................................................................................................

..........................................................................................................................

.................................................................................................................. [2]

**(c)** The total mass of the horse and rider is 520 kg.

**(i)** As they approach a fence, the horse and rider have a total kinetic energy of 4000 J.

Calculate their speed.

speed = ........................................................ [3]

**(ii)** The centre of mass of the horse and rider is 1.4 m above the ground.

The maximum potential energy gained by the horse and rider as they jump over the fence is 3000 J.

Calculate the maximum height above the ground of the centre of mass during the jump.

The gravitational field strength $g$ = 10 N / kg.

height = ........................................................ [3]

**10** A car approaches a set of traffic lights. The lights change to red at time $t$ = 0. **5054/22/M/J/21/Q2**

Fig. 2.1 shows how the speed of the car changes with time.

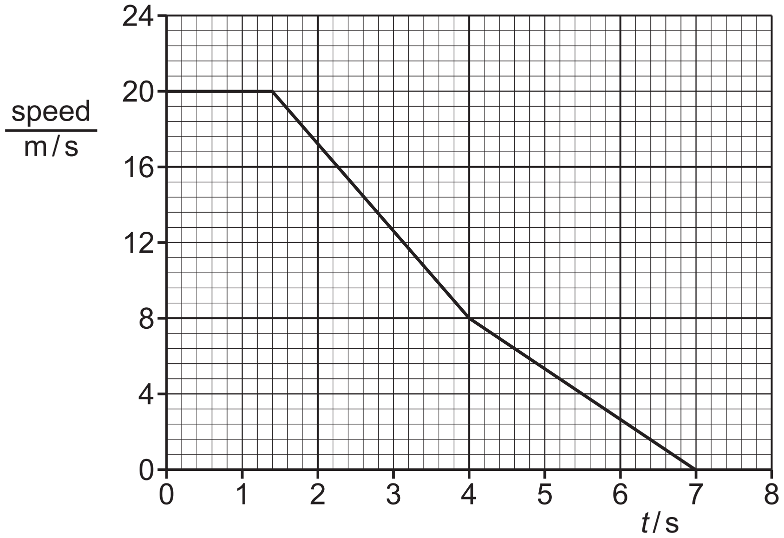


**Fig. 2.1**

**(a)** The car starts to slow down a short time after the lights change to red.

Determine the time between the lights changing to red and the car starting to slow down.

.................................................................................................................................... [1]

**(b)** **(i)** State what is meant by *uniform acceleration*.

....................................................................................................................................

.................................................................................................................................... [1]

**(ii)** State how Fig. 2.1 shows that the deceleration of the car between $t$ = 2 s and $t$ = 7 s is *non-uniform*.

....................................................................................................................................

.................................................................................................................................... [1]

**(c)** Determine the distance the car travels from the moment the car starts to slow down until it stops.

distance = ........................................................... [3]

## 2020

**5054/22/O/N/20/Q7**

**11** A bus leaves a bus-stop at time $t = 0$ and travels along a horizontal road until it reaches a second bus-stop. Fig. 7.1 is the distance-time graph for the bus between $t = 0$ and $t = 60$ s.

