SECTION B: MECHANICS

Answer ALL questions. Write your answers in the spaces provided.

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

1.

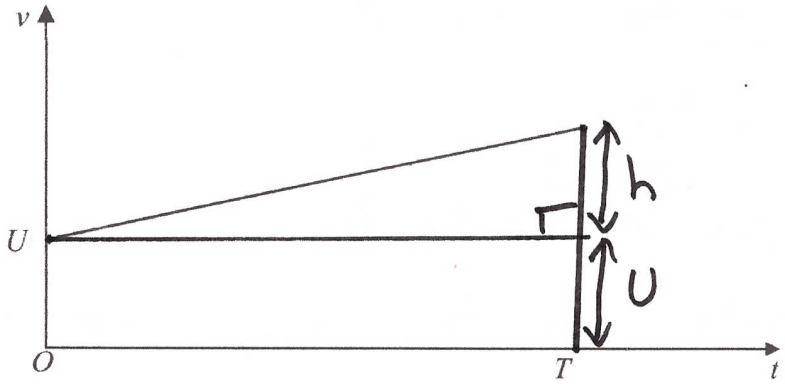


Figure 1

A car moves along a straight horizontal road. At time $t = 0$, the velocity of the car is $U\ \text{m s}^{-1}$. The car then accelerates with constant acceleration $a\ \text{m s}^{-2}$ 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 $0 \leqslant t \leqslant T$.

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)

Distance, D = Area under graph

$= UT + \frac{1}{2}hT$

Since the gradient is the acceleration, $h = aT$

So, $D = UT + \frac{1}{2}(aT)T$

$\therefore \boxed{D = UT + \frac{1}{2}aT^2}$

2. 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 $0.3\,\text{m s}^{-2}$ for 80 s.
The train then moves at constant velocity before it moves with a constant deceleration of $0.5\,\text{m s}^{-2}$, 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)

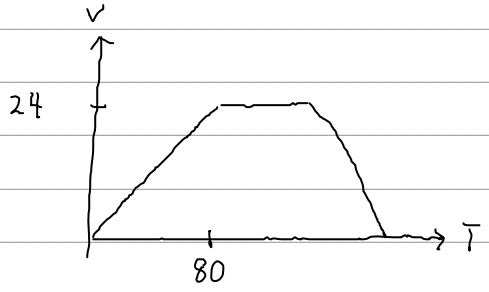
ai) $v = u + at$

$= 0 + 80(0.3)$

$= 24\ \text{ms}^{-1}$

ii) $\frac{24}{0.5} = 48\text{s}$

iii)



b) $80\left(\frac{1}{2}\right)(24) + 24T + 48\left(\frac{1}{2}\right)(24) = 4800$

$T = 136$

Total time : $136 + 80 + 48$

$= 264\ \text{s}$

c) variable acceleration and deceleration