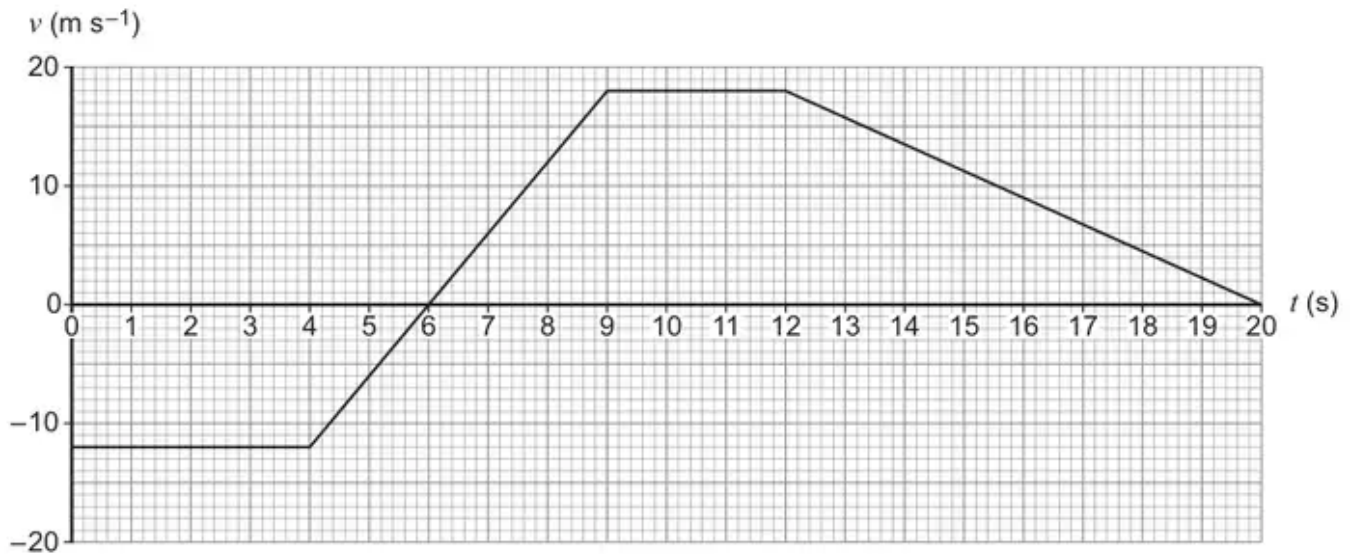


QQQ – Mechanics Year 1 – Chapter 9 – Time-Series Graphs (Version 2)

Total Marks: 24

(24 = Platinum, 22 = Gold, 19 = Silver, 16 = Bronze)

1. The diagram below shows a velocity-time graph for a particle moving with velocity $v \text{ m s}^{-1}$ at time t seconds.



Which statement is correct?

Tick (✓) **one** box.

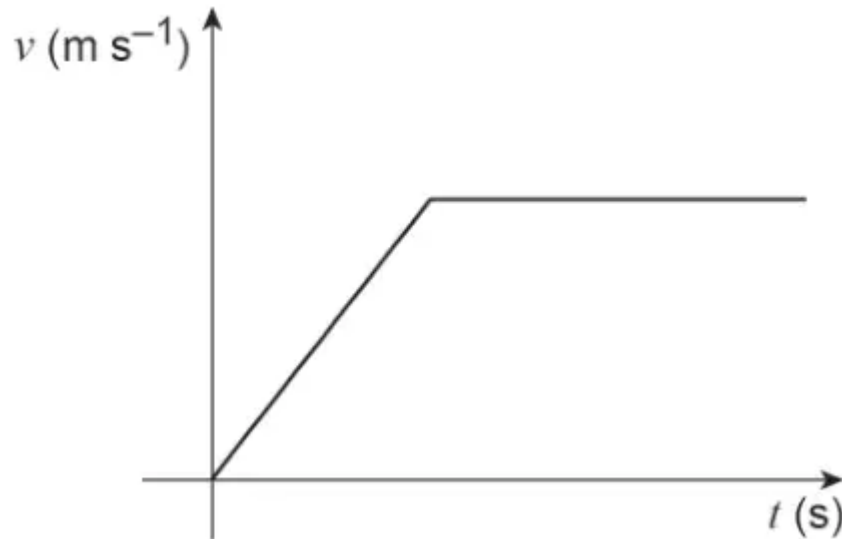
[1 mark]

