1. Motion, forces and energy

1.2 Motion

Paper 3 and 4

Question Paper

Paper 3

Questions are applicable for both core and extended candidates

1 Fig. 1.1 shows the speed–time graph for a cyclist riding a bicycle.

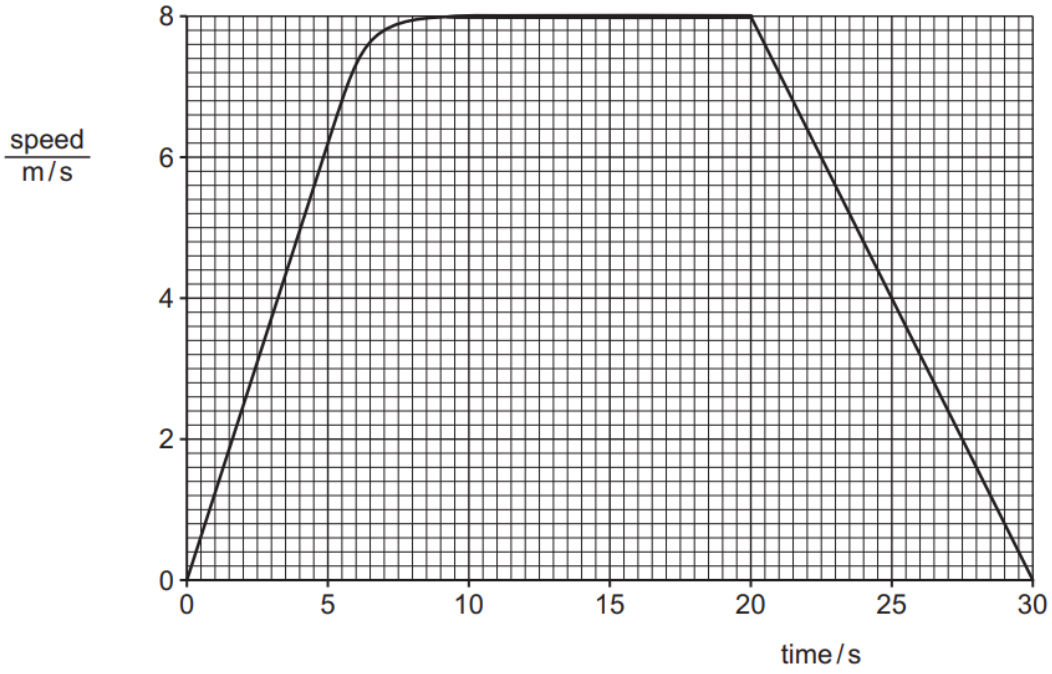


Fig. 1.1

(a) State the speed of the cyclist at time = 15 s.

speed of cyclist = ... m/s [1]

(b) Describe the motion of the cyclist

1. from time = 0 to time = 5 s .....

2. from time = 10 s to time = 20 s .....

3. from time = 20 s to time = 30 s .....

[3]

(c) Calculate the distance travelled by the cyclist from time = 20 s to time = 30 s.

distance = ... m [3]

[Total: 7]

2 Fig. 1.1 shows the distance–time graph for a student's journey.

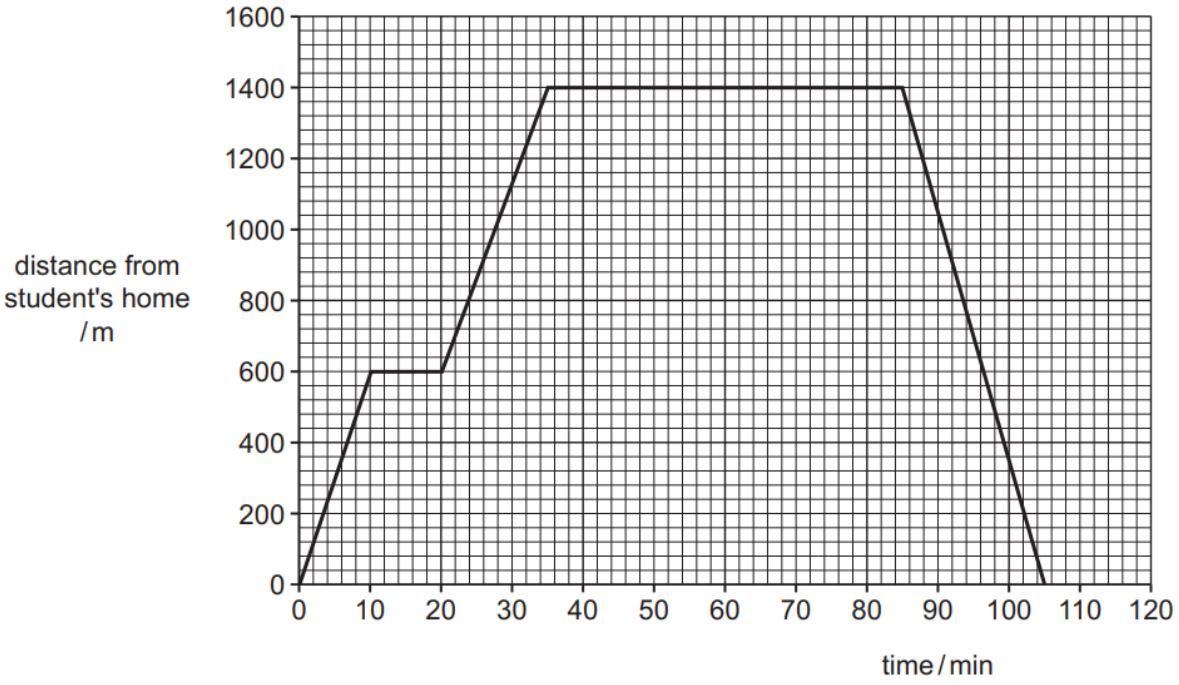


Fig. 1.1

The student walks from his home to a shop. He stops at the shop.
Then he walks to his friend's house and stops there for 50 minutes.
Then he walks back to his home without stopping.

(a) (i) Determine the distance between the student's home and his friend's house.

distance = ... m [1]

(ii) Calculate the distance between the shop and the friend's house.

distance = ... m [1]

(b) Calculate the total time for which the student is walking.

time = ... min [1]

(c) Calculate the average speed of the student when he walks back to his home.

speed = ... m / s [4]

[Total: 7]

3 Fig. 1.1 shows the speed–time graph for a car.

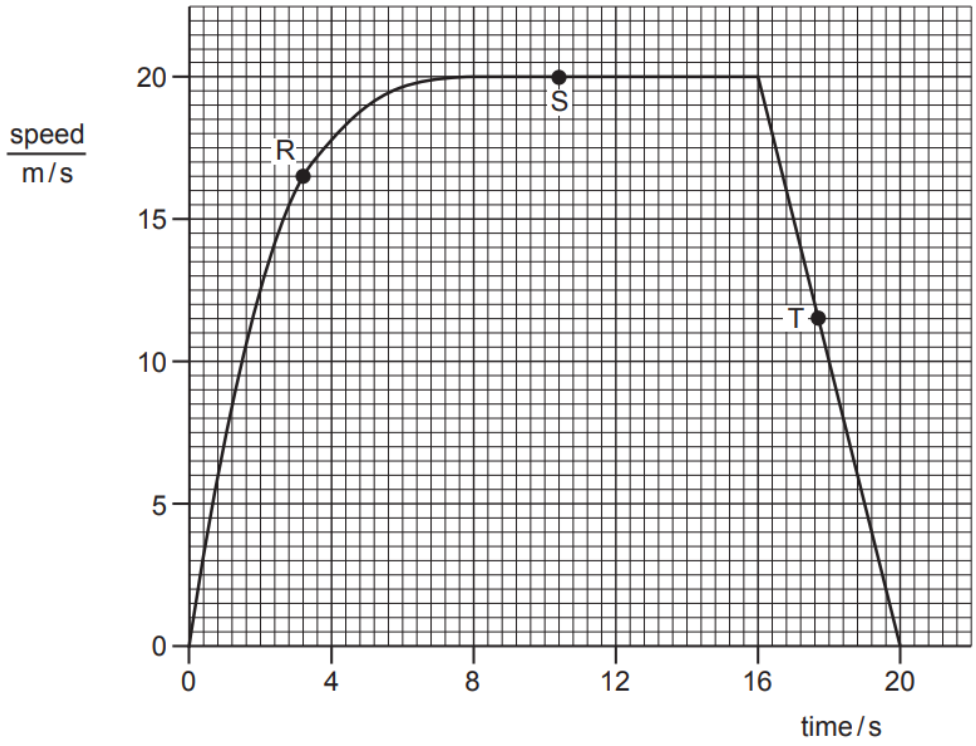


Fig. 1.1

(a) (i) For the graph in Fig. 1.1, match each letter, R, S and T, with the motion at that point.

Draw **one** line from each letter to the correct description. One has been done for you.

letter on the graph	**description of motion**
R	at rest
S	moving with constant speed
T	decelerating (negative acceleration)
	accelerating (positive acceleration)

[2]

(ii) Determine the speed of the car at time = 4.0 s.

speed = ... m/s [1]

(iii) Determine the distance moved by the car from time = 16.0 s to time = 20.0 s.

distance moved = ... m [3]

(b) Define the term velocity.

..... [1]

[Total: 7]

4 Fig. 1.1 shows the speed–time graph for a car travelling along a flat straight road.

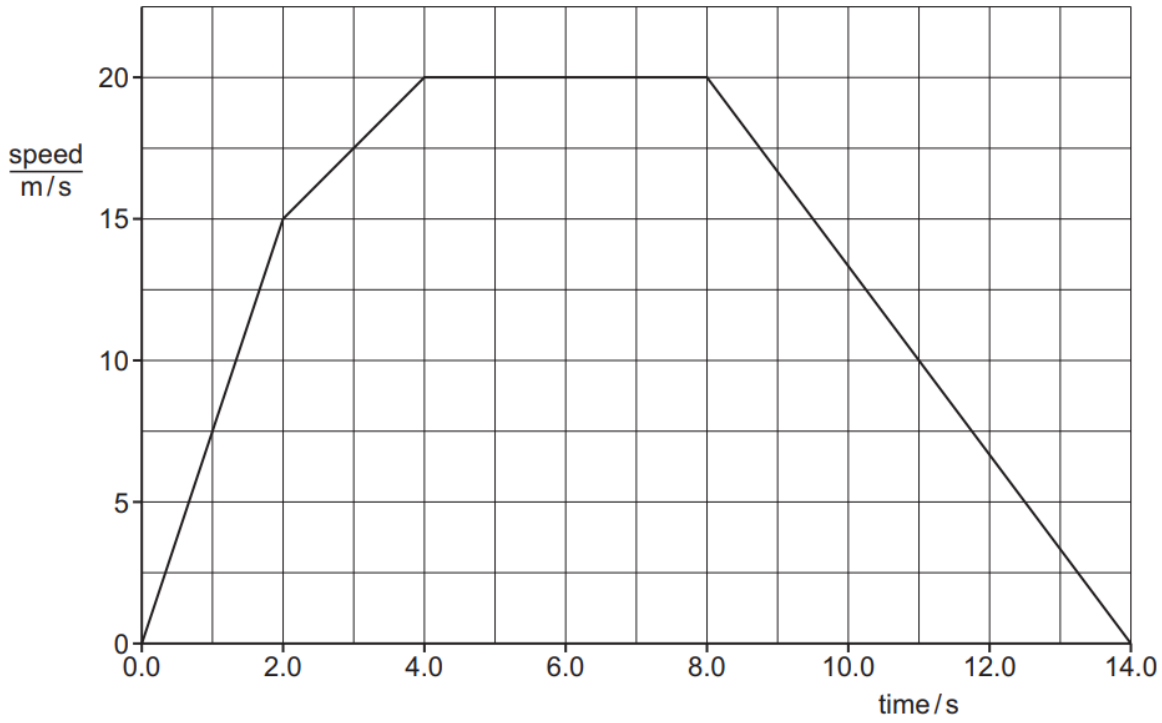


Fig. 1.1

(a) Describe the motion of the car between time = 0 and time = 2.0 s.

..... [1]

(b) State the value of the acceleration of the car between time = 4.0 s and time = 8.0 s.

