Questions

Q1.

Unless otherwise indicated, whenever a numerical value of g is required, take $g = 9.8$ m s^{-2} and give your answer to either 2 significant figures or 3 significant figures.

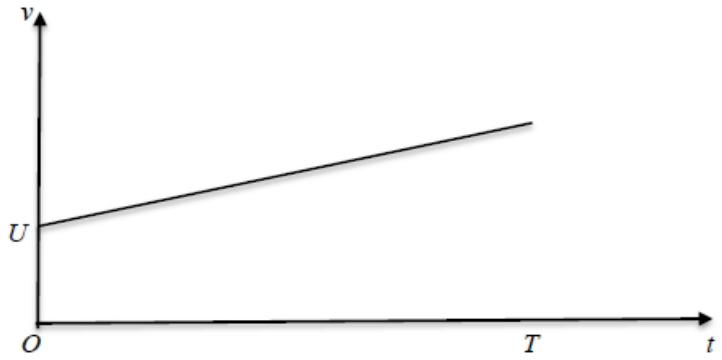


Figure 1

A car moves along a straight horizontal road. At time $t = 0$, the velocity of the car is U m s^{-1}. The car then accelerates with constant acceleration a m s^{-2} for T seconds. The car travels a distance D metres during these T seconds.

Figure 1 shows the velocity-time graph for the motion of the car for $0 \leq t \leq T$.

Using the graph, show that $D = UT + \frac{1}{2}aT^2$.

(No credit will be given for answers which use any of the kinematics (*suvat*) formulae listed under Mechanics in the AS Mathematics section of the formulae booklet.)

(4)

(Total for question = 4 marks)

Q2.

Unless otherwise indicated, wherever a numerical value of g is required, take $g = 9.8$ m s^{-2} and give your answer to either 2 significant figures or 3 significant figures.

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 for question = 7 marks)

Mark Scheme

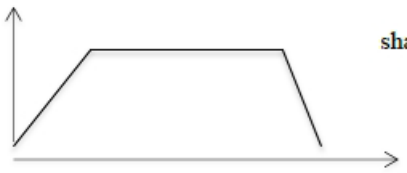
Q1.

Question	Scheme	Marks	AOs
	Using distance = total area under graph (e.g. area of rectangle + triangle or trapezium or rectangle – triangle)	M1	2.1
	e.g. $D = UT + ½ Th$, where h is height of triangle	A1	1.1b
	Using gradient = acceleration to substitute $h = aT$	M1	1.1b
	$D = UT + ½ aT^2$ *	A1 *	1.1b
		4	
			(4 marks)

Notes

1st M1 for use of distance = total area to give an equation in D, U, T and one other variable
1st A1 for a correct equation
2nd M1 for using gradient = a to eliminate other variable to give an equation in D, U, T and a *only*
2nd A1* for a correct **given answer**

Q2.

Question	Scheme	Marks	AOs
(a) (i)	24 ($m\,s^{-1}$)	B1	1.1b
(ii)	48 (s)	B1	1.1b
(iii)	 shape	B1	1.1b
		(3)	
(b)	Equating area under graph to 4800 to give equation in one unknown	M1	3.1b
	$\frac{1}{2}(T+T+80+48) \leftrightarrow 24 = 4800$ **OR** $(\frac{1}{2}\times 80\times 24)+24T+(\frac{1}{2}\times 48\times 24) = 4800$ **oe**	A1ft	1.1b
	$T = 136$ so total time is 264 (s)	A1	1.1b
		(3)	

(c)	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. B0 if either an incorrect extra is included or an incorrect reason for a valid improvement is included. N.B. 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:

(a)

(i) B1: 24 (m s^{-1})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.

(b)

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)

(c)

B1:

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

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