Homework 1

1)

An automated train is programmed to move from rest under constant acceleration to a maximum speed of $20\,\mathrm{m\,s^{-1}}$ in a distance of 300 m. It is brought to rest under uniform deceleration in 15 seconds. Two stations are 5 kilometres apart and the train is programmed to stop at each station.

Find the time taken to travel between the two stations. 5

2)

A body moves along the X-axis from rest at the origin with acceleration, measured in ms^{-2}, given by

$$\underline{a} = (2 - \sqrt{t})\underline{i}$$

where $\underline{i}$ is the unit vector in the positive direction of the X-axis and t is the time in seconds from the start of the motion.

a) Show that the speed increases to a maximum value then decreases. Find this value.

b) Find

i) the time till the body is instantaneously at rest again

ii) the time before it again passes through its starting point.

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3)

As a set of traffic lights changes to green, a car accelerates uniformly from rest along a straight horizontal road at $a\,\mathrm{m\,s^{-2}}$. At the same instant, a lorry travelling at constant speed $U\,\mathrm{m\,s^{-1}}$ overtakes the car.

Find an expression, in terms of U and a, for the distance travelled by the car when it draws level with the lorry. 4