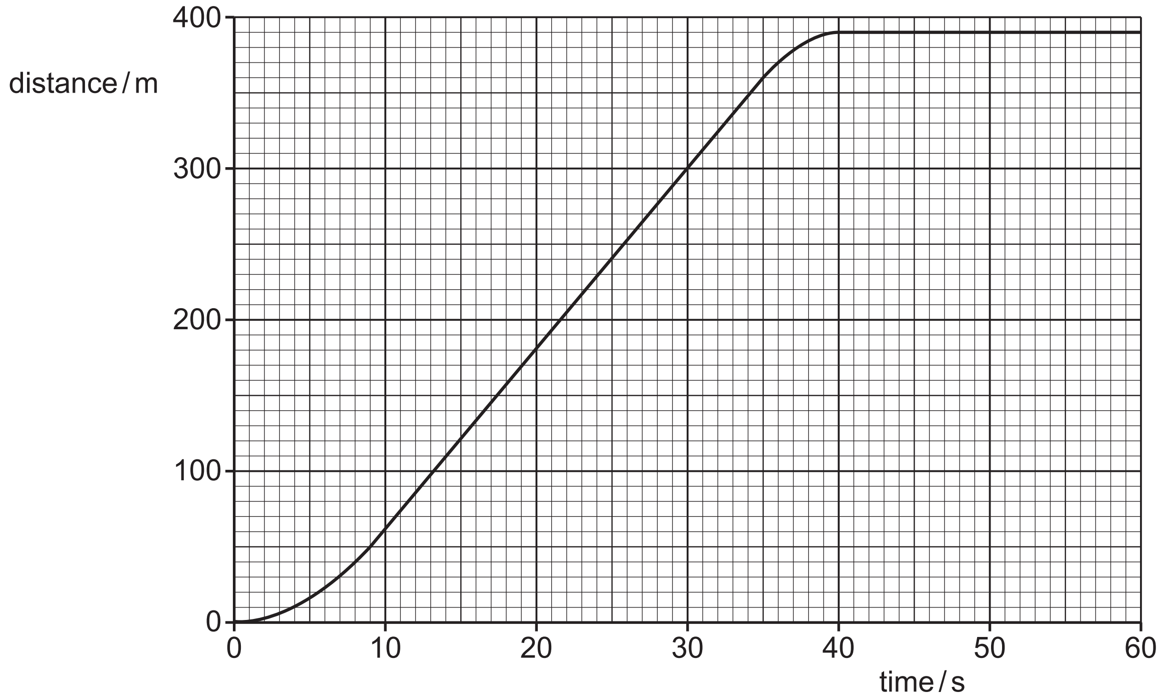


**Fig. 7.1**

The road on which the bus is travelling is straight except for a short, curved section. The bus travels around this circular curve between $t = 21$ s and $t = 24$ s.

**(a)** Describe how the motion of the bus between $t = 0$ and $t = 10$ s differs from its motion between $t = 35$ s and $t = 40$ s.

..........................................................................................................................................

..........................................................................................................................................

..........................................................................................................................................

..........................................................................................................................................

.......................................................................................................................................... [3]

**(b)** Determine:

**(i)** the maximum speed of the bus during these 60 s

maximum speed = ........................................................ [3]

**(ii)** the average speed of the bus between leaving the first bus-stop and arriving at the second bus-stop.

average speed = ........................................................ [2]

**(c)** **(i)** State how *velocity* differs from *speed*.

...................................................................................................................................

................................................................................................................................... [1]

**(ii)** There are **three** periods during the 60 s when there is a non-zero resultant force acting on the bus.

Complete the statements to indicate these three time periods and state the direction of the resultant force in that period.

1. Between *t* = .............. and *t* = .............. the direction of the resultant force is

...................................................................................................................................

2. Between *t* = .............. and *t* = .............. the direction of the resultant force is

...................................................................................................................................

3. Between *t* = .............. and *t* = .............. the direction of the resultant force is

...................................................................................................................................
[4]

**(d)** During the journey, the air resistance acting on the bus varies.

**(i)** State why the air resistance changes during the journey.

...................................................................................................................................

................................................................................................................................... [1]

**(ii)** On Fig. 7.1, mark and label with an M a time when the air resistance is a maximum value.
[1]

**5054/21/O/N/20/Q1**

**12** Fig. 1.1 is the distance–time graph for a skydiver who jumps from a balloon at time $t = 0$.

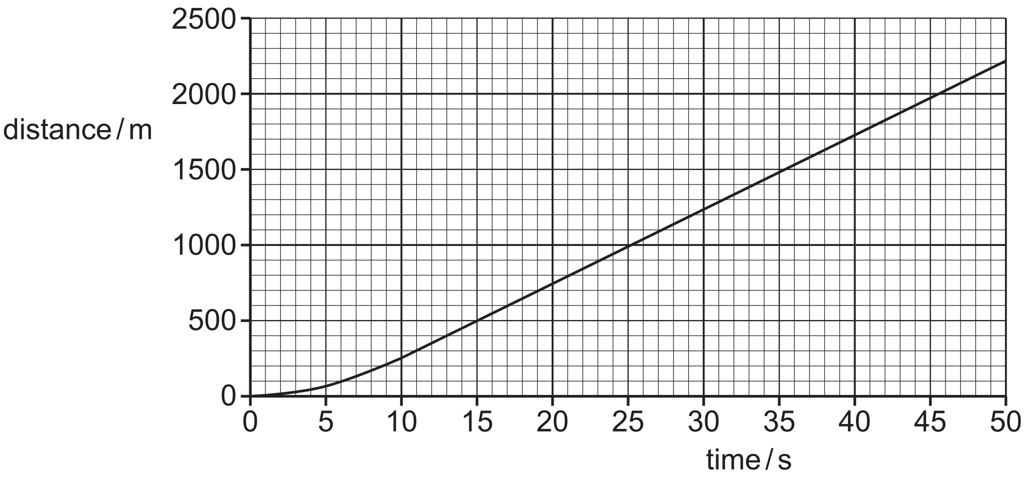


**Fig. 1.1**

**(a)** The first part of the graph shows the motion of the skydiver from when he jumps until he reaches terminal velocity.

**(i)** Describe the motion of the skydiver between $t = 0$ and $t = 20$ s.

..........................................................................................................................................

..........................................................................................................................................

.................................................................................................................................... [2]

**(ii)** Explain the motion of the skydiver between $t = 0$ and $t = 20$ s in terms of the forces acting on him.

..........................................................................................................................................

..........................................................................................................................................

..........................................................................................................................................

.................................................................................................................................... [3]

**(b)** Using Fig. 1.1, determine the terminal velocity of the skydiver.

On Fig. 1.1, indicate any values used for your calculation.

terminal velocity = ....................................................... [3]