1.2-Motion

- **Speed:**

Definition: Speed is the distance travelled by a body in unit time.
Speed is a scalar quantity.
Units: m/s or km/hr

- **Average speed:**

Definition: Average speed is the total distance travelled by a body in total time .
Speed is a scalar quantity.
Units: m/s or km/hr

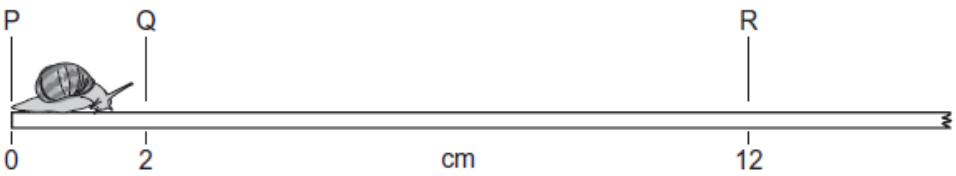
- **Speed and velocity:**

Speed	Velocity
Scalar quantity	Vector quantity
Units: m/s	Units: m/s
Speed=$\frac{distance}{time}$	Velocity= $\frac{displacement}{time}$
Speed of a body can never be negative. it can be zero	Velocity of a body can be positive, negative or zero

Sums-Speed

4 A snail moves along a ruler. It takes 20s to move from Q to R.

0625/11/M/J/10



What is its average speed from Q to R?

A $\frac{12}{20}$ cm/s

B $\frac{12-2}{20}$ cm/s

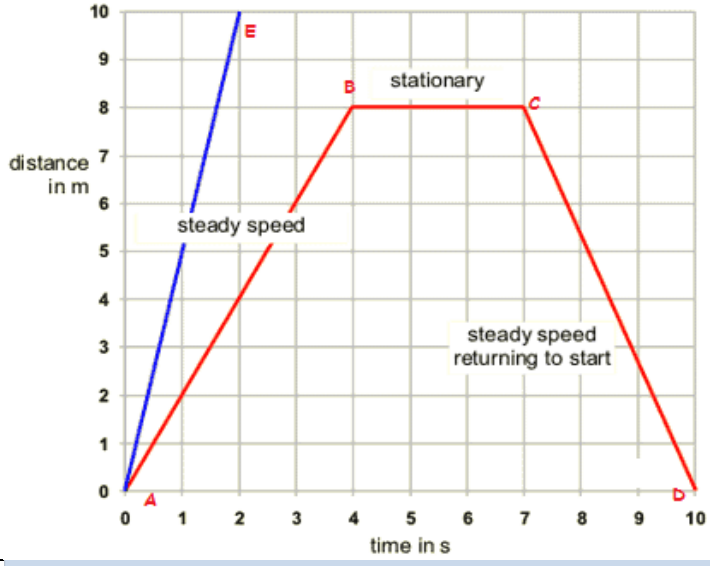
C $\frac{20}{12}$ cm/s

D $\frac{20}{12-2}$ cm/s

The concept of speed can be represented by two kinds of graphs:

- **distance -time graphs**
- **speed-time graphs**

Distance -time graphs:



A-B ⇒ Steady speed-Constant slope

B-C⇒Vehicle has stopped-Zero speed-Zero slope

C-D ⇒ Constant speed-Constant slope. Object returning to the starting point

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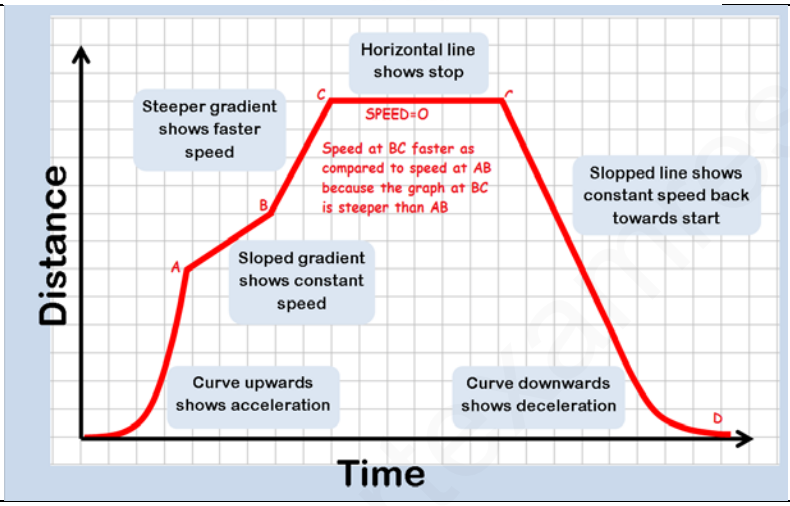
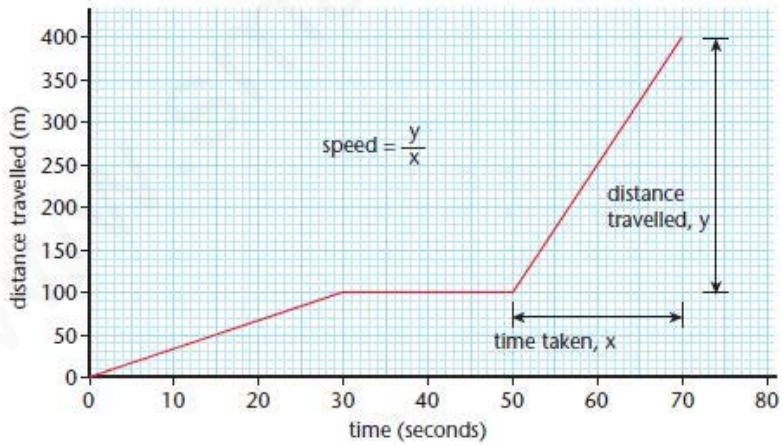
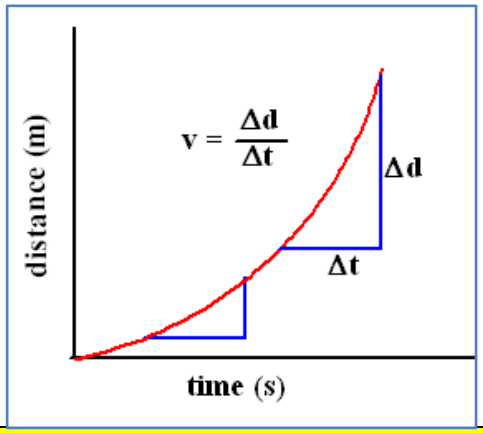