..... [1]

(c) Calculate the distance travelled by the car between time = 8.0 s and time = 14.0 s.

distance travelled = ... m [3]

[Total: 5]

5 Fig. 1.1 shows a distance–time graph for a cyclist.

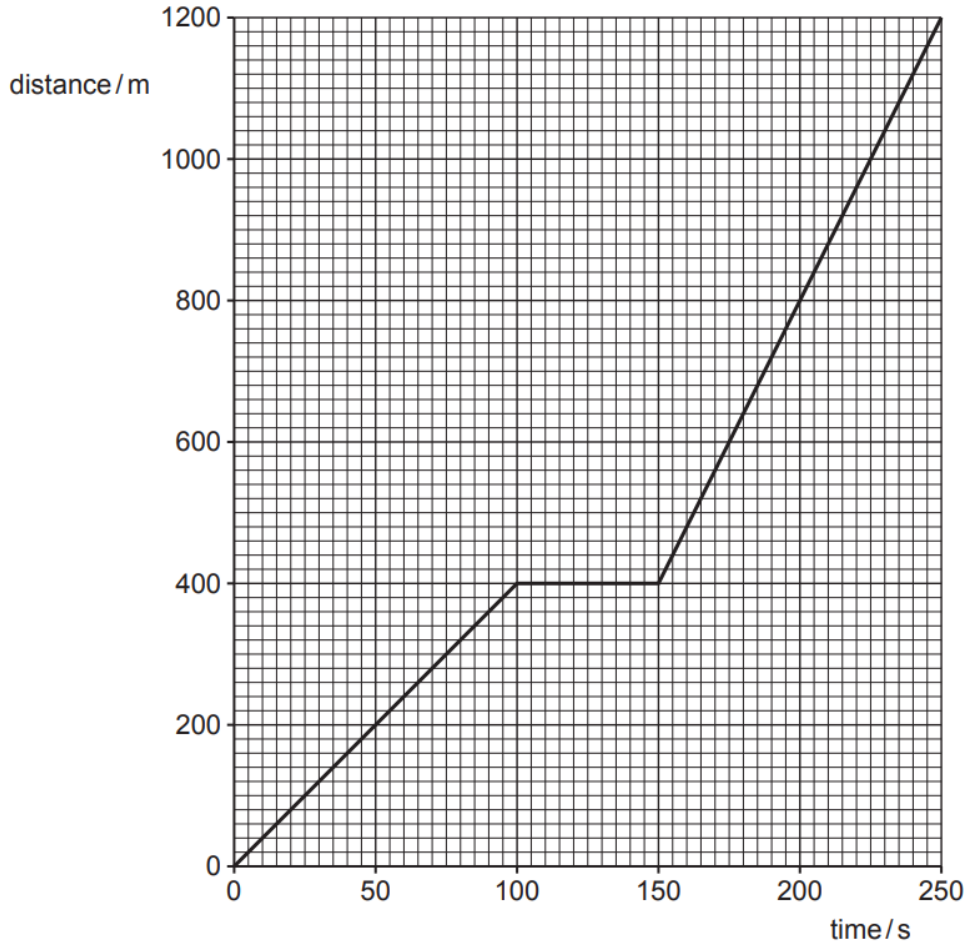


Fig. 1.1

(a) (i) Determine the distance travelled by the cyclist between time = 0 and time = 100 s.

distance travelled = ... m [1]

(ii) Calculate the speed of the cyclist between time = 0 and time = 100 s.

speed = ... m / s [3]

(iii) Describe the motion of the cyclist between time = 100 s and time = 250 s.

.....

..... [2]

(b) Fig. 1.2 shows the cyclist riding along a long straight road.

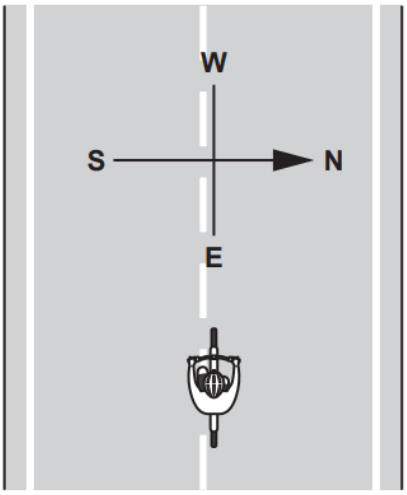


Fig. 1.2

The speed of the cyclist is 15 m/s. Determine the velocity of the cyclist.

velocity = ... m/s

direction .....

[1]

[Total: 7]

6 Fig. 1.1 shows the speed–time graph for a cyclist beginning a race. The motion of the cyclist changes at points A, B and C.

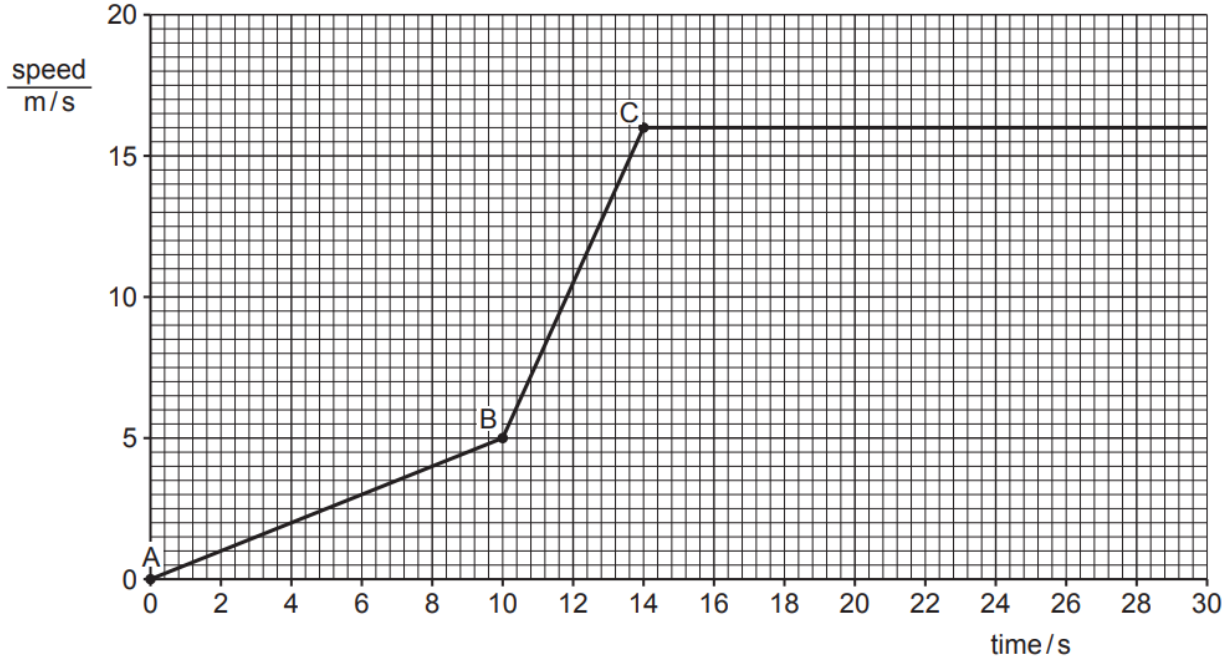


Fig. 1.1

(a) Using information from Fig. 1.1, determine:

(i) the speed of the cyclist at time = 6.0 s

speed = ... m/s [2]

(ii) the maximum speed of the cyclist.

maximum speed = ... m/s [1]

(b) **(i)** Describe the motion of the cyclist between point A and point B.

..... [1]

(ii) Describe how the motion of the cyclist between points B and C differs from the motion between points A and B.

Give a reason for your answer.

difference .....

reason .....
[2]

(c) Determine the distance travelled by the cyclist between point A and point B.

distance = ... m [3]
[Total: 9]

7 A cyclist is travelling along a straight road. Fig. 1.1 shows the speed–time graph for the cyclist. The graph is divided into four sections labelled P, Q, R and S.

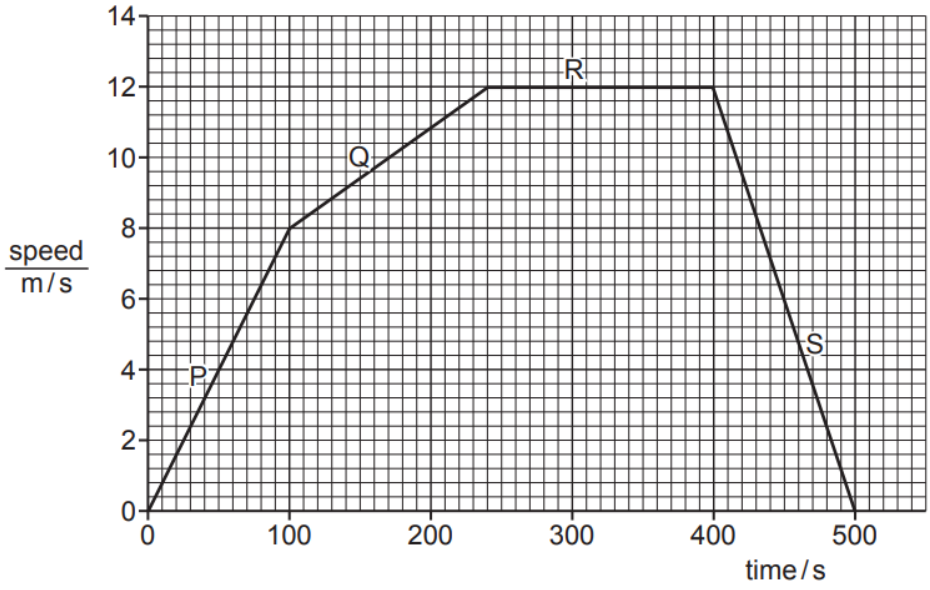


Fig. 1.1

(a) Calculate the distance travelled by the cyclist in section P from time = 0 to time = 100 s.

distance travelled = ... m [3]

(b) Describe the motion of the cyclist in each of sections Q, R and S shown in Fig. 1.1.

Q .....

R .....

S .....

[3]

(c) The cyclist is moving north along the road.

Determine the velocity of the cyclist at time = 300 s. Include the unit.

velocity of cyclist = ... [2]

[Total: 8]

8 Fig. 2.1 shows the speed–time graph for a cyclist.

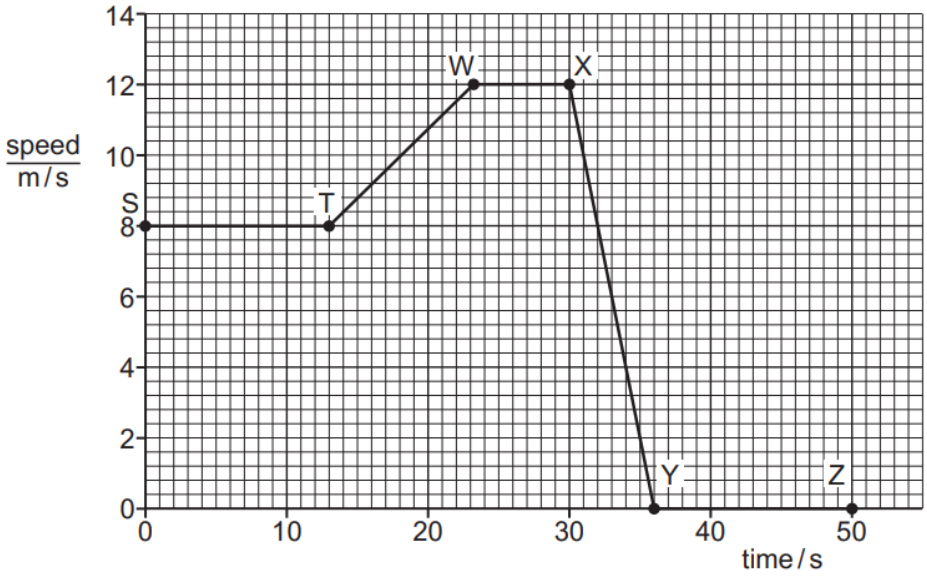


Fig. 2.1

(a) In Fig. 2.1, the sections ST, TW, WX, XY and YZ indicate stages of the cyclist's journey.

State **one** section which shows the cyclist **moving** with:

(i) constant speed

..... [1]

(ii) constant deceleration

..... [1]

(iii) constant non-zero acceleration.

..... [1]

(b) Calculate the distance travelled by the cyclist in section ST.

distance travelled = ... m [3]

9 A student uses a digital stop-watch to measure the time for the car to travel 100 m.

Fig. 2.2 shows the time reading on the stop-watch.

Fig. 2.2

(i) Using the information in Fig. 2.2, state the time taken to travel 100 m.

time to travel 100 m = ... s [1]

(ii) The car takes 12.8 s to travel the next 200 m.

Calculate the average speed of the car for this 200 m.

average speed = ... m/s [3]

(c) Fig. 2.3 shows the speed–time graph for another car.

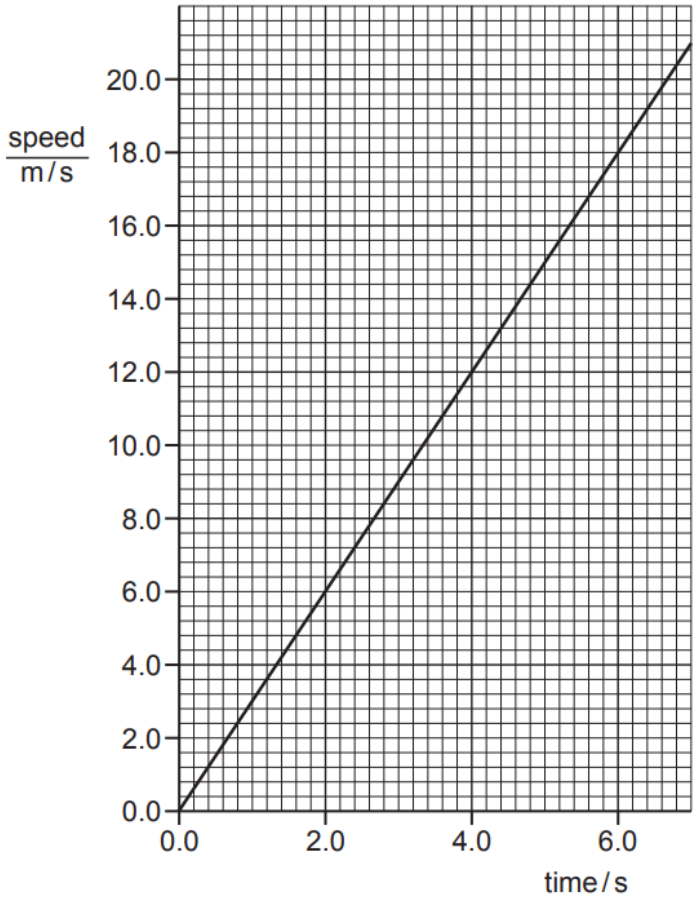


Fig. 2.3

Calculate the distance travelled by this car between time = 2.0 s and time = 6.0 s.

distance travelled = ... m [3]

[Total: 10]

10 A skydiver jumps from an aeroplane. She falls freely with her parachute closed; then she opens her parachute.

Fig. 1.1 shows the skydiver falling freely with her parachute closed.

Fig. 1.2 shows the skydiver falling with the parachute open.