- The particle was stationary for $9 \leq t \leq 12$
- The particle was decelerating for $12 \leq t \leq 20$
- The particle had a displacement of zero when $t = 6$
- The particle's speed when $t = 4$ was -12 m s^{-1}

(Total 1 marks)

2. A car starting from rest moves forward in a straight line.

The motion of the car is modelled by the velocity–time graph below:



One of the following assumptions about the motion of the car is implied by the graph.

Identify this assumption.

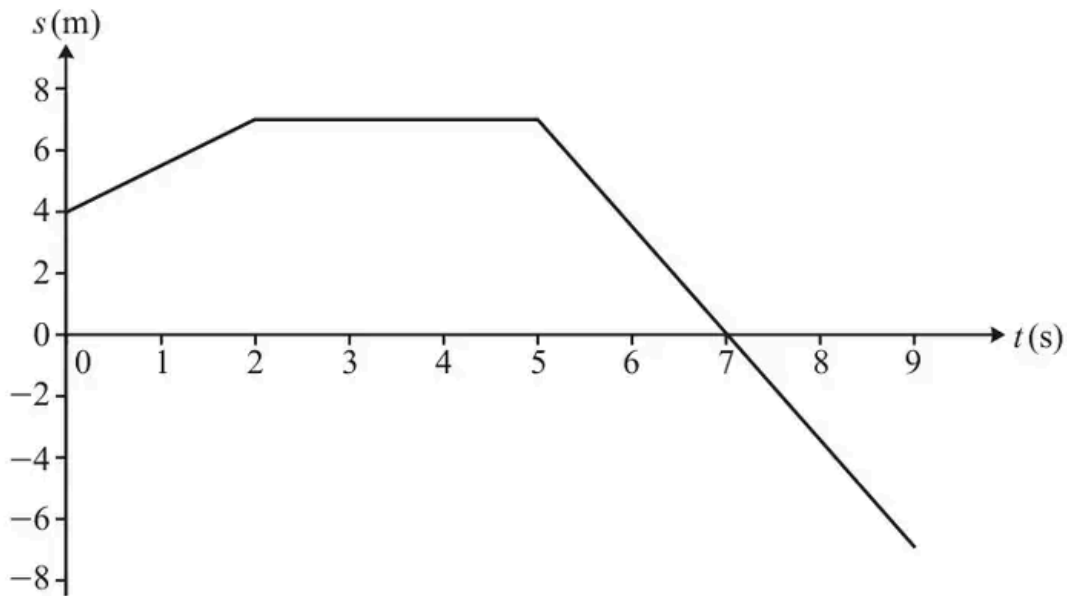
[1 mark]

Tick (✓) **one** box.

- The car never accelerates.
- The acceleration of the car is always positive.
- The acceleration of the car can change instantaneously.
- The acceleration of the car is never constant.

(Total 1 marks)

3. The graph shows displacement s m against time t s for a model of the motion of a bead moving along a straight wire. The points $(0, 4)$, $(2, 7)$, $(5, 7)$ and $(9, -7)$ are the endpoints of the line segments.