Slope of a distance time graph gives you the speed of the graph



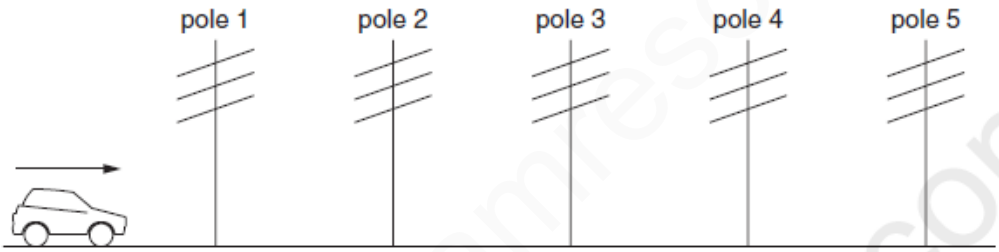


When a body covers unequal distances in equal intervals of time then the graph is a curved graph. Then the speed at a particular time is found by drawing a tangent to the point and calculating its slope.

APPLICATION BASED QUESTIONS:

3 Five telegraph poles are positioned at equal distances along the side of a road.

0625/01/O/N/03



A car accelerates until it is level with pole 4. The car then continues along the road at a steady speed. The times taken to travel between one pole and the next are measured.

Which time is the greatest?

The time between

A pole 1 and pole 2.

B pole 2 and pole 3.

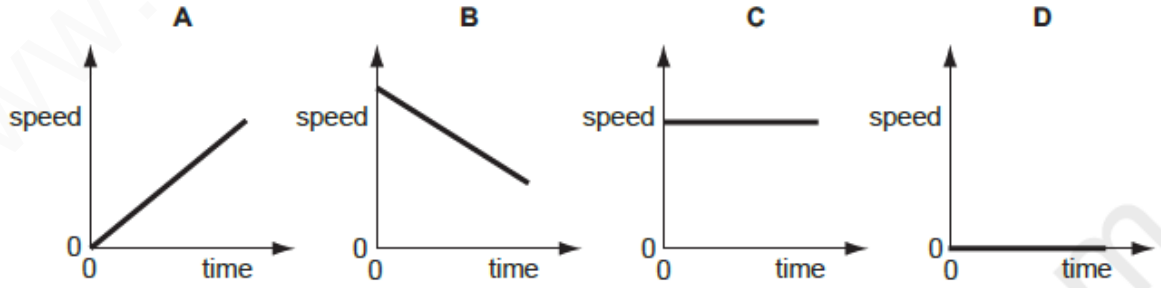
C pole 3 and pole 4.

D pole · pole 5.

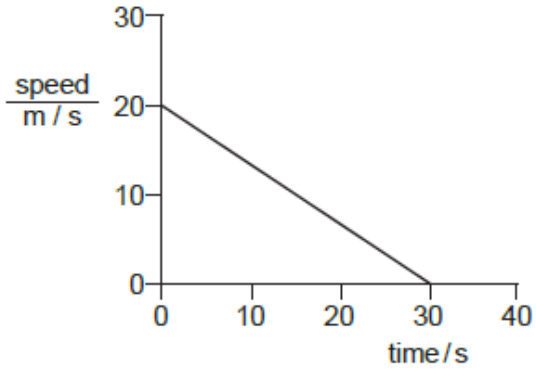
29

3 Which speed/time graph applies to an object at rest?

0625/01/O/N/04



2 The graph represents part of the journey of a car. **0625/01/O/N/05**



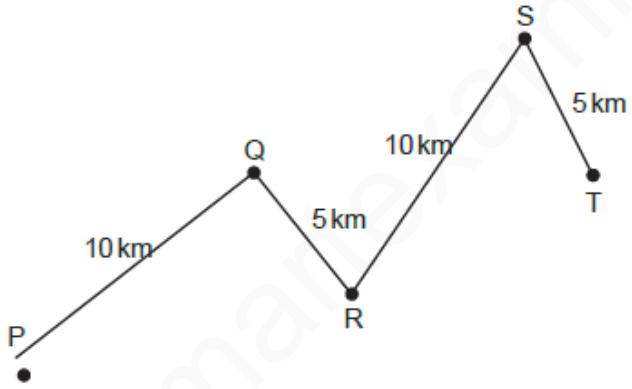
What distance does the car travel during this part of the journey?

A 150 m **B** 300 m **C** 600 m **D** 1200 m

31

3 A car travels along the route PQRST in 30 minutes. **0625/01/O/N/06**

What is the average speed of the car?



A 10 km / hour

B 20 km / hour

C 30 km / hour

D 60 km / hour

APPLICATION BASED QUESTIONS-EXTENDED THEORY:

1 Fig. 1.1 is a distance/time graph showing the motion of an object. 20

M/J/2-P32

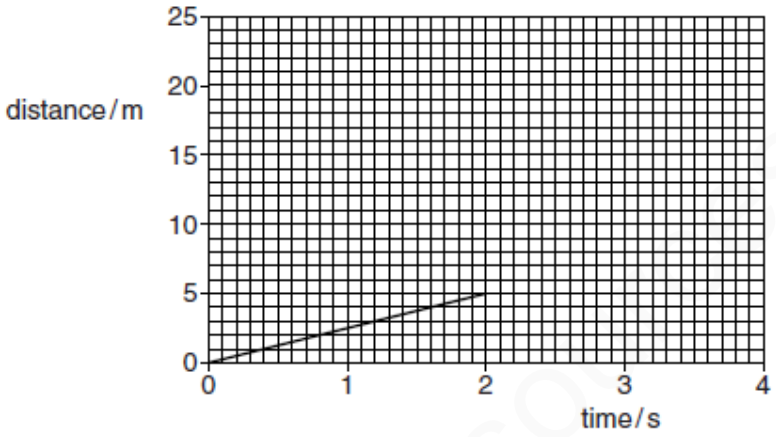


Fig. 1.1

(a) (i) Describe the motion shown for the first 2 s, calculating any relevant quantity.