Fig. 1.1

Fig. 1.2

Fig. 1.3 shows the speed–time graph for the skydiver's vertical motion, from leaving the aeroplane to landing on the ground.

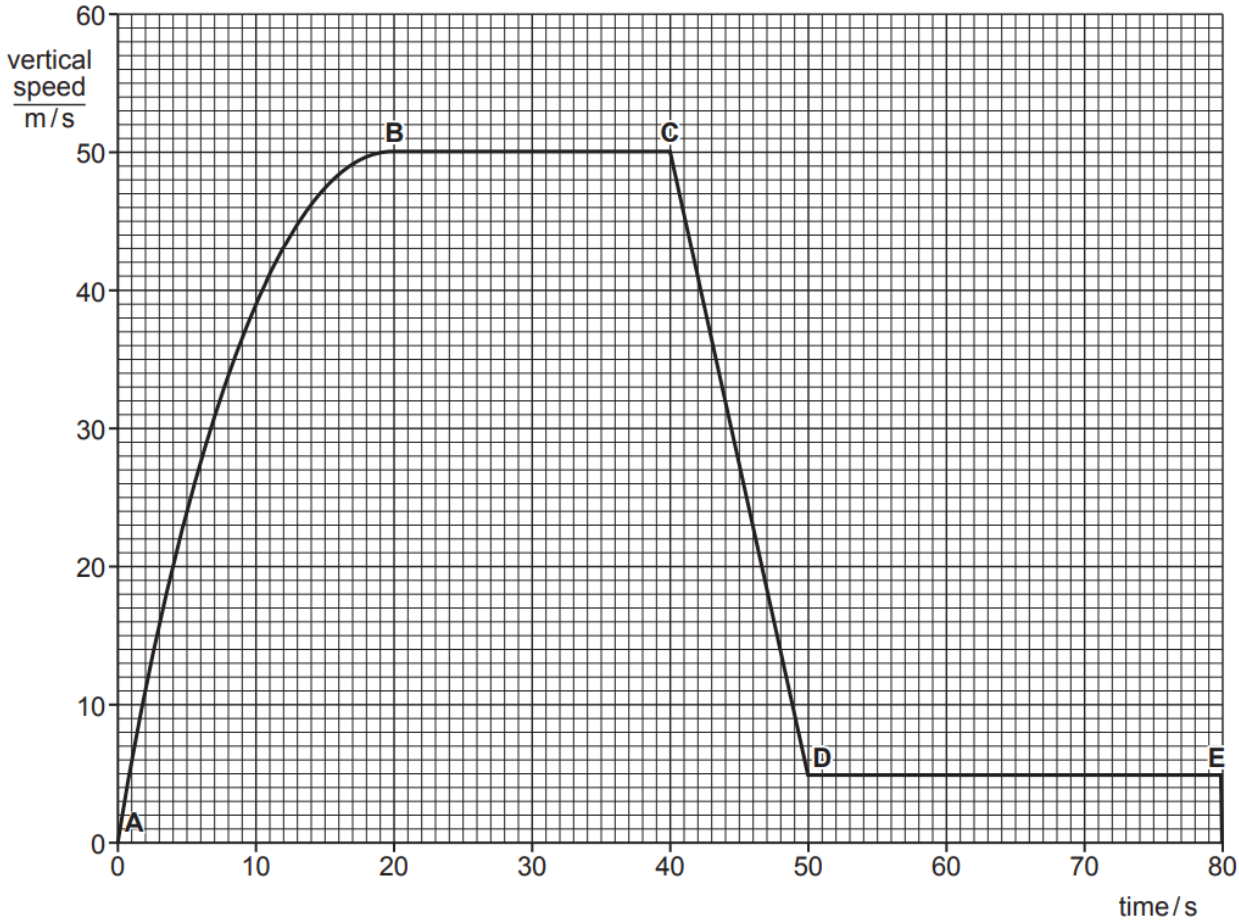


Fig. 1.3

(a) Using the information from Fig. 1.3:

(i) Describe the vertical motion of the skydiver between time = 0 and time = 20 s.

..... [1]

(ii) Determine the maximum vertical speed of the skydiver.

maximum speed = ... m/s [1]

(iii) Determine the point, A, B, C, D or E, at which the skydiver opens her parachute.

..... [1]

(iv) Determine the distance the skydiver falls between time = 50 s and time = 80 s.

distance = ... m [3]

11 Fig. 2.1 shows the speed–time graphs for two cars, A and B.

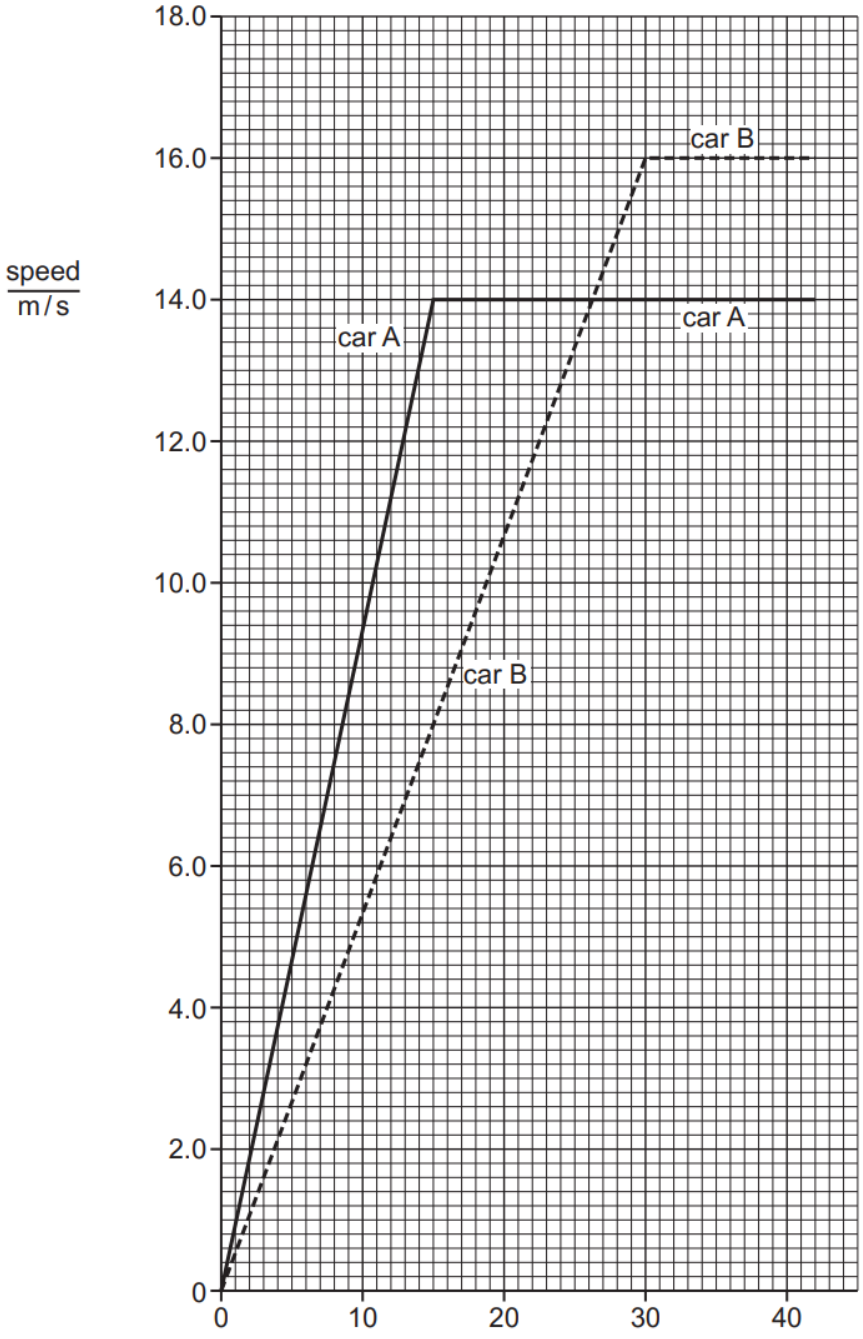


Fig. 2.1

(a) (i) Determine the speed of car A at time = 10 s.

speed = ... m/s [2]

(ii) State and explain which car, A or B, has the greater acceleration during the first 10 seconds. Use information from the graph in Fig. 2.1 in your explanation.

.....

..... [2]

(b) (i) Describe the motion of car B after 30 s.

.....

..... [2]

(ii) Calculate the distance moved by car B from time = 0 to time = 30.0 s.

distance = ... m [3]

[Total: 9]

12 A student investigates the motion of a trolley as it travels down a slope.

(a) The student makes **two** measurements to determine the average speed of the trolley as it travels down the slope.

State the **two** measurements.
For each measurement, suggest the instrument used for making the measurement.

1. measurement ..... instrument used .....

2. measurement ..... instrument used .....

[2]

(b) Fig. 1.1 shows the speed–time graph for a different trolley as it travels down a slope.

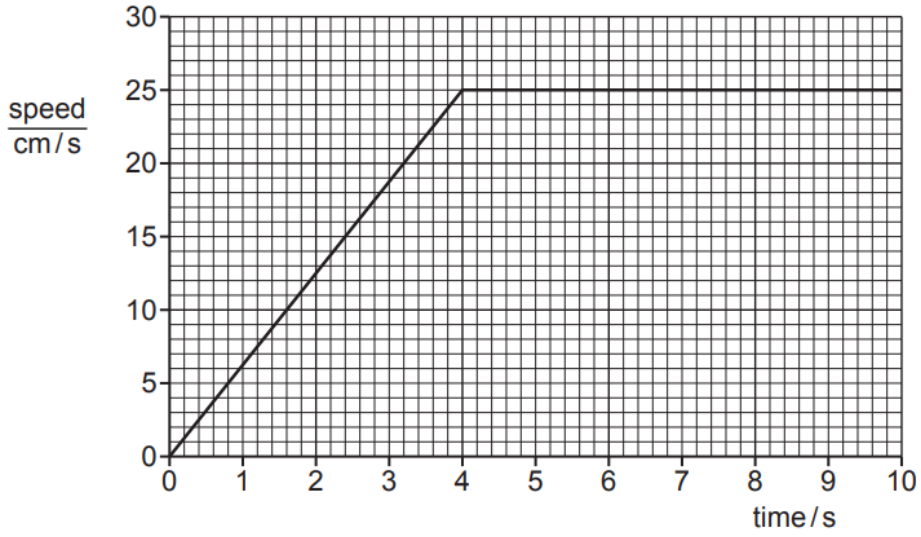


Fig. 1.1

(i) Determine the speed of the trolley at time = 2.0 s.

speed = ... cm / s [2]

(ii) Determine the distance moved by the trolley from time = 0 to time = 4.0 s.

distance = ... cm [3]

(iii) Using the information in Fig. 1.1, describe the motion of the trolley from time = 0 to time = 10 s.

.....

..... [2]

[Total: 9]

13 A slope is made by resting one end of a plank of wood on a block, as shown in Fig. 2.1.

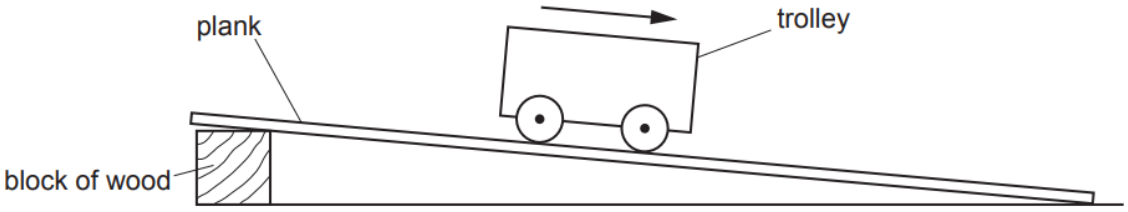


Fig. 2.1

Two students each use a digital stop-watch to measure the time for a small trolley to roll down the full length of the slope.

Fig. 2.2 shows the times on the stop-watches.

student 1

time = ... s

student 2

time = ... s

Fig. 2.2

(a) (i) On the line next to each stop-watch, write the time it shows. [1]

(ii) Calculate the average time for the trolley to roll down the slope.

average time = ... s [2]

(iii) The students want the same trolley to take more time to roll down the plank.

Suggest how the students alter the arrangement in Fig. 2.1.

..... [1]

(b) A different trolley travels 1.2 m down the slope in a time of 7.8 s.

Calculate the average speed of the trolley.

average speed = ... m/s [3]

(c) The trolley travels down a different slope. Fig. 2.3 shows the speed–time graph.

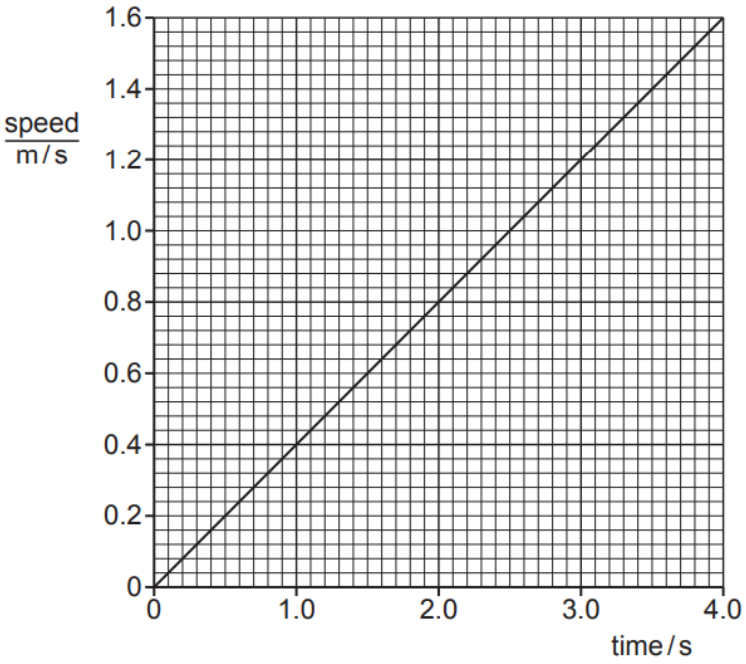


Fig. 2.3

Calculate the distance travelled by the trolley between time = 0 and time = 4.0 s.

distance travelled = ... m [3]

[Total: 10]

14 A cyclist travels to a friend's house.

Fig. 1.1 shows the distance–time graph of the journey.