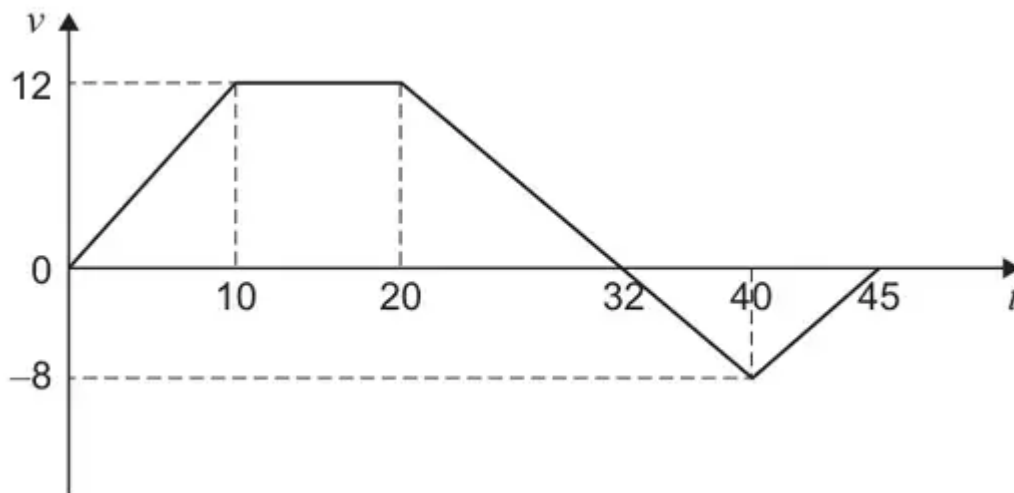


- (a) Find an expression for the displacement of the bead for $0 \leq t \leq 2$. [2]
- (b) Sketch the velocity-time graph for this model. [2]
- (c) Explain why the model may not be suitable at $t = 2$ and $t = 5$. [1]

(Total 5 marks)

4. A car, initially at rest, is driven along a straight horizontal road.

The graph below is a simple model of how the car's velocity, v metres per second, changes with respect to time, t seconds.

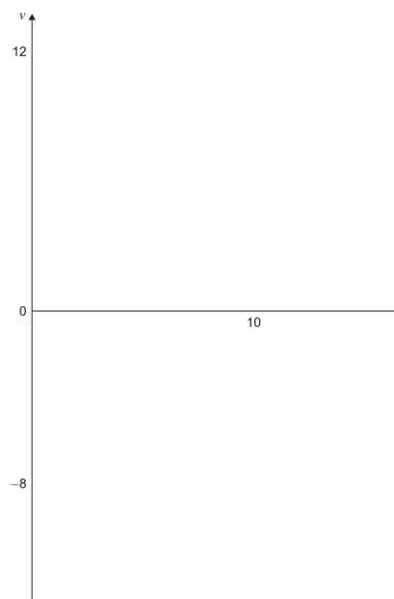


(a) Find the displacement of the car when $t = 45$ [3 marks]

(b) Shona says:

“This model is too simple. It is unrealistic to assume that the car will instantaneously change its acceleration.”

On the axes below sketch a graph, for the first 10 seconds of the journey, which would represent a more realistic model. [2 marks]



(Total 5 marks)

5. A child is running up and down a path. A simplified model of the child's motion is as follows:

- he first runs north for 5 s at 4 m s^{-1} ;
- he then suddenly stops and waits for 8 s;
- finally he runs in the opposite direction for 7 s at 3.5 m s^{-1} .

(a) Taking north to be the positive direction, sketch a velocity-time graph for this model of the child's motion. [2]

Using this model,

(b) calculate the total distance travelled by the child, [2]

(c) find his final displacement from his original position. [1]

(Total 5 marks)

OCR MEI October 2020 Paper 1 Q5

6. A train travels along a straight horizontal track between two stations, A and B .

In a model of the motion, the train starts from rest at A and moves with constant acceleration 0.3 m s^{-2} for 80 s.

The train then moves at constant velocity before it moves with a constant deceleration of 0.5 m s^{-2} , coming to rest at B .

- (a) For this model of the motion of the train between A and B ,
- (i) state the value of the constant velocity of the train,
 - (ii) state the time for which the train is decelerating,
 - (iii) sketch a velocity-time graph. (3)

The total distance between the two stations is 4800 m.