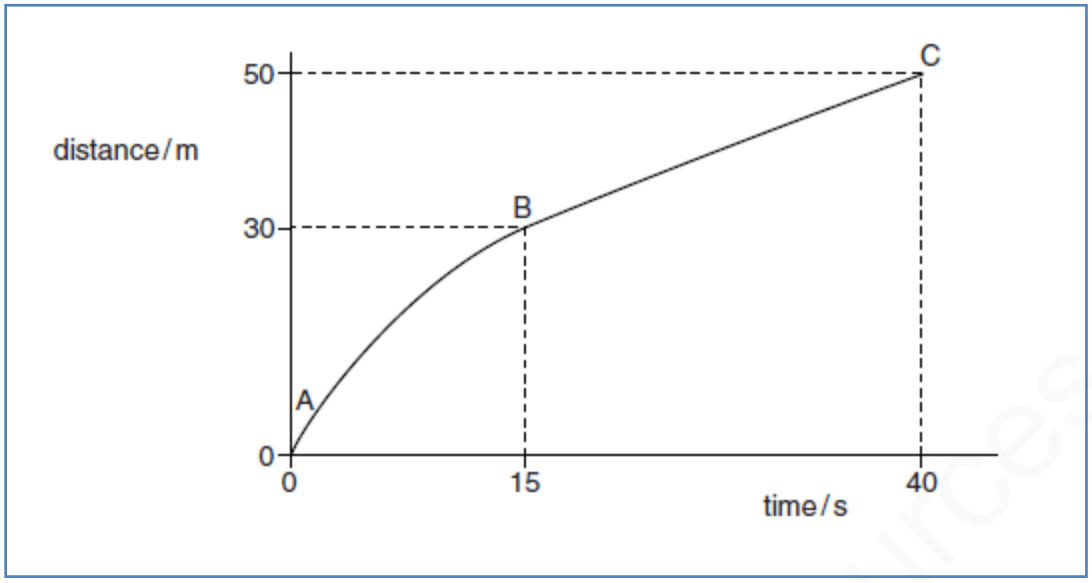
The journey during the first two seconds is described using the words:constant/steady or uniform(Speed or velocity)
You may also mathematically decribe the speed or tlee velocity as being 2.5m/s .
So remember you may decribe the graph in words or in figures through calculations , both are equally acceptabe

(ii) After 2 s the object accelerates.
On Fig. 1.1, sketch a possible shape of the graph for the next 2 s. [2]

The word accelerate means to speed up. So the graph has to be drwan as curving upwards
Rejected: If u draw a straight line going upwards. [1]
Note Next 2 seconds is mentioned . So u need to extend your graph to this distance. (Ms says either graph should touch 25m or upto 3.5s)

(b) Describe how a distance/time graph shows an object that is stationary.

Horizontal straight line or a line parallel to x axis or time axis is the vocab to be used. [1]



Speed of the objects between points AB can be described as:

1. Decreasing or
2. Average speed =2m/s. (The word average is important as it is the total distance /total time taken $=\frac{30}{15}=2m/s$
3. Acceleration=negative

Speed of the objects between points BC can be described as:

1. Constant or
2. Speed =0.8m/s. (distance / time taken $=\frac{50-30}{40-15}=0.8m/s$
3. Acceleration=Zero (Because: Velocity is constant, so change in velocity is zero)

Calculate the average speed of the object during the first 40s:

Must show calculation as = Velocity=d/t=50/40-=1.25m/s

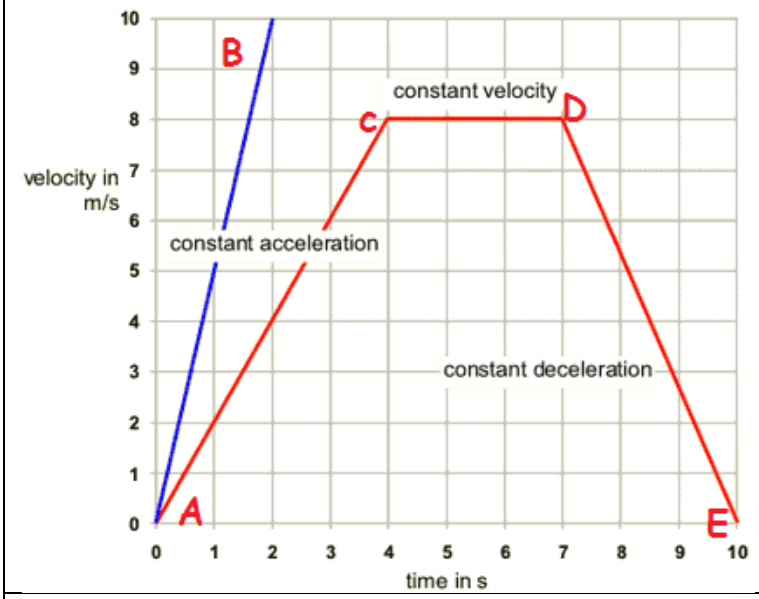
==========

OBSERVATIONS:

- Describe a section of a graph: You may describe using words or even through calculations.
- Calculate means to show the formula and the steps.

==========

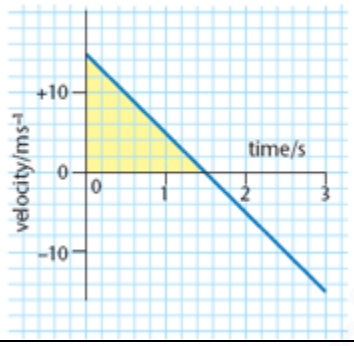
Speed/Velocity- time graph:



AB shows the journey with greater constant acceleration compared to part AC.

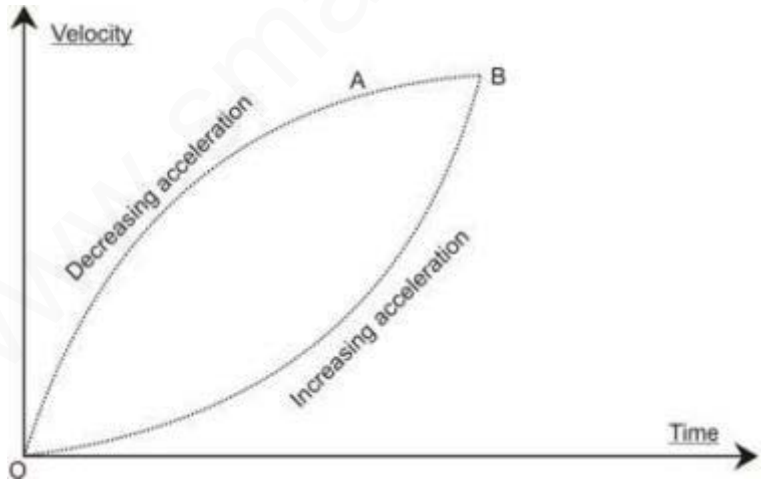
CD shows constant velocity as value of the value of velocity does not change

DE shows constant deceleration because the graph is sloping downwards.