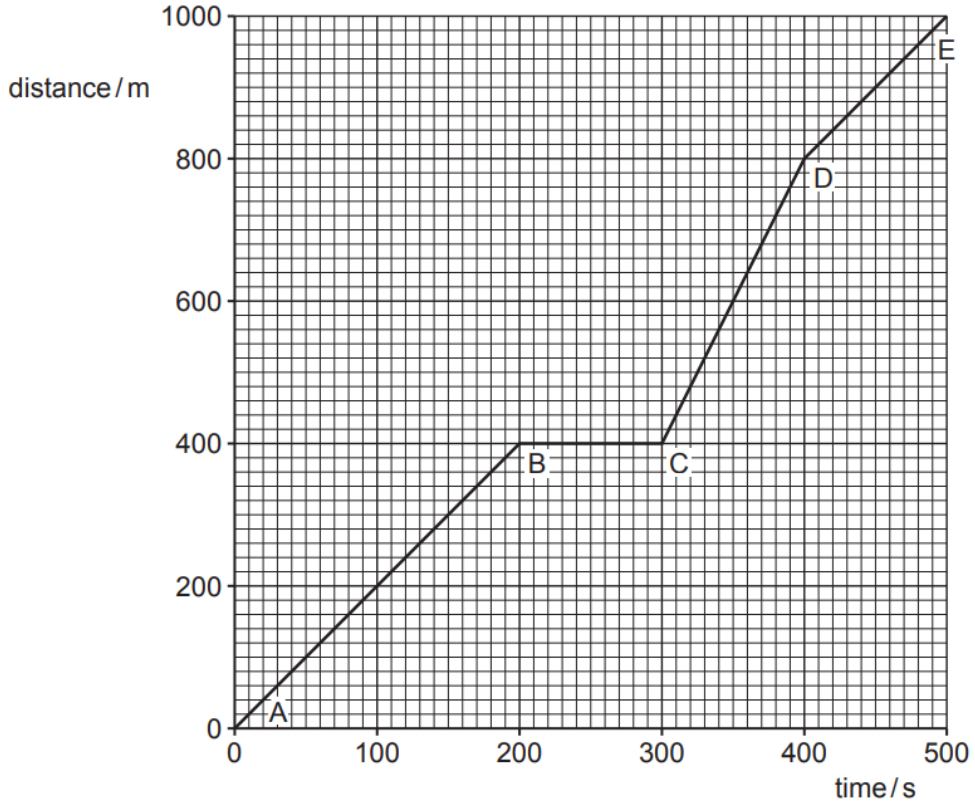


Fig. 1.1

(a) Determine the distance travelled by the cyclist between points C and E.

distance travelled = ... m [2]

(b) Describe the motion, if any, of the cyclist between points B and C. ..... [1]

(c) State the section, AB, BC, CD or DE, of the graph in which the speed of the cyclist is the fastest. Give a reason for your answer.

section of graph .....

reason ..... [2]

(d) Calculate the average speed of the cyclist between points A and E. Include the unit in your answer.

average speed = ... unit ..... [4]

[Total: 9]

15 Fig. 1.1 shows a speed–time graph for a car.

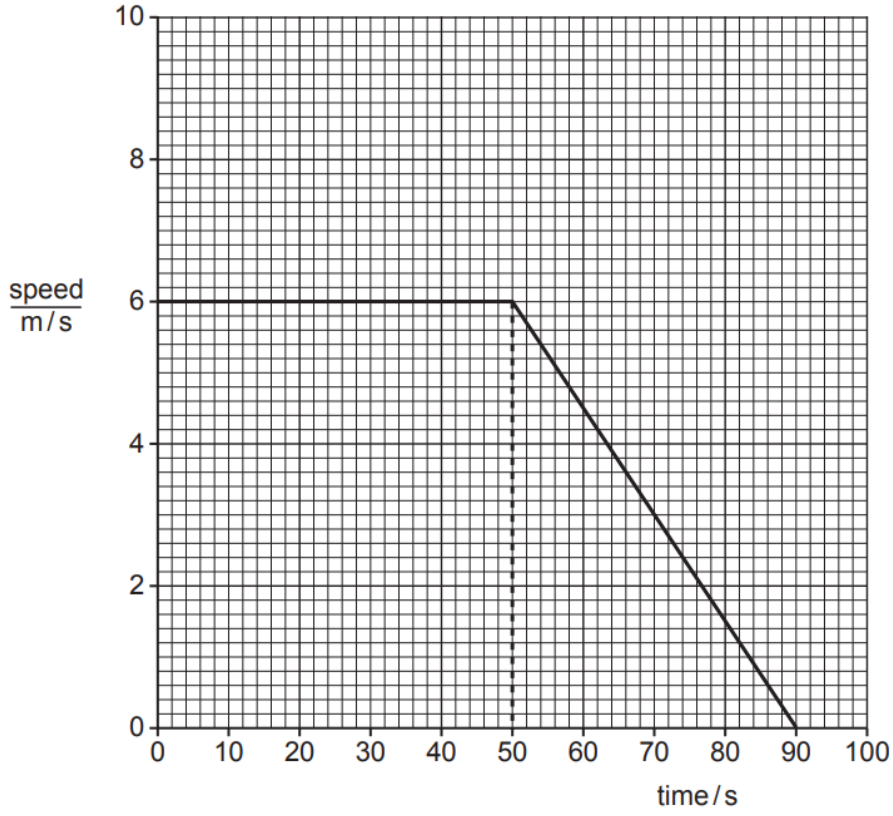


Fig. 1.1

(a) (i) Describe the motion of the car from 0 to 50 s, as shown in Fig. 1.1.

..... [1]

(ii) Describe the motion of the car from 50 s to 90 s, as shown in Fig. 1.1.

.....

..... [1]

(iii) Calculate the distance travelled by the car between 50 s and 90 s.

distance travelled = ... m [3]

(b) A motorcycle travels at a constant speed.

(i) The motorcycle travels 710 m in 87 s.

Calculate the speed of the motorcycle and show that it is close to 8 m / s.

[3]

(ii) The motorcycle in part **(b)(i)** travels at a constant speed for 87 s.

On Fig. 1.1, draw the speed–time graph for the motorcycle. [2]

[Total: 10]

16 Fig. 2.1 shows how the speed of a car varies between 0 and 60.0 s.

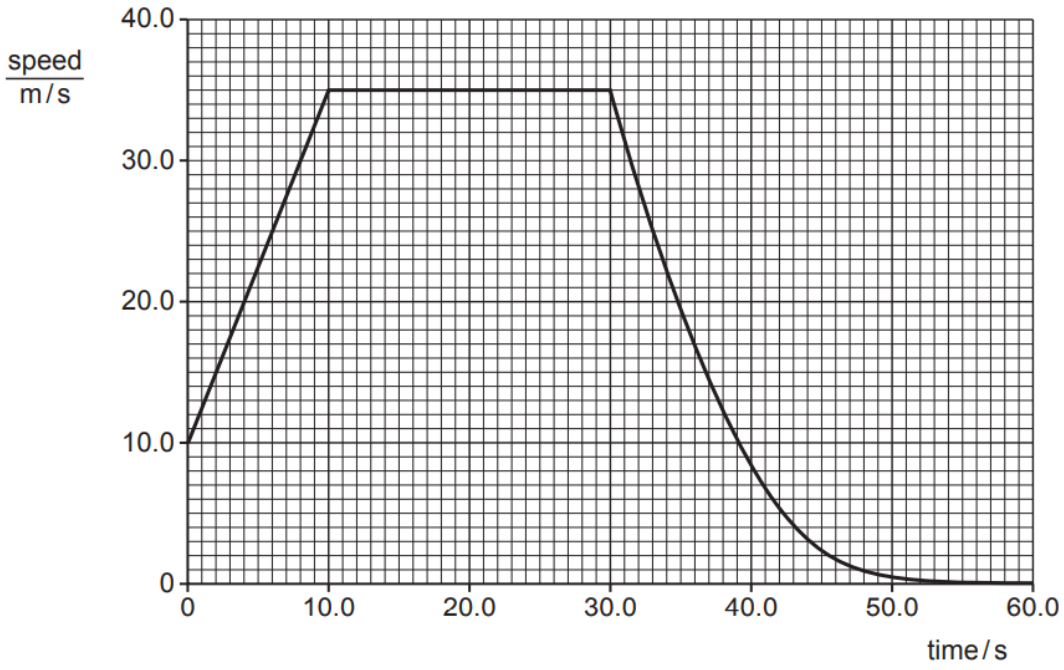


Fig. 2.1

(a) Determine the speed of the car using information from Fig. 2.1:

(i) when the time is 5.0 s

speed = ... m/s [2]

(ii) when the car is moving with a constant speed.

speed = ... m/s [1]

(b) Describe how the speed of the car changes between 30.0 s and 60.0 s.

..... [2]

(c) Determine the distance travelled by the car between 10.0 s and 30.0 s.

distance travelled = ... m [3]

(d) The total distance travelled by the car in the last 30.0 s is 226 m.

Calculate the average speed of the car in the last 30.0 s.

average speed = ... m/s [3]

[Total: 11]

17 Student P and student Q run in a 100 m race.
Fig. 1.1 shows the distance–time graph for each student during the race.

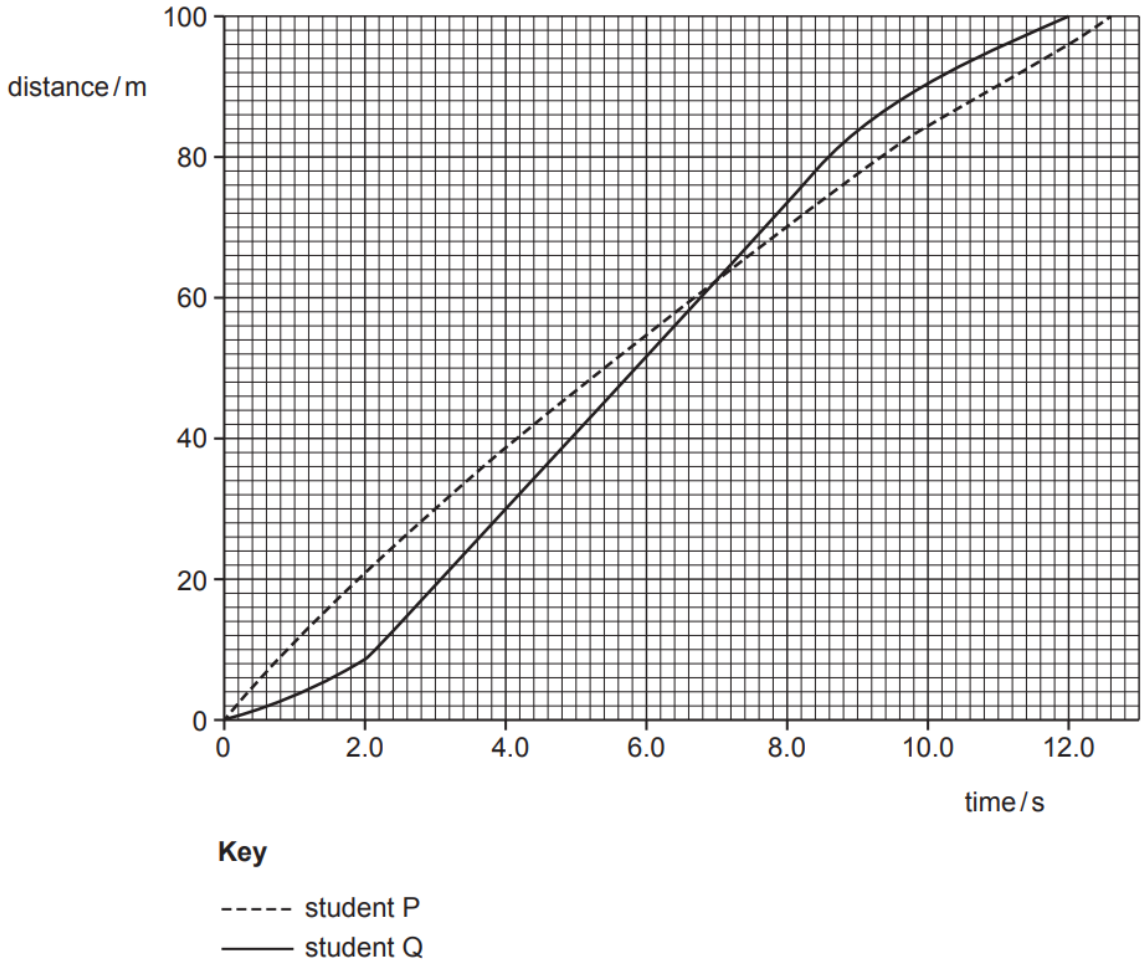


Fig. 1.1

(a) Determine the time taken for student Q to run 100 m.

time = ... s [1]

(b) Determine the distance between the two students as Q reaches 100 m.

distance = ... m [1]

(c) Calculate the average speed of student Q during the 100 m race.

average speed = ... m/s [3]

(d) State which student has the faster speed between 3.0 s and 6.0 s.