(b) Using the model, find the total time taken by the train to travel from A to B . (3)

(c) Suggest one improvement that could be made to the model of the motion of the train from A to B in order to make the model more realistic. (1)

(Total 7 marks)

Edexcel June 2018 Mechanics Q7

Solutions

1.

Scheme	Marks	AO
Ticks correct box	B1	2.2a
	(1 mark)	

Typical solution

The particle was decelerating for $12 \leq t \leq 20$

2.

Scheme	Marks	AO
Ticks the 3 rd box	B1	2.2a
	(1 mark)	

Typical solution

The acceleration of the car can change instantaneously

3.

Mark scheme (a)

Scheme	Marks	AO
gradient from (0, 4) to (2, 7) is 1.5	M1	3.3
So $s = 1.5t + 4$	A1	3.3
	[2]	

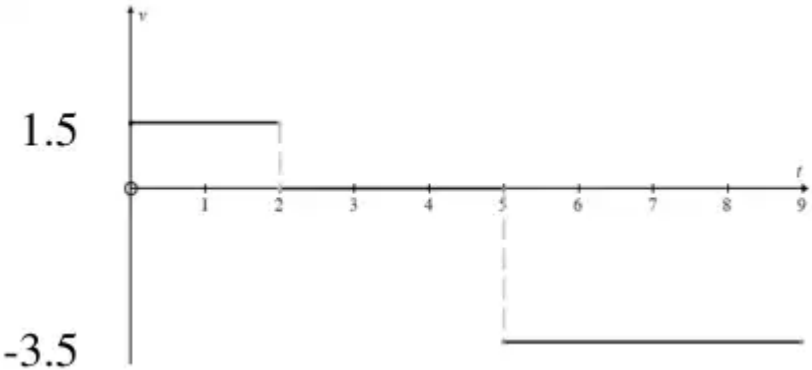
Notes

M1: attempt to find the gradient – award if $\frac{3}{2}$ seen

A1: must be s in terms of t

Mark scheme (b)

Scheme	Marks	AO
--------	-------	----

	B1* B1 (dep)	3.4 3.4
	[2]	

Notes

B1*: Three horizontal lines, above, on and below the t -axis. Also allow if the third line segment is above the first line segment because speed is given instead of velocity.

B1 (dep): their 1.5 and -3.5 seen and $t = 2$ and $t = 5$ clear

Mark scheme (c)

Scheme	Marks	AO
The changes in velocity are instantaneous. In reality, the velocity changes over a period of time	E1	3.5b
	[1]	

Notes

E1: Accept “suddenly stops” or similar. Also accept that the velocity at $t = 2$ or $t = 5$ is ambiguous

4.

Mark scheme (a)

Scheme	Marks	AO
Finds any area either above or below the axis	M1	3.1b
Obtains correct values of area above or area below the axis PI	A1	1.1b
Obtains correct displacement condone missing units	A1	1.1b
	(3)	

Typical solution

$$\text{Area above} = \left(\frac{1}{2}\right)(12)(10 + 32) = 252$$

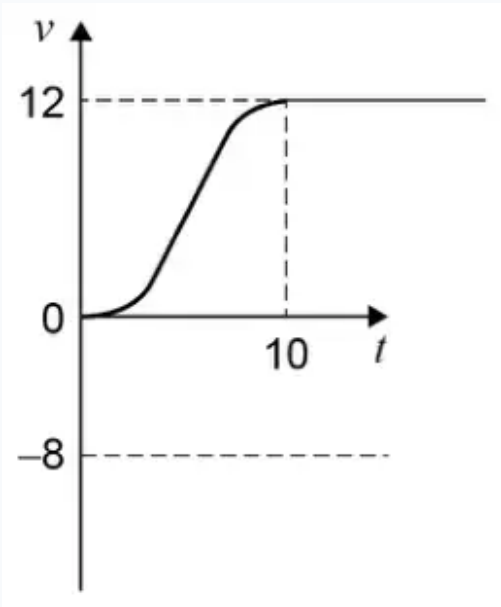
$$\text{Area below} = \left(\frac{1}{2}\right)(13)(8) = 52$$

$$r = 252 - 52 = 200 \text{ m}$$

Mark scheme (b)