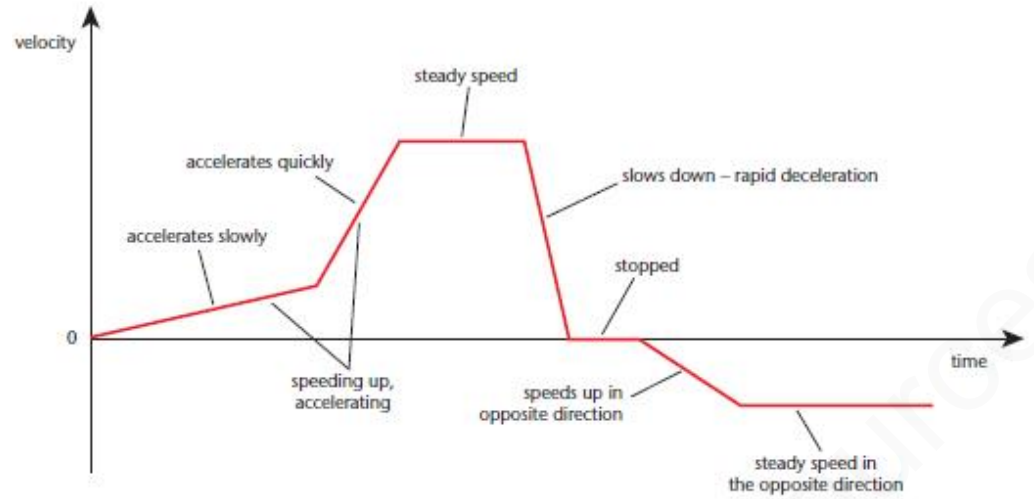


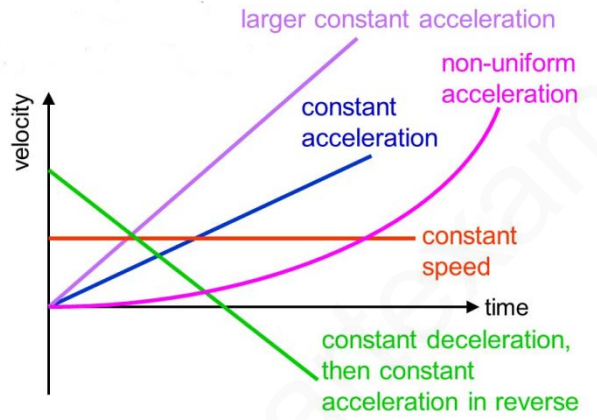
The positive and negative velocity means that the motion is in the opposite direction.

The graph shows decreasing and increasing acceleration.



In addition to the other features described in the previous graphs the following graph tells you how to represent a stopped vehicle (velocity=0)

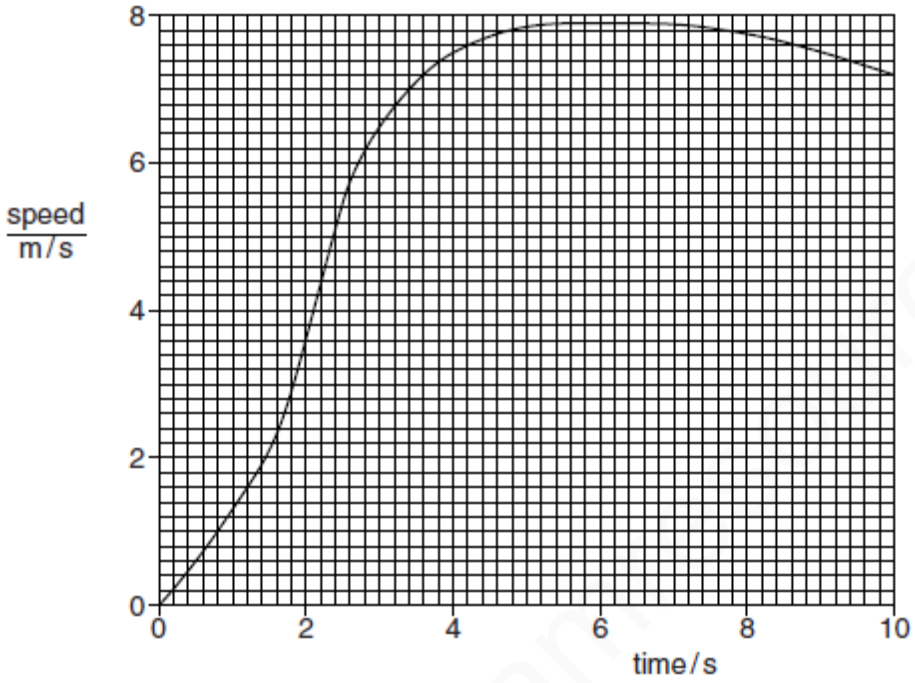




The changing acceleration is better described as non-uniform acceleration.

Application based concepts discussed

Graph of an athlete's race:



Calculate the distance that the athlete runs:

Found by calculating the area under the graph.

Maximum acceleration of the athlete: [4m] Observe the graph carefully and draw a tangent to the steepest part of the curve[1m]. Draw a tangent at this point and show the calculation of $\frac{\Delta v}{\Delta t}$ [1m].Plug in values[1m].State the final answer[1m]

If she runs a distance of 62m . Calculate her average speed:

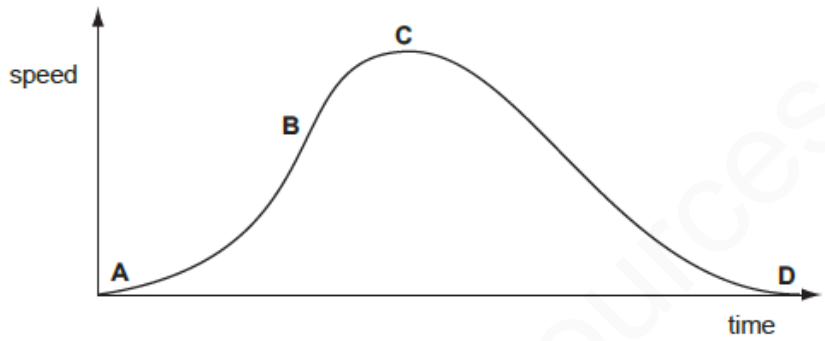
Average speed $= \frac{Total\ distance}{Total\ time}$

$$\Rightarrow \frac{62}{10} = 6.2m/s$$

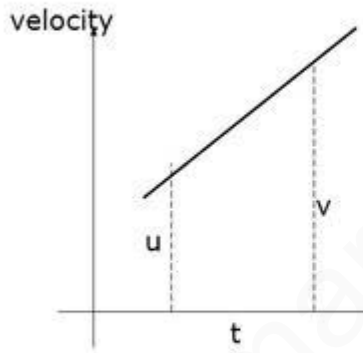
Application based questions-MCQ:

1 The speed-time graph shown is for a bus travelling between stops.

Where on the graph is the acceleration of the bus greatest? **0625/12/O/N/11**



Properties of a velocity time graph



Gradient = $\frac{v-u}{t}$

Gradient = Acceleration

Area under graph = $\frac{1}{2}(u+v)t$

Area = Distance travelled

40

1 A comet, travelling in space, enters the atmosphere of a planet.

Fig. 1.1 is the speed-time graph for the comet from time $t = 0$ s. O/N/15-P32-Q1

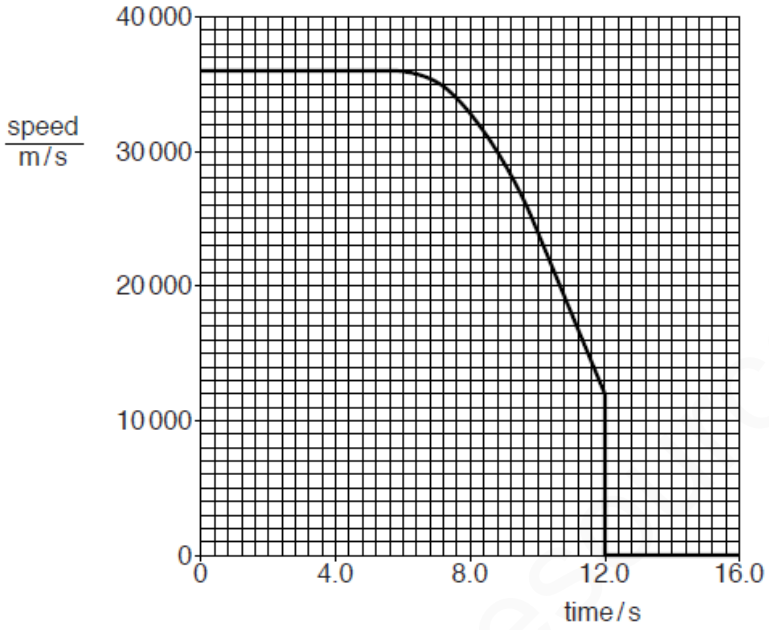


Fig. 1.1

(a) (i) During the period $t = 0$ s to $t = 6.0$ s, both the speed of the comet and the velocity of the comet remain constant.

State what this suggests about the motion of the comet.

.....

.....[1]

(ii) Determine the distance travelled during the period $t = 0$ s to $t = 6.0$ s.

distance = ...[2]

(b) Explain what the graph shows about the motion of the comet during the period $t = 6.0\,s$ to $t = 10.0\,s$.

.....

.....

.....[2]

(c) Determine the acceleration of the comet at $t = 11.0\,s$. 41

acceleration = ...[2]

(d) Suggest what happens to the comet at $t = 12.0\,s$.

.....

.....[1]

[Total: 8]

1 Fig. 1.1 shows a smooth metal block about to slide down BD, along DE and up EF.
BD and DE are friction-free surfaces, but EF is rough. The block stops at F.

O/N/2002-P3-Q1

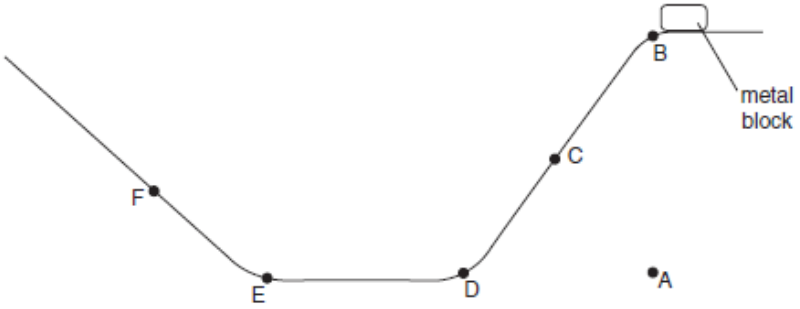


Fig. 1.1

(a) On Fig. 1.2, sketch the speed-time graph for the journey from B to F.
Label D, E and F on your graph. [3]

(c) As it passes D, the speed of the block remains almost constant but the velocity changes. Using the terms *vector* and *scalar*, explain this statement.

.....

.....

.....[2]

1 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.

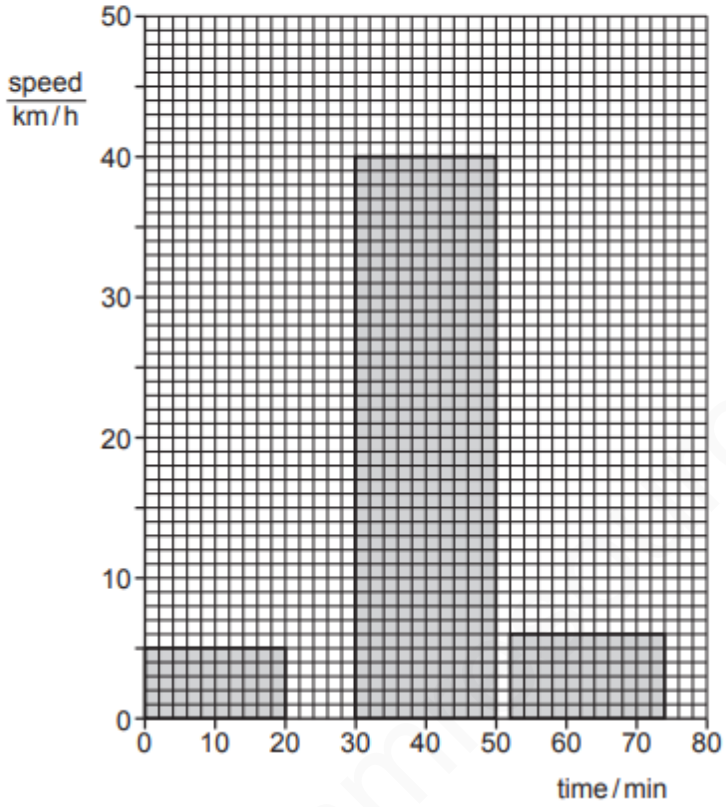


Fig. 1.1

(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]

Acceleration of free fall:

- An object that is moving only under the influence of gravity is said to be under free fall.
- Free falling objects accelerate at a constant rate.
- The acceleration due to gravity is approximately $9.8 m/s^2$
- Under free fall, objects reach the earth at the same time , irrespective of their masses; if dropped from the same height above the earth's surface because the acceleration of free fall is constant.
- A non zero resultant force acts on a free falling object that has just been released.