Explain how Fig. 1.1 allows you to compare speeds without calculation.

.....

.....

..... [1]

[Total: 6]

18 **(a)** During part of a race, a skier travels a distance of 200 m in a time of 6.4 s.

Calculate the average speed of the skier.

average speed = ... m/s [3]

(b) Fig. 4.1 shows a speed–time graph for the skier in another part of the race.

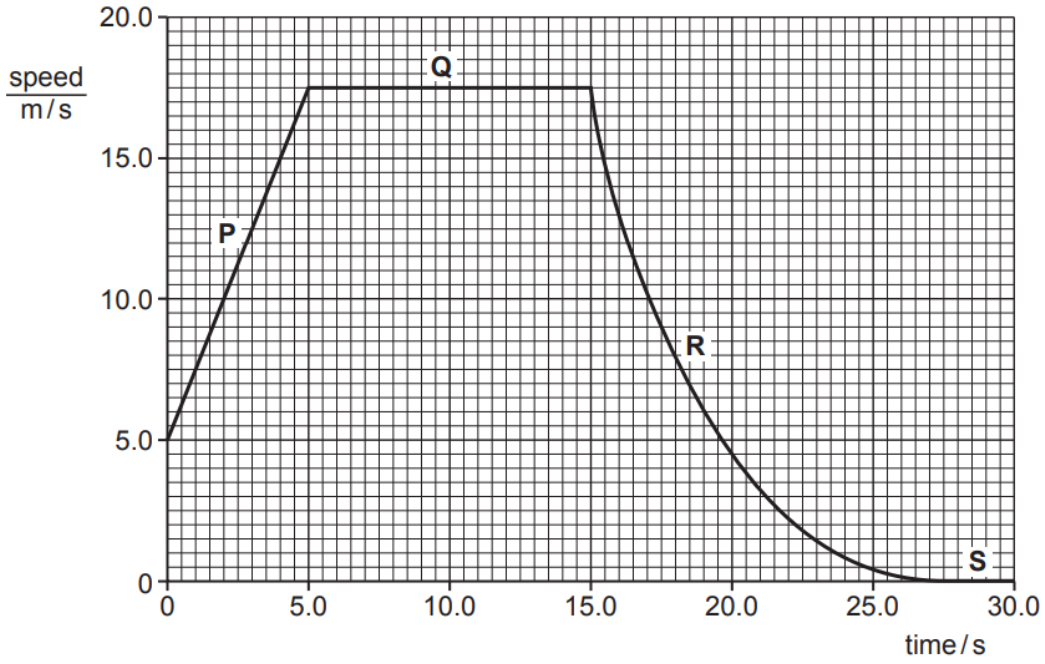


Fig. 4.1

Describe the motion of the skier at each point **P**, **Q**, **R** and **S** on the graph.

P .....

Q .....

R .....

S .....

[4]

(c) Skis are strapped to a skier's feet and are longer and wider than the skier's feet.

Explain how the skis prevent the skier from sinking into soft snow.

.....

.....

..... [2]

[Total: 9]

19 **(a)** Some students determine the speed of a car on a road. The students measure the time for the car to travel 30 m along the road. The time is 5.4 s.

Calculate the average speed of the car.

average speed = ... m/s [3]

(b) Another car moves at a constant speed of 16 m/s for 4.0 seconds. During the next 2.0 seconds, the car decelerates from a speed of 16 m/s to a speed of 13 m/s. It then continues at a constant speed of 13 m/s for 3.0 seconds.

On Fig. 2.1, plot the speed–time graph for the motion of the car during these 9.0 s.

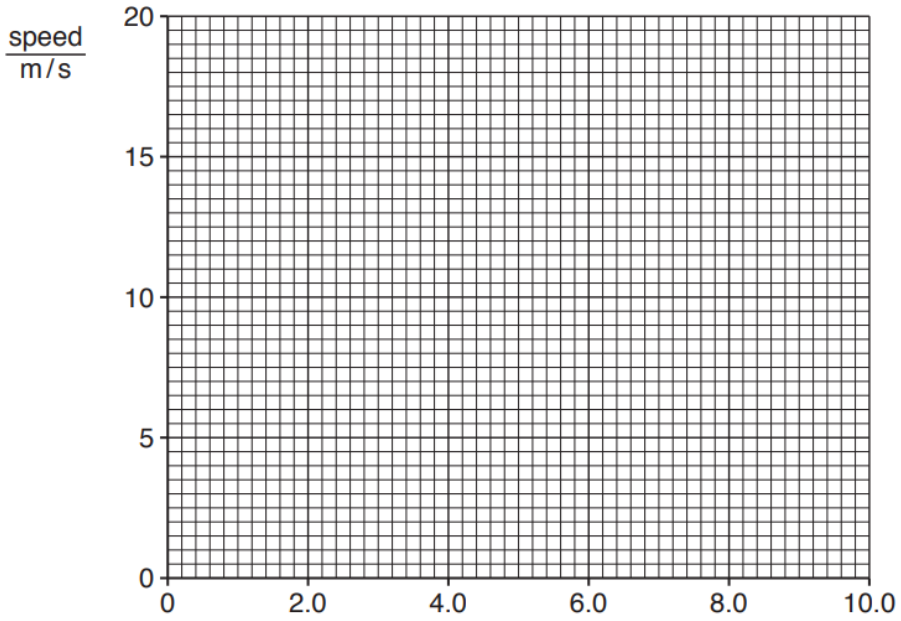


Fig. 2.1

[3]

(c) A motorcycle accelerates as shown in Fig. 2.2. Calculate the distance the motorcycle travels while it is accelerating. Use information from Fig. 2.2.

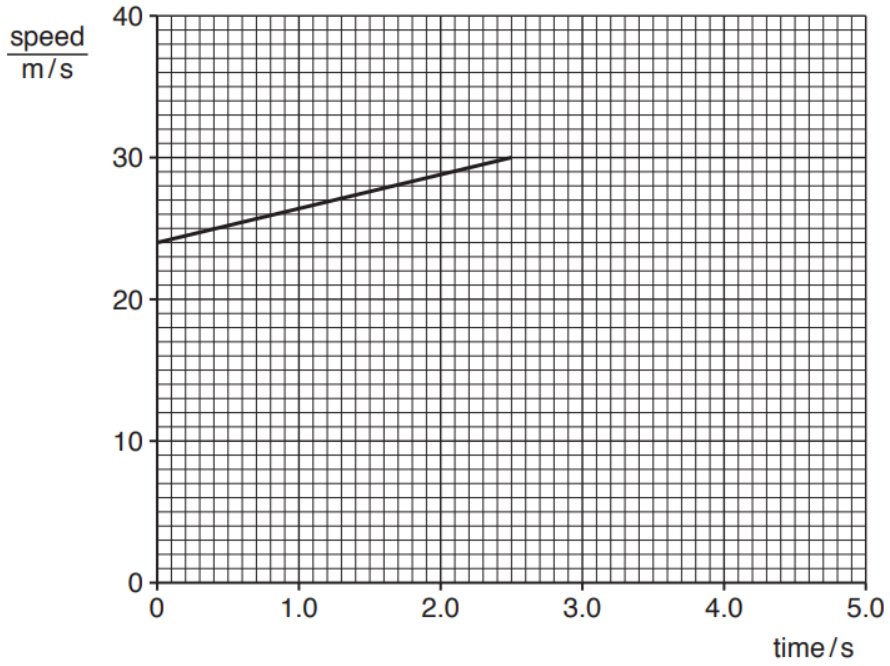


Fig. 2.2

distance travelled = ... m [3]

[Total: 9]

20 Fig. 1.1 shows a water tank that is leaking. Drops of water fall from the tank at a constant rate.

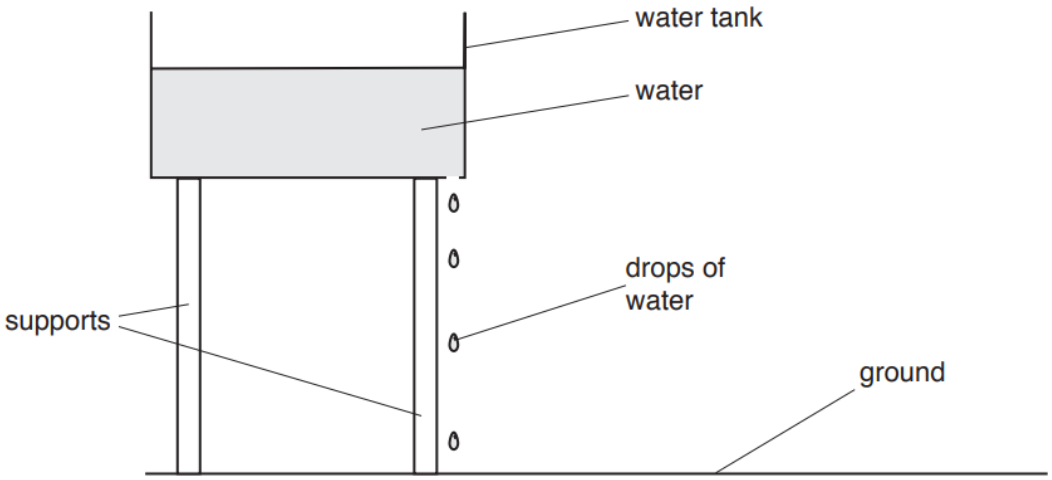


Fig. 1.1 (NOT to scale)

(a) A student uses a stopwatch to determine the time between two drops hitting the ground.

He sets the stopwatch to zero. He starts the stopwatch when the first drop hits the ground.

He stops the stopwatch after a further 30 drops have hit the ground.

The reading on the stopwatch is recorded and shown in Fig. 1.2.

Fig. 1.2

(i) State the time taken for 30 drops to hit the ground.

time = ... s [1]

(ii) Calculate the average time between two drops hitting the ground.

time = ... s [2]

(iii) Explain why the student measures the time for 30 drops to hit the ground instead of measuring the time for one drop to hit the ground.

.....

..... [1]

(b) Fig. 1.1 shows that the drops get further apart as they get close to the ground.

State why the drops get further apart.

.....

..... [1]

(c) In another experiment the student determines the speed of a falling weight at different times. The speed–time graph for his results is shown in Fig. 1.3.

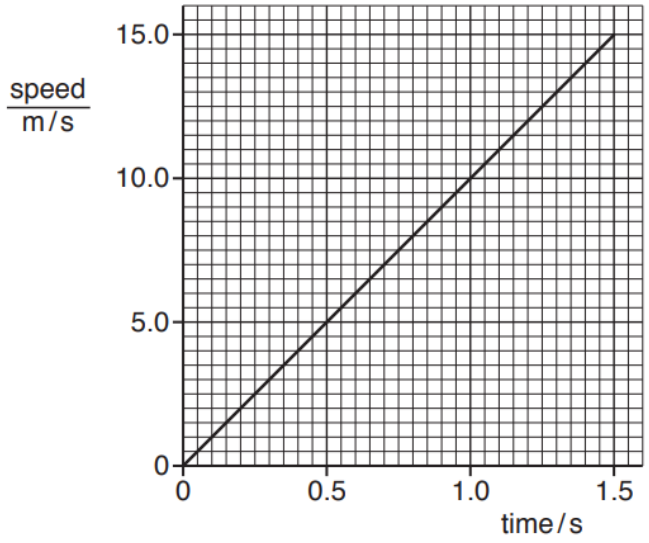


Fig. 1.3

Calculate the distance fallen by the weight in the first 1.5 s.

distance = ... m [3]

[Total: 8]

21 Fig. 1.1 shows a speed-time graph for a student who is running.

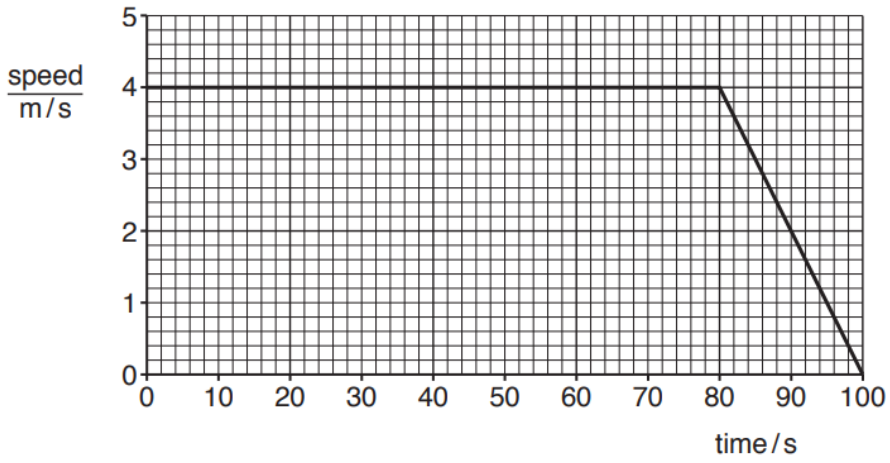


Fig. 1.1

(a) **(i)** Describe the movement of the student, as shown in Fig. 1.1.

.....

.....

.....[2]

(ii) Calculate the distance travelled by the student between 80 s and 100 s.

distance travelled = ...m [3]

(b) An athlete runs 630 m in 130 s on a flat section of a road and then 254 m in 40 s on a downhill slope.