Scheme	Marks	AO
Sketches a curve at the end $t = 0$ correctly	B1	3.5c
Sketches a curve at the end $t = 10$ correctly	B1	3.5c
	(2)	
	(5 marks)	

Typical solution



5.

Mark scheme (a)

Scheme	Marks	AO
--------	-------	----

	B1	1.1
	B1	1.1
	[2]	

Notes

B1: Graph from 3 horizontal line segments. Correct velocities labelled

Any lines joining the horizontal lines should be vertical

B1: Times seen – either $t = 5, 13, 20$ or lengths of line segments 5, 8, 7 seen.

Mark scheme (b)

Scheme	Marks	AO
Distance = $(4 \times 5) + (7 \times 3.5)$ m	M1	1.1a
= 44.5	A1	1.1
	[2]	

Notes

M1: finding the area of at least one region from their graph or

May work directly from the information in the question without reference to their graph

A1: cao

Mark scheme (c)

Scheme	Marks	AO
Displacement = $20 - 24.5 = -4.5$ m	B1	1.1
	[1]	

Notes

B1: Allow for -4.5 m or for 4.5 m south

Do not allow -4.5 m south

6.

Mark scheme (a)

Scheme	Marks	AO
(i) $24 \text{ (m s}^{-1}\text{)}$	B1	1.1b
(ii) 48 (s)	B1	1.1b
(iii) 	B1	1.1b
	(3)	

Notes

(i) **B1:** $24 \text{ (m s}^{-1}\text{)}$ Must be stated i.e. not just inserted on the graph

(ii) **B1:** 48 (s) (Allow -48 changed to 48) Must be stated i.e. not just inserted on the graph

(iii) **B1:** A trapezium starting at the origin and ending on the t -axis.

Mark scheme (b)

Scheme	Marks	AO
Equating area under graph to 4800 to give equation in one unknown	M1	3.1b
$\frac{1}{2}(T + T + 80 + 48) \times 24 = 4800$ OR $\left(\frac{1}{2} \times 80 \times 24\right) + 24T + \left(\frac{1}{2} \times 48 \times 24\right) = 4800$ oe	A1ft	1.1b
$T = 136$ so total time is 264 (s)	A1	1.1b
	(3)	

Notes

M1: Complete method to find area of trapezium using trapezium rule with correct structure or using two triangles and a rectangle and equate to 4800 to give equation in *one* unknown

N.B. $\frac{1}{2}(T + 80 + 48) \times 24 = 4800$ is M0 (equivalent to using three triangles)

OR they may use *suvat* on one or more sections (must have $a = 0$ for middle section) and equate total distance travelled to 4800 to give equation in *one* unknown

A1ft: For a correct equation in their unknown **ft** on their 24 and 48 (but must be positive times)

A1: For 264 (s)

Mark scheme (c)

Scheme	Marks	AO
Accept Either: a smooth change from acceleration to constant velocity or from constant velocity to deceleration. Or have train accelerating and/or decelerating at a variable rate Do not accept e.g. Comments on air resistance or resistive forces, straightness of track, horizontal track, friction, length of train, mass of train, not having train moving with constant velocity. <u>B0 if either an incorrect extra is included or an incorrect reason for a valid improvement is included.</u> <u>N.B.</u> Variable acceleration due to air resistance is B0 BUT Variable acceleration due to variable air resistance is B1	B1	3.5c
	(1)	
	(7 marks)	

Notes

B1: Either: Include time to change from constant accln to constant velocity and/or time to change from constant velocity to constant deceleration or

Or: Have train accelerating and/or decelerating at a variable rate