FALLING OBJECTS ARE AFFECTED BY TWO TYPES OF FORCES:

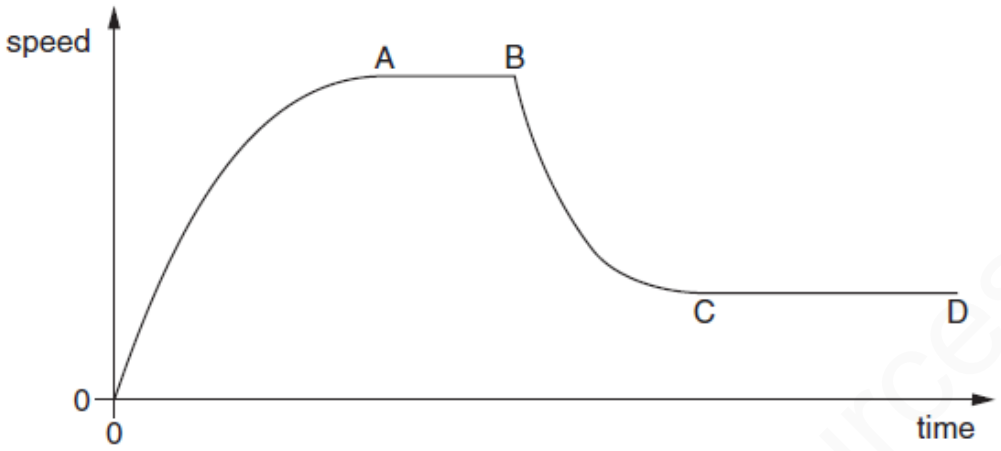
1. **The weight of the object:** This is a force acting downwards, caused by the object's mass being pulled by the Earth's gravitational field.
2. **Air resistance:** This is a frictional force acting in the opposite direction to the movement of the object.

THE ACT OF FALLING OF OBJECTS CAN BE CATEGORISED INTO 3 STAGES BEFORE IT HITS THE GROUND:

1. At the start, the object accelerates downwards because of its weight. There is no air resistance. There is a resultant force acting downwards.
2. As it gains speed, the object's weight stays the same, but the air resistance on it increases. There is a resultant force acting downwards.
3. Travelling at steady speed: Eventually, the object's weight is balanced by the air resistance. There is no resultant force and the object reaches a steady speed, called the terminal velocity.

Free fall graphs:

A parachutist jumps out of an aeroplane but does not open his parachute until some time has elapsed.



a. The value of the acceleration immediately after he has jumped from the aeroplane is: $10 m/s^2$.
b. The acceleration decreases until point A on the graph is reached. This is because the graph becomes less steep (or the gradient decreases)
c. The parachutist's speed in region AB is: constant
d. The forces on the parachute in the AB region: There is no resultant force(Or upward force = downward force or weight= air resistance)
e. The point at which the parachutist opened his parachute: B
f. The speed decrease from B-D because: the air resistance is bigger than the weight because as the parachute is opened it provides a larger surface area

---

APPLICATION BASED QUESTIONS

4 Two stones of different weight fall at the same time from a table. Air resistance may be ignored.

What will happen and why?

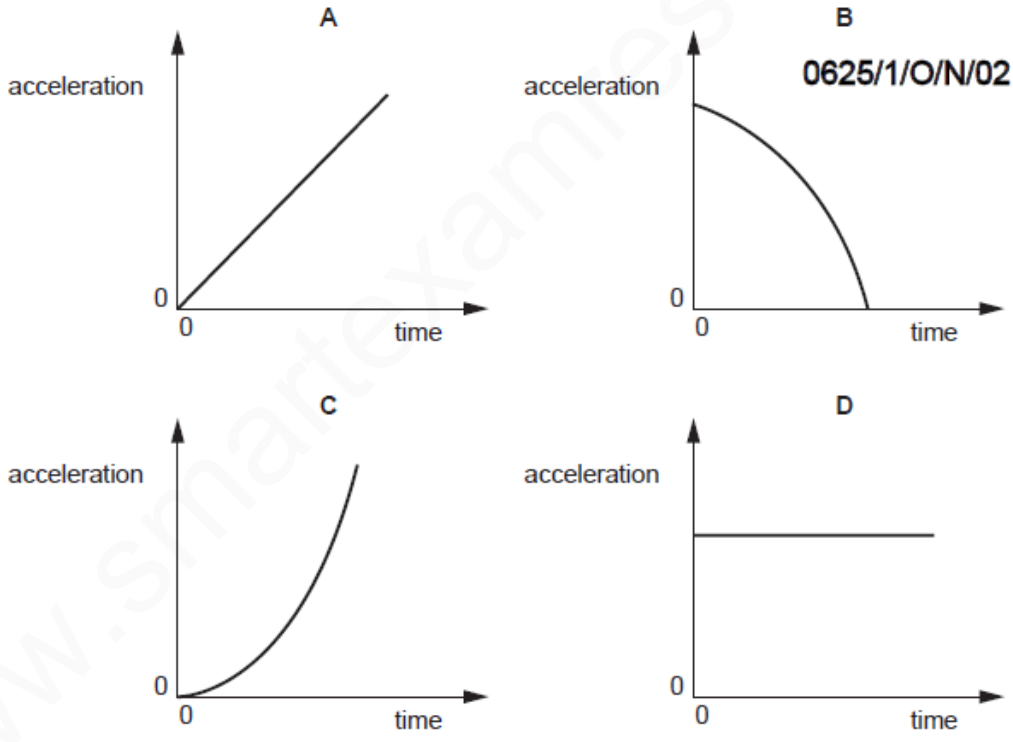
0625/12/O/N/12

	what will happen	why
A	both stones hit the floor at the same time	acceleration of free fall is constant
B	both stones hit the floor at the same time	they fall at constant speed
C	the heavier stone hits the floor first	acceleration increases with weight
D	the heavier stone hits the floor first	speed increases with weight

3 A stone falls freely from the top of a cliff into the sea. Air resistance may be ignored.

Which graph shows how the acceleration of the stone varies with time as it falls?