Calculate the average speed for the total distance run by the athlete.

average speed = ... m/s [3]

[Total: 8]

22 A person on roller skates makes a journey. Fig. 1.1 shows the speed-time graph for the journey.

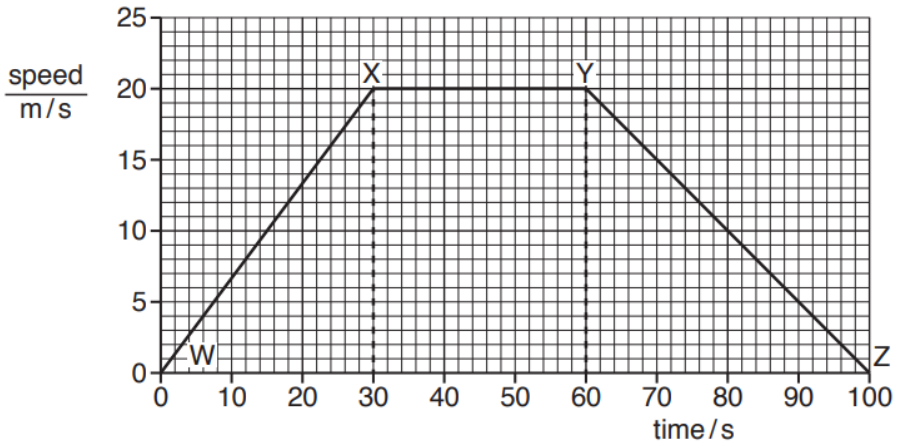


Fig. 1.1

(a) The graph shows three types of motion.

Complete the table to show when each type of motion occurs. Use the letters shown on Fig. 1.1. Add a letter to each of the blank spaces.
The first row is done for you.

motion	start of motion	end of motion
acceleration	W	X
deceleration		
constant speed		

[2]

(b) Calculate the distance travelled between 60 s and 100 s.

distance = ... m [3]

(c) The size of the acceleration is greater than the deceleration.

Describe how Fig. 1.1 shows this.

.....

..... [1]

[Total: 6]

23 Model trains move along a track passing through two model stations. Students analyse the motion of a train. They start a digital timer as the train starts to move. They record the time that it enters Station A and the time it enters Station B.

Fig. 1.1 shows the time on entering Station A and the time on entering Station B.

time entering Station A

time entering Station B

Fig. 1.1

(a) Calculate the time taken from the train entering Station A to the train entering Station B. State your answer in seconds.

time taken = ... s [1]

(b) A faster train takes 54 s to travel from Station A to Station B. The distance between the stations is 120 m.

Calculate the average speed of this train.

average speed = ... m/s [3]

(c) Fig. 1.2 shows the speed-time graph for a train travelling on a different part of the track.

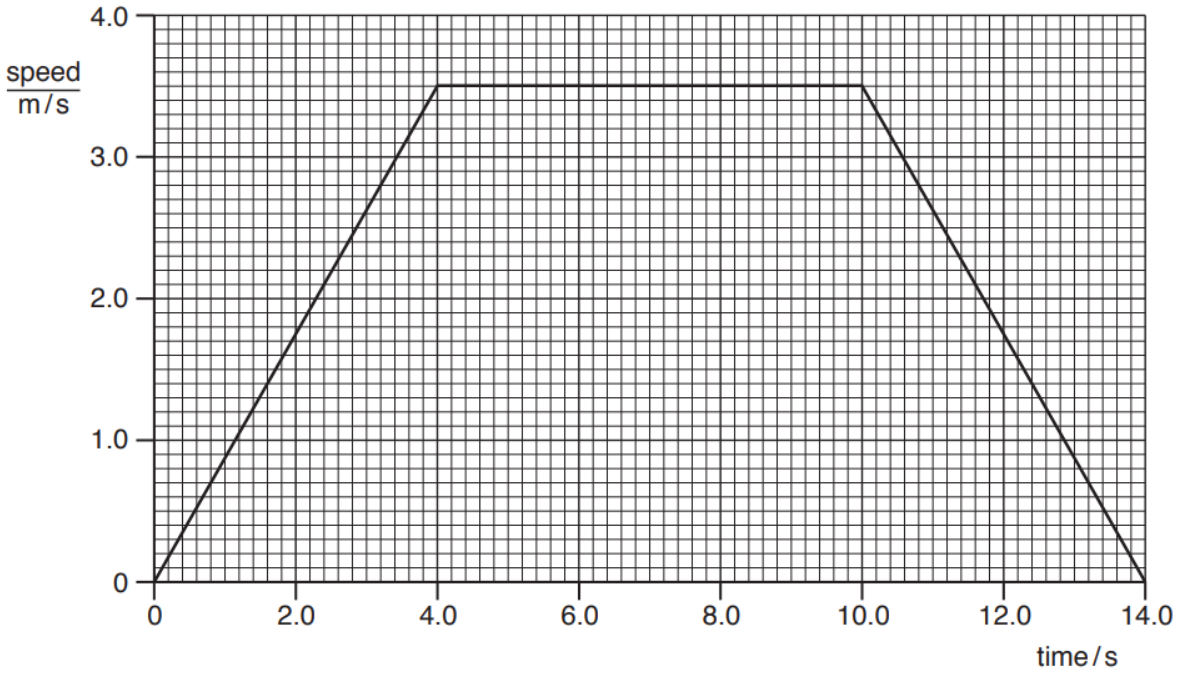


Fig. 1.2

Determine the total distance travelled by the train on this part of the track.

distance = ... m [4]

[Total: 8]

24 Fig. 1.1 shows the speed-time graph for a car.

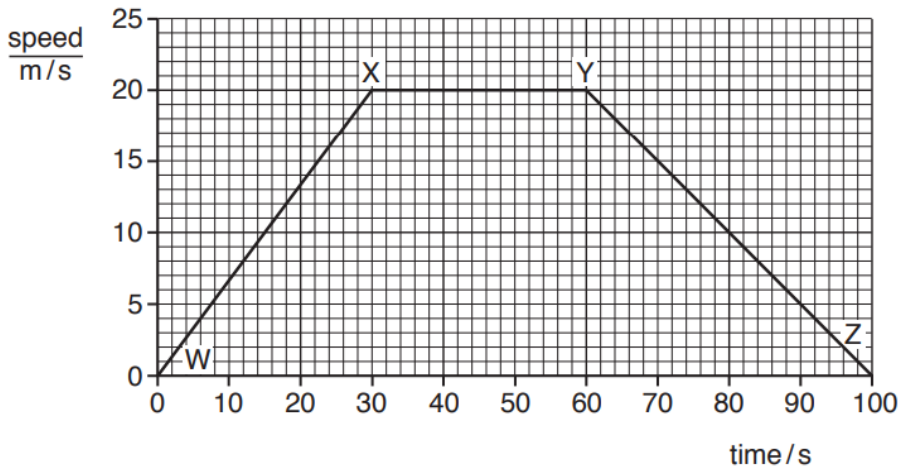


Fig. 1.1

(a) On Fig. 1.1, the labels W, X, Y and Z show the points when the car's motion changed.

On Fig. 1.2, draw a line from each section of the graph to the correct description of the motion.

section of graph	description of the motion
from W to X	accelerating
from X to Y	decelerating
from Y to Z	stationary
	constant speed

Fig. 1.2 [3]

(b) Calculate the distance that the car travels between 60 s and 100 s.

distance travelled = ... m [3]

(c) Fig. 1.1 shows that the car's acceleration is greater than its deceleration.

Explain how the graph shows this.

.....

.....[1]

[Total: 7]

25 A student moves a model car along a bench.

Fig. 1.1 is the speed-time graph for the motion of the model car.

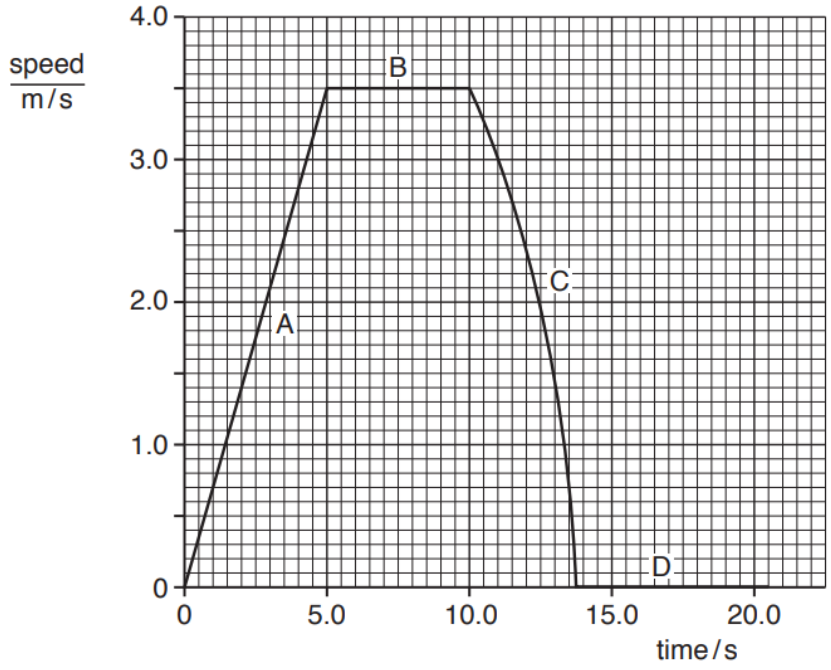


Fig. 1.1

(a) Describe the motion of the car in each of the sections A, B, C and D.

A .....

B .....

C .....

D .....

[4]

(b) Determine the distance moved by the model car in the first five seconds.

distance = ... m [3]

[Total: 7]

Paper 4

Questions are applicable for both core and extended candidates unless indicated in the question

26 A drag car is a racing car that is powered by a rocket engine.

A drag car accelerates uniformly from rest until it reaches the finishing line. The engine is then switched off and a parachute opens. The car decelerates until it stops.

Fig. 2.1 shows a drag car decelerating after a race.

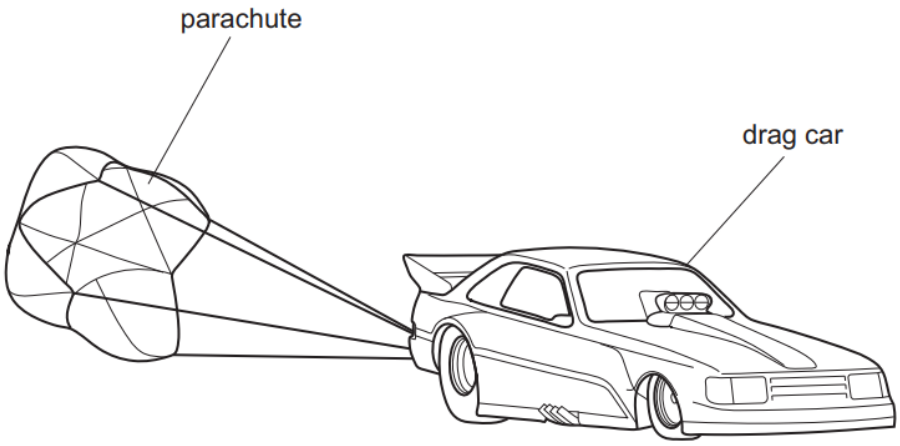


Fig. 2.1

This drag car has a mass of 1400 kg.

Fig. 2.2 is the speed–time graph for the car during a race on a straight horizontal track.

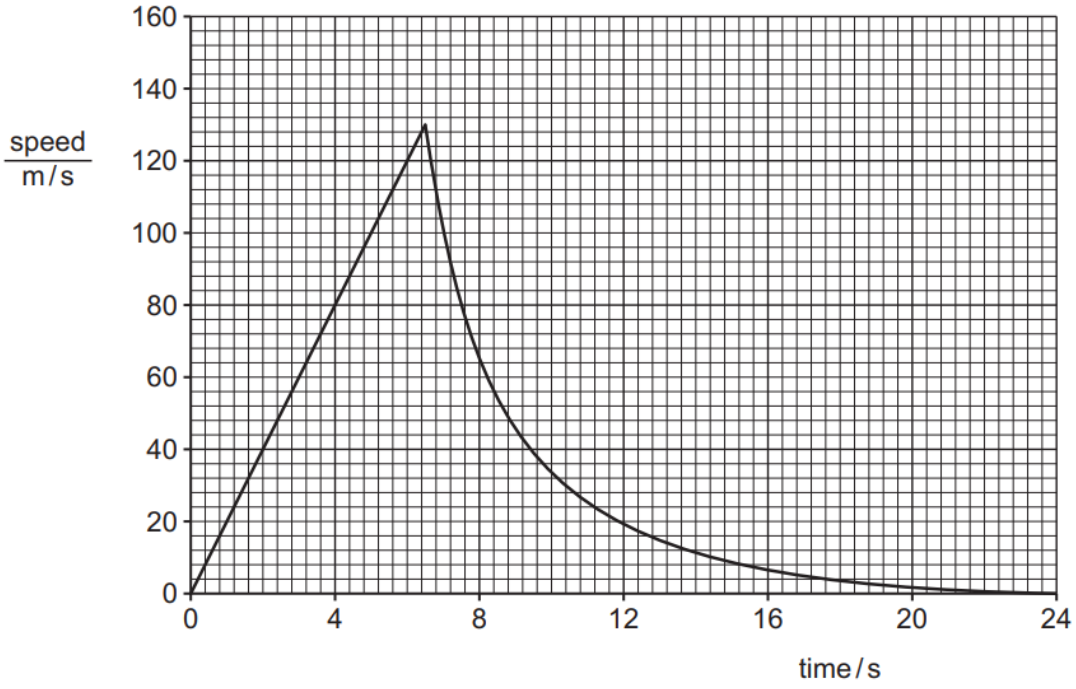


Fig. 2.2

The car reaches its maximum speed of 130 m/s at a time of 6.5 s.

(a) **(i)** Calculate the maximum momentum of the car during the race. **(extended only)**

maximum momentum = ... [2]

(ii) State the feature of Fig. 2.2 that represents the distance travelled by the car.

.....

..... [1]

(iii) Determine the distance travelled by the car in the first 6.5 s.

distance = ... [2]

(b) The parachute opens at 6.5 s and the car decelerates.

Describe how Fig. 2.2 shows that, after 6.5 s:

(i) the car decelerates

.....

..... [1]

(ii) the deceleration of the car is **not** constant.

.....

..... [1]

(c) Describe the energy transfer that takes place as the car slows down.

.....

..... [2]

[Total: 9]

27 A rocket has an initial mass of 7.4×10^6 kg.

(b) Fig. 1.1 shows part of the speed-time graph for the rocket as it leaves the ground and travels into space.

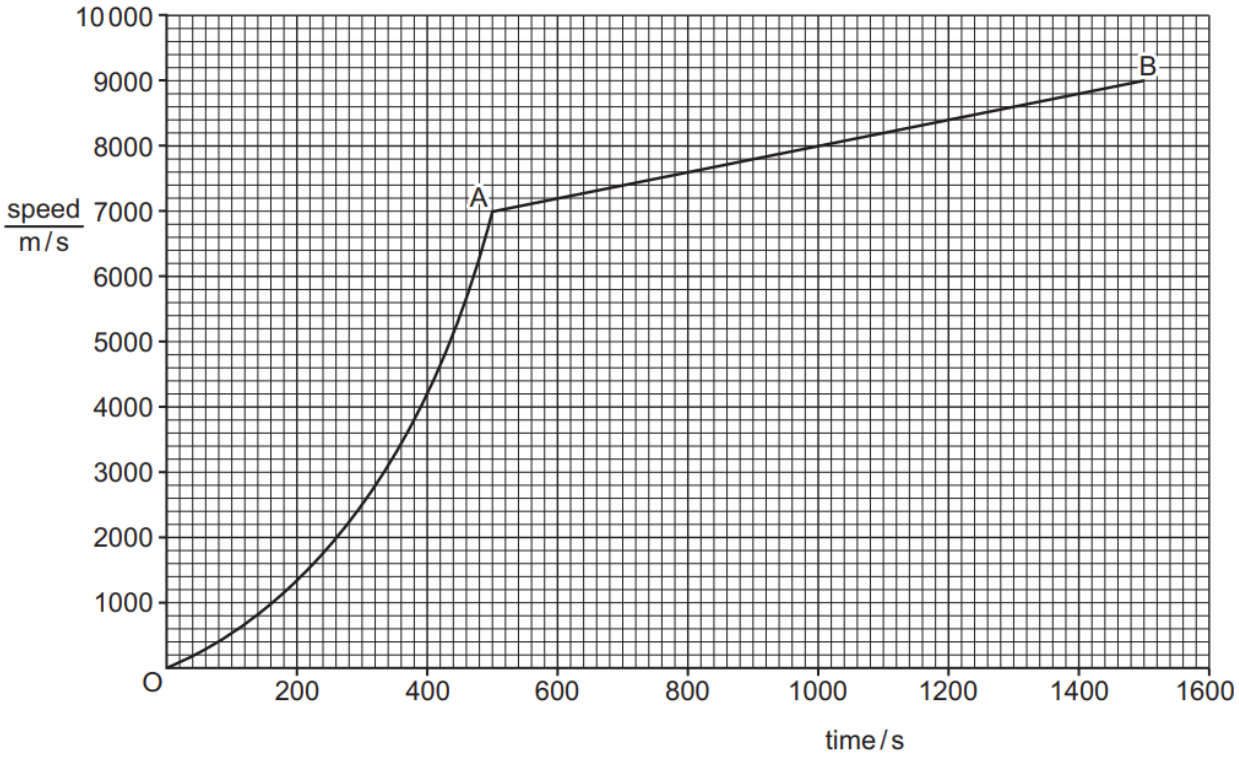


Fig. 1.1

(i) Describe the motion of the rocket:

From O to A .....

From A to B .....

[2]

(ii) Draw a tangent to the graph at time = 400 s and use this to calculate the acceleration of the rocket at this time. Show your working. **(extended only)**

acceleration = ... [2]

(c) Rockets are used to launch satellites into space. When the satellite is released, the rocket returns to the Earth. **(extended only)**

Explain in terms of forces why the rocket reaches terminal velocity as it travels through the atmosphere back to the Earth.

.....

.....

..... [2]

[Total: 8]

28 A long tube contains oil. A small ball is held at rest at the surface of the oil. At time $t = 0$, the ball is released and begins to fall vertically through the oil.

Fig. 1.1 shows the ball falling through the oil.

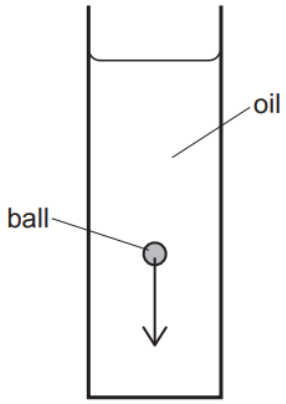


Fig. 1.1

As the ball begins to fall through the oil, it accelerates.

(a) Define acceleration. **(extended only)**

.....

..... [1]

(b) The mass of the ball is 0.0075 kg. **(extended only)**

Calculate the resultant force acting on the ball when it is accelerating downwards at $2.8\,m/s^2$.

resultant force = ... [2]

(c) As the ball falls, its speed v is recorded. Fig. 1.2 is the speed–time graph for the falling ball.

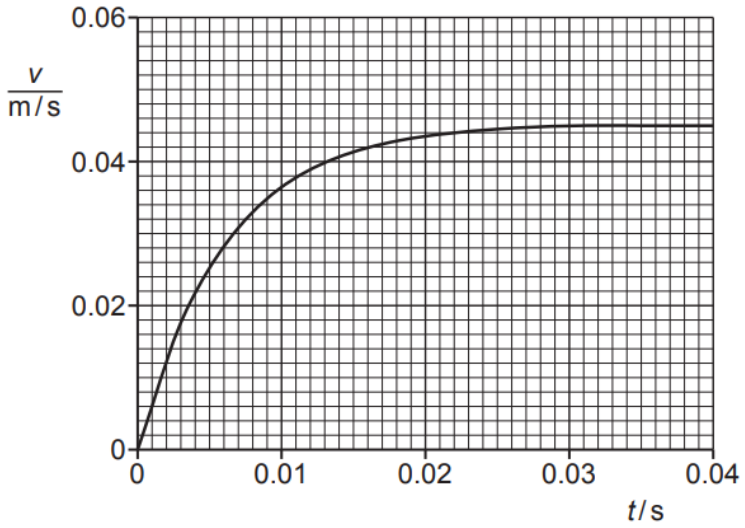


Fig. 1.2

(i) Describe what happens to the acceleration between $t = 0$ and $t = 0.040$ s.

Explain why this happens. **(extended only)**

.....

.....

.....

..... [4]

(ii) By drawing a tangent on Fig. 1.2, determine a value for the acceleration of the ball at $t = 0.010$ s. **(extended only)**

acceleration = ... [3]

[Total: 10]

29 **(a)** Define acceleration. **(extended only)**

.....

..... [1]

(b) A train has a total mass of 520 000 kg. The train accelerates at 1.1 m/s^2.

(i) Calculate the time taken for the train to increase its speed from 15 m/s to 28 m/s. **(extended only)**

time = ... [2]

(ii) Calculate the force required to produce an acceleration of 1.1 m/s^2 for this train. **(extended only)**

force = ... [2]

(iii) The train uses electric motors.

Explain why the force on the train due to the motors is greater than the value calculated in **(ii)**.

.....

..... [1]

[Total: 6]

30 Fig. 1.1 shows a straight section of a river where the water is flowing from right to left at a speed of 0.54 m/s.

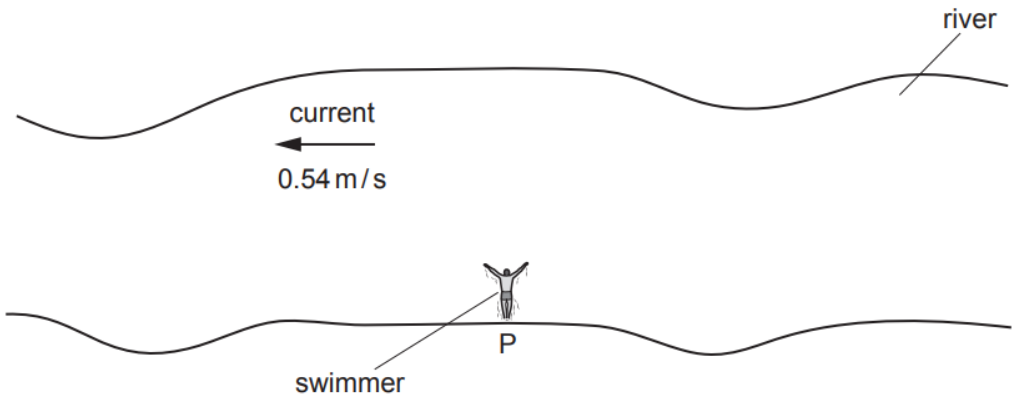


Fig. 1.1 (not to scale)

A swimmer starts at point P and swims at a constant speed of 0.72 m/s relative to the water and at right angles to the current.

(a) (i) Determine, relative to the river bank, both the magnitude and direction of the swimmer's velocity. **(extended only)**

magnitude of velocity = ...

direction of velocity .....

[4]

(ii) After 1.5 minutes, the swimmer reaches point Q. **(extended only)**

Calculate the distance between P and Q.

distance = ... [3]

(b) When the swimmer is crossing the river, his actions produce a constant forward force on his body.

Explain why he moves at a constant speed.

.....

.....

.....

..... [2]

[Total: 9]

31 A car of mass m is travelling along a straight, horizontal road at a constant speed v.

At time $t = 0$, the driver of the car sees an obstruction in the road ahead of the car and applies the brakes.

The car does **not** begin to decelerate at $t = 0$.

(a) Explain what is meant by deceleration. **(extended only)**

.....

.....

..... [2]

(b) Suggest **one** reason why the car does **not** begin to decelerate at $t = 0$.

.....

..... [1]

(c) Fig. 1.1 is the distance–time graph for the car from $t = 0$.

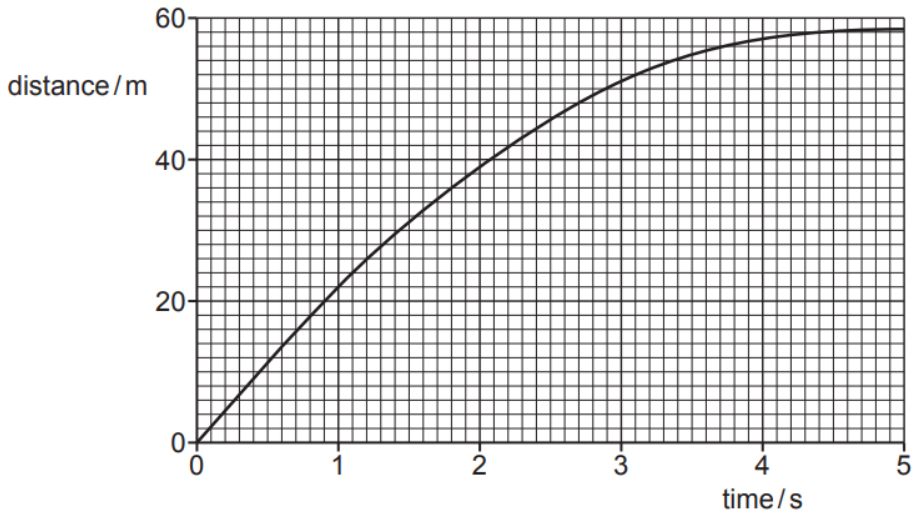


Fig. 1.1

(i) State the property of a distance–time graph that corresponds to speed.

..... [1]

(ii) Using Fig. 1.1, determine the initial speed v of the car.

$v =$ ..... [2]

(d) When the car is decelerating, there is a constant resistive force F on the car due to the brakes.

The deceleration of the car is greater than $\frac{F}{m}$ and is **not** constant.

Explain why:

(i) the deceleration of the car is greater than $\frac{F}{m}$ **(extended only)**

.....

..... [1]

(ii) the deceleration is **not** constant.

.....

.....

..... [2]

[Total: 9]

32 Fig. 1.1 shows a space rocket accelerating away from a launch pad.

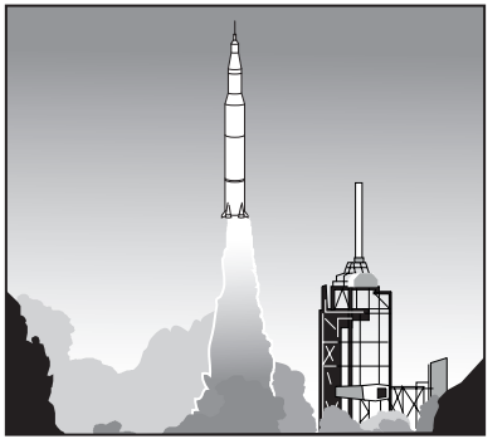


Fig. 1.1

Fig. 1.2 is a speed–time graph for the first 30 s of the rocket's flight.