0625/1/O/N/02



APPLICATION BASED QUESTIONS:

1 An experiment is carried out to find the acceleration of free fall.

A strip of paper is attached to a heavy object. The object is dropped and falls to the ground, pulling the paper strip through a timer. The timer marks dots on the paper strip at intervals of 0.020 s.

Fig. 1.1 shows a section of the paper strip with the first three dots marked. The first dot on the paper strip, labelled A, is marked at the instant the object is dropped.

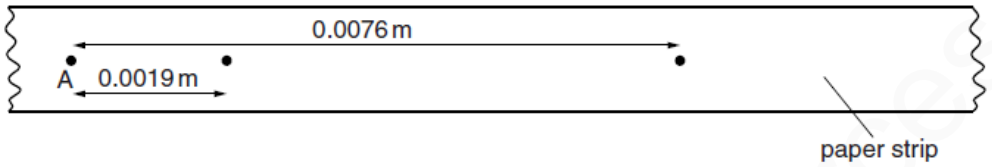


Fig. 1.1 (not to scale)

(a) State how the dots on the paper strip show that the object is accelerating.

.....

.....[1]

(b) Calculate the average speed of the object

(i) in the first 0.020 s after the object is dropped,

average speed = ...

(ii) in the second 0.020 s after the object is dropped.

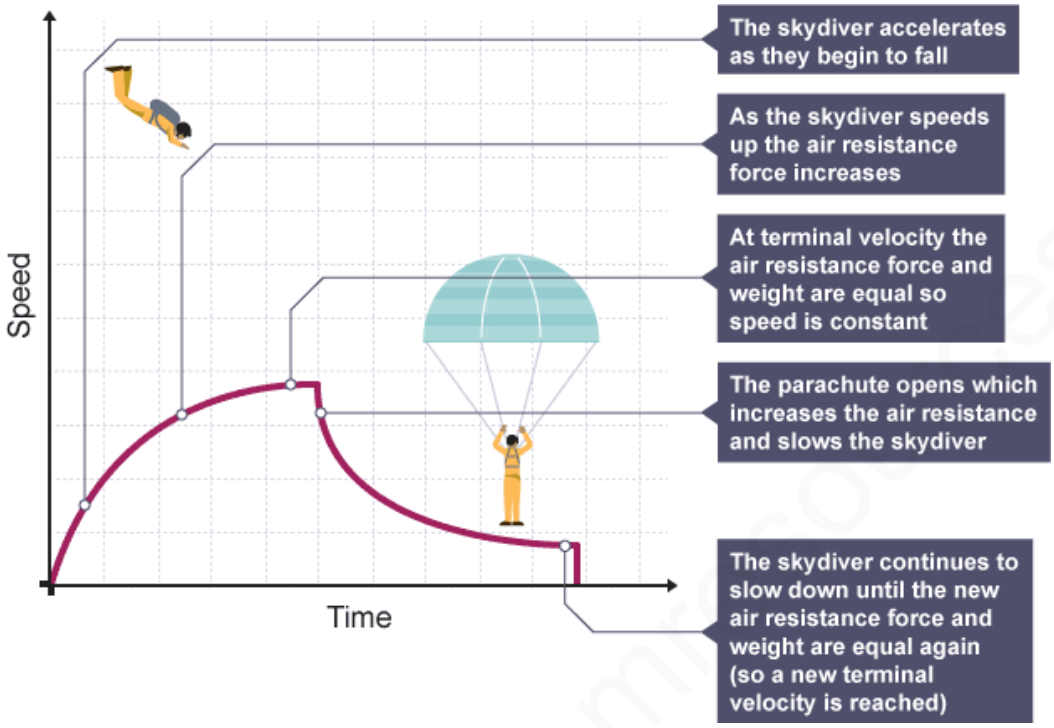
average speed = ...
[3]

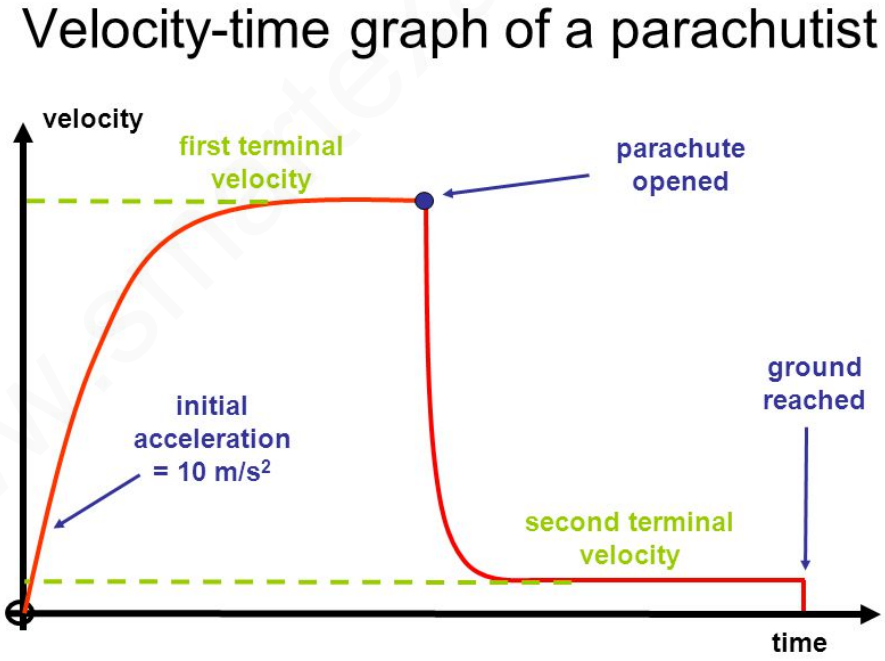
(c) Use the results from **(b)** to calculate the acceleration of the falling object.