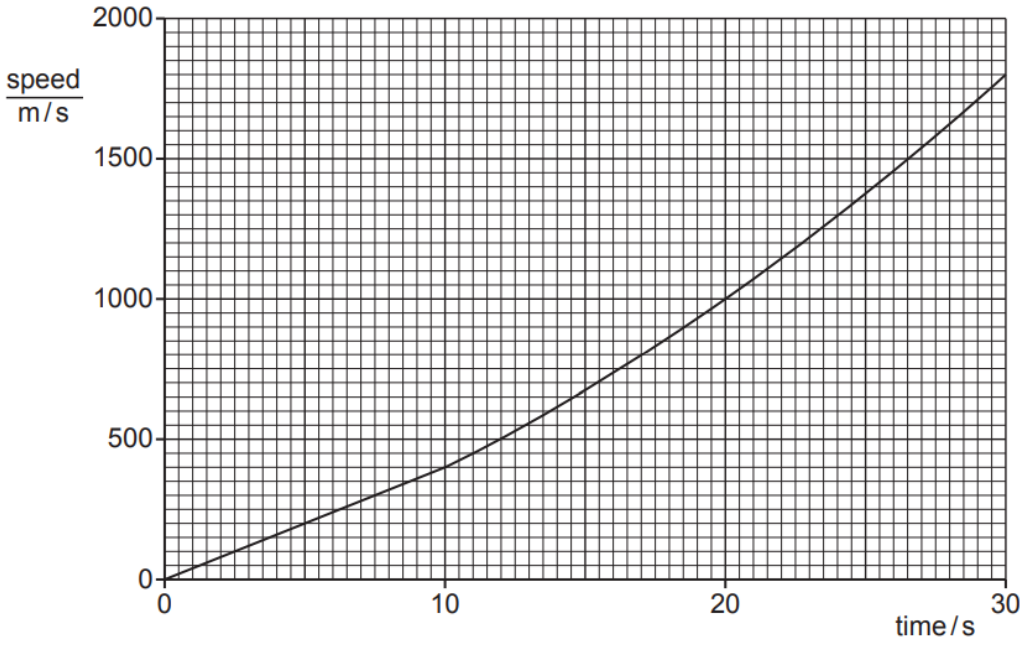


Fig. 1.2

(extended only)

(a) Describe how the acceleration of the rocket changes between time = 10 s and time = 30 s.

..... [1]

(b) By drawing a tangent to the graph, determine the acceleration of the rocket at time = 25 s.
(extended only)

acceleration = ... [2]

(c) Determine the distance travelled by the rocket between time = 0 and time = 10 s.

distance = ... [2]

[Total: 5]

33 A vertical tube contains a liquid. A metal ball is held at rest by a thread just below the surface of the liquid, as shown in Fig. 2.1.

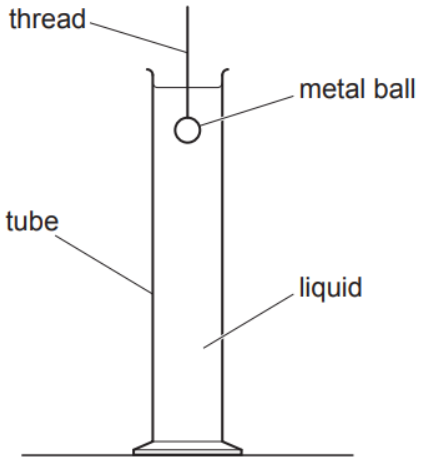


Fig. 2.1 (not to scale)

The diameter of the tube is much greater than the diameter of the ball. The ball is released and it accelerates downwards uniformly for a short period of time.

(a) Describe what happens to the velocity of the ball in the short period of time as it accelerates downwards uniformly. **(extended only)**

.....

..... [2]

(b) The ball reaches terminal velocity. **(extended only)**

Describe and explain the motion of the ball from when it is released until it reaches terminal velocity.

.....

.....

.....

..... [3]

34 A sky-diver jumps out of a hot-air balloon, which is 4000 m above the ground. At time = 30 s, she opens her parachute.

Fig. 1.1 is the speed-time graph of her fall.

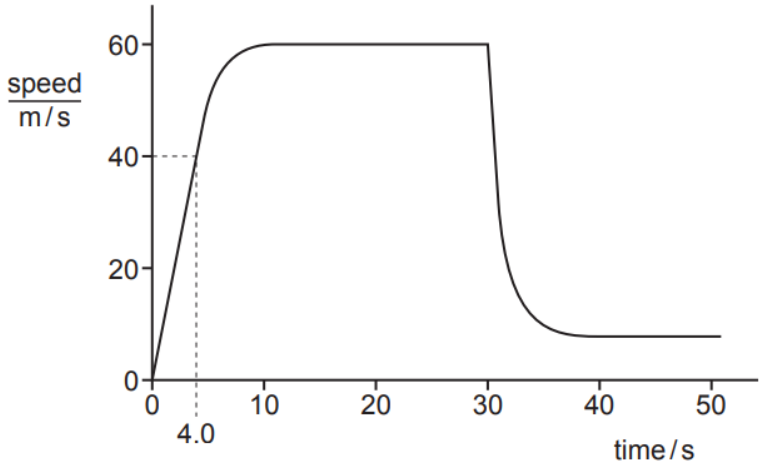


Fig. 1.1

(a) **(i)** Label with the letter X the point on the graph where the sky-diver opens her parachute. [1]

(ii) Label with the letters Y and Z the **two** parts of the graph where the sky-diver falls at terminal velocity. **(extended only)** [1]

(b) Describe, in terms of the forces acting on the sky-diver, her motion between leaving the balloon and opening her parachute. **(extended only)**

.....

.....

.....

.....

.....

..... [4]

(c) Calculate the average speed of the sky-diver in the first 4.0 s of her fall.

average speed = ... [2]

[Total: 8]

35 Fig. 1.1 shows the speed–time graph of a person on a journey.

On the journey, he walks and then waits for a bus. He then travels by bus. He gets off the bus and waits for two minutes. He then walks again. His journey takes 74 minutes.

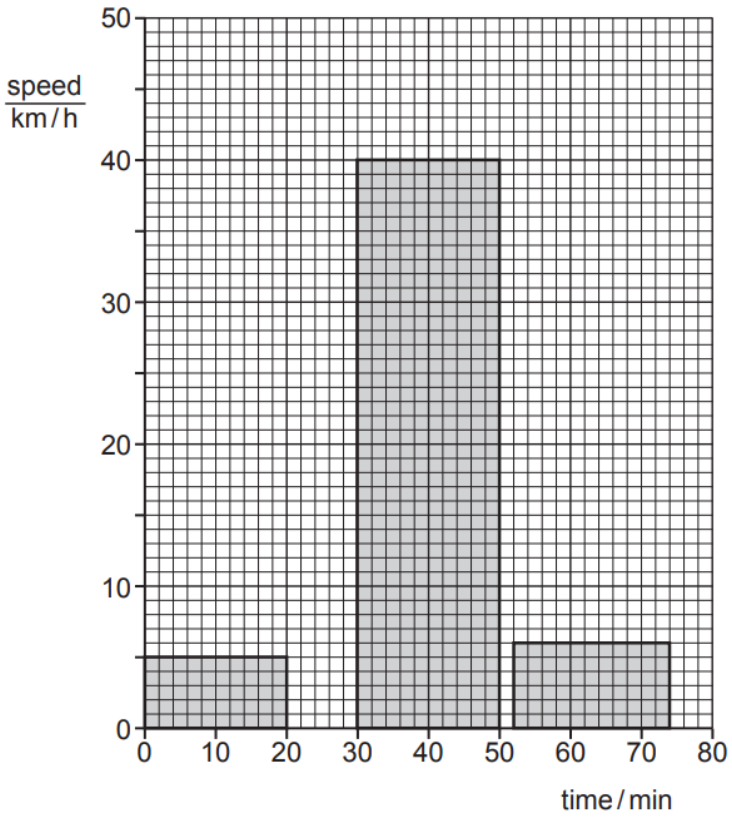


Fig. 1.1

(a) For the whole journey calculate:

(i) the distance travelled

distance = ... [3]

(ii) the average speed.

average speed = ... [2]

(b) State and explain which feature of a speed–time graph shows acceleration.

.....

..... [2]

(c) State and explain the acceleration of the person at time = 40 minutes.

.....

..... [2]

[Total: 9]

36 A rocket is stationary on the launchpad. At time $t = 0$, the rocket engines are switched on and exhaust gases are ejected from the nozzles of the engines. The rocket accelerates upwards.

Fig. 1.1 shows how the acceleration of the rocket varies between time $t = 0$ and time $t = t_f$.

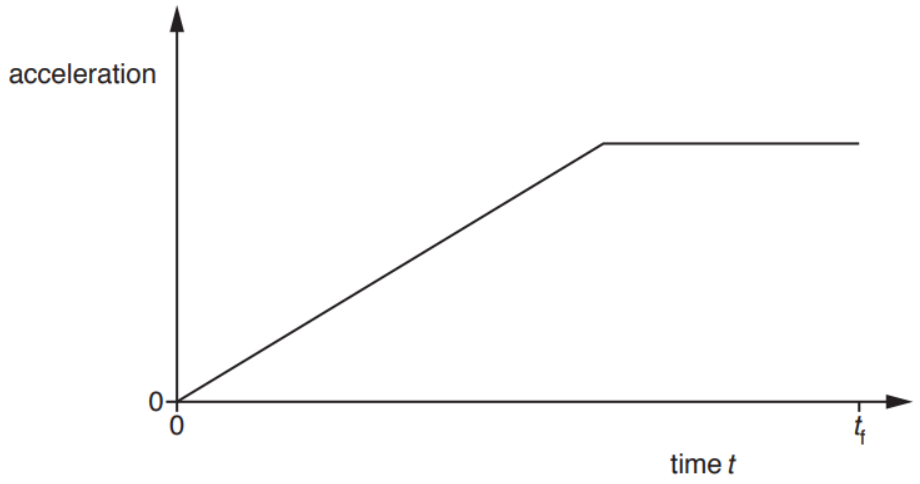


Fig. 1.1

(a) Define *acceleration*. **(extended only)**

.....

..... [1]

(b) On Fig. 1.2, sketch a graph to show how the speed of the rocket varies between time $t = 0$ and time $t = t_f$. **(extended only)**

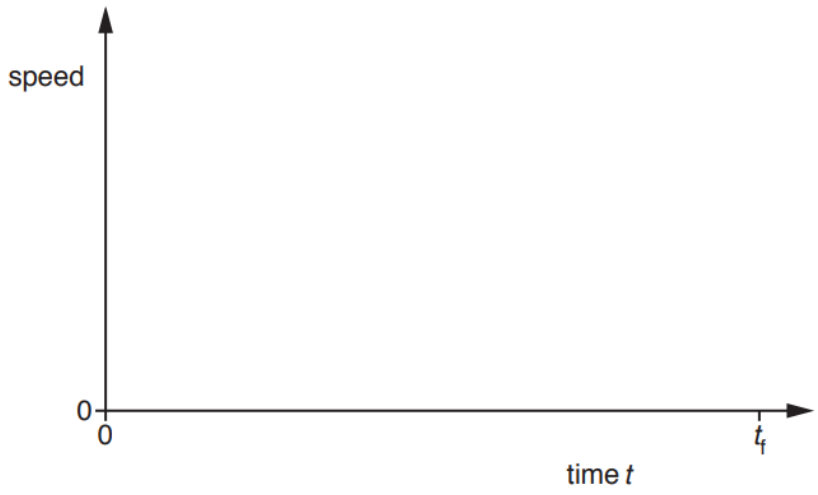


Fig. 1.2

[3]

37 A car accelerates uniformly in a straight line from rest at time $t = 0$. At $t = 3.2\,s$, the speed of the car is $13.0\,m/s$.

(a) (i) Calculate the acceleration of the car. **(extended only)**

acceleration = ... [2]

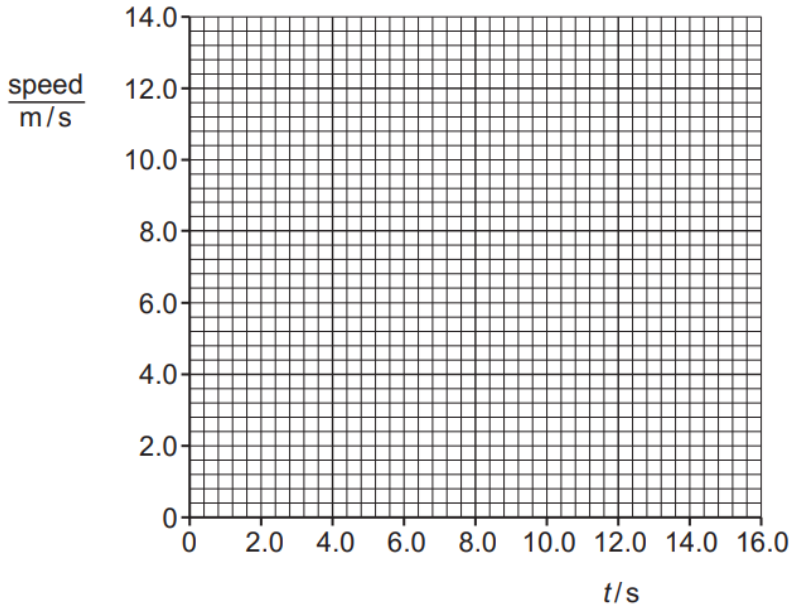
(ii) Explain in words what is meant by the term acceleration. **(extended only)**

.....

..... [1]

(b) The car travels at $13.0\,m/s$ from $t = 3.2\,s$ to $t = 12.0\,s$.

(i) Plot the speed–time graph for the car from $t = 0$ to $t = 12.0\,s$.



[2]

(ii) Determine the distance travelled by the car between $t = 0$ and $t = 3.2\,s$.

distance = ... [2]

(c) The car decelerates from 13.0 m/s to 0 m/s at a constant deceleration. The mass of the car is 1350 kg. The car travels 13 m in 2.0 s as it decelerates. **(extended only)**

Show that the work done by the car as it decelerates is approximately 1.1×10^5 J.

[4]

(d) On another day, the car in **(c)** travels a longer distance while it decelerates from 13.0 m/s to 0 m/s. The deceleration is constant.

Suggest and explain what causes the stopping distance to increase. **(extended only)**

suggestion .....

.....

explanation .....

.....

[2]

[Total: 13]