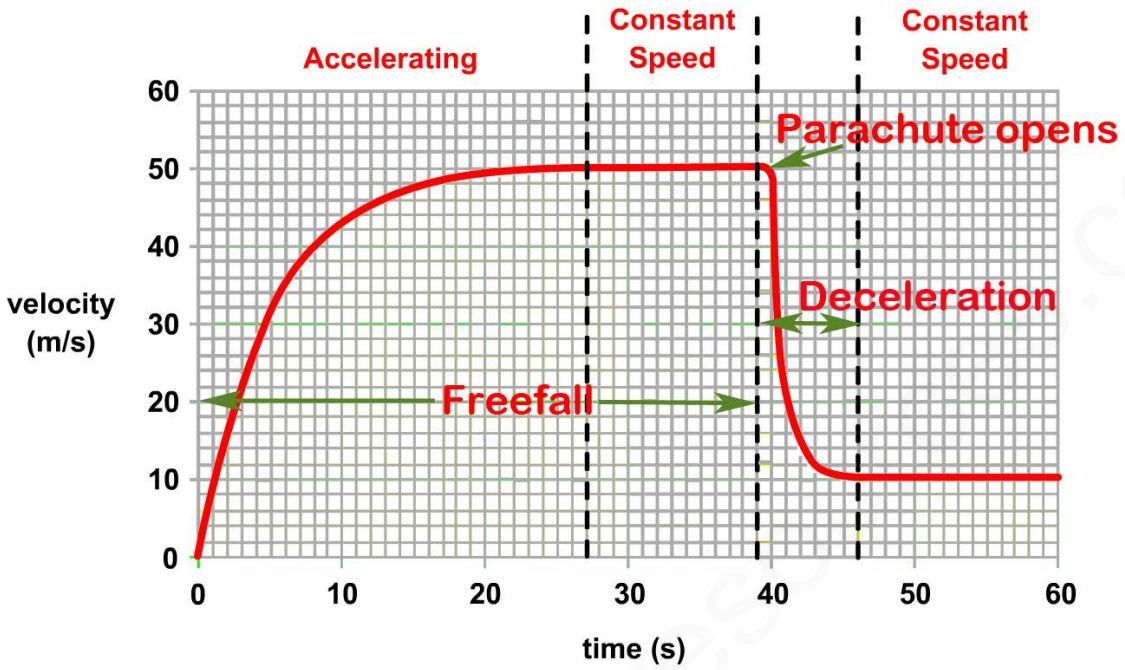
acceleration = ...[3]

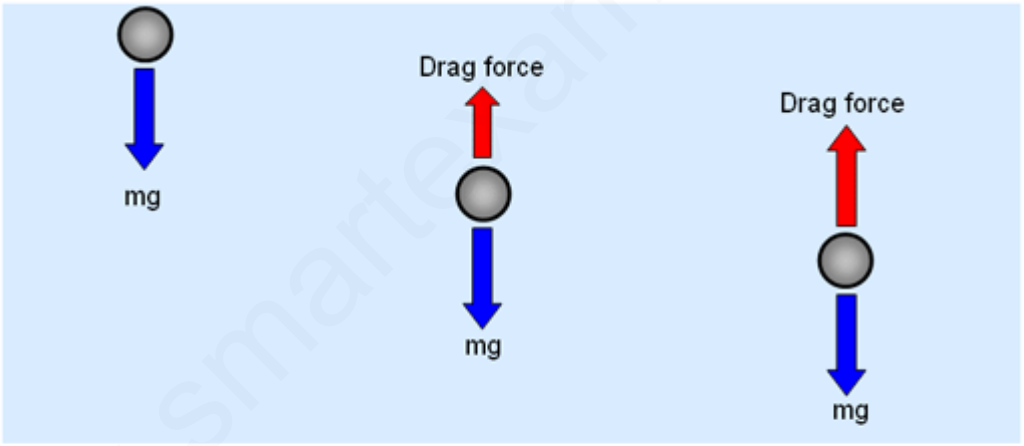
[Total: 7]

FREE FALL GRAPHS:









Body released from rest

Forces on body during acceleration

Forces on body at terminal velocity

EXTENDED THEORY

1 A free-fall parachutist jumps from a helium balloon, but does not open his parachute for some time.

O/N-P33-Q1

Fig. 1.1 shows the speed-time graph for his fall. Point B indicates when he opens his parachute.

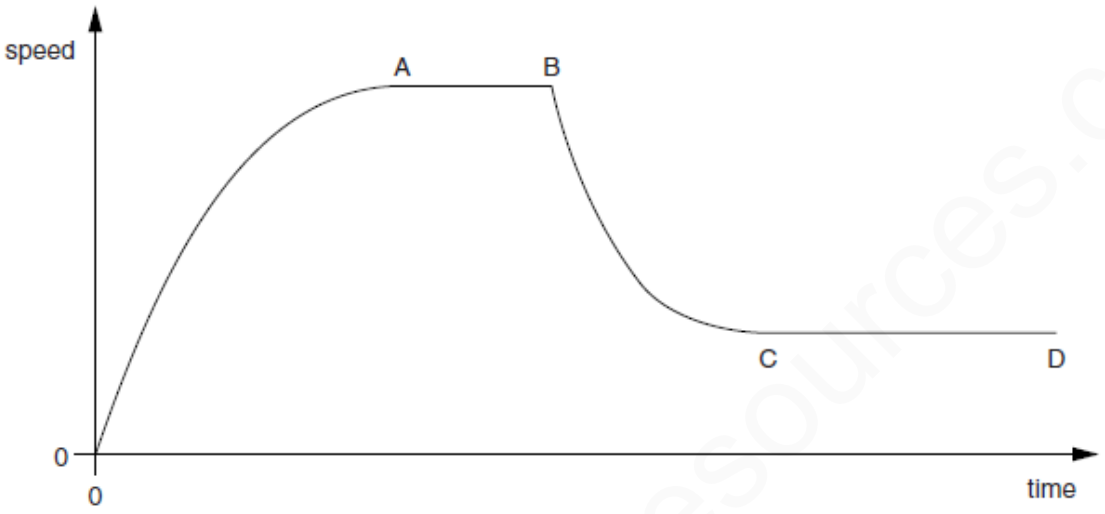


Fig. 1.1

(a) (i) State the value of the gradient of the graph immediately after time $t = 0$.

gradient = ... [1]

(ii) Explain why the gradient has this value.

.....

.....[1]

(b) State how Fig. 1.1 shows that the acceleration decreased between time $t = 0$ and the time to A.

.....

.....[1]

(c) Explain, in terms of forces, what is happening in section AB of the graph in Fig. 1.1.

.....

.....

.....[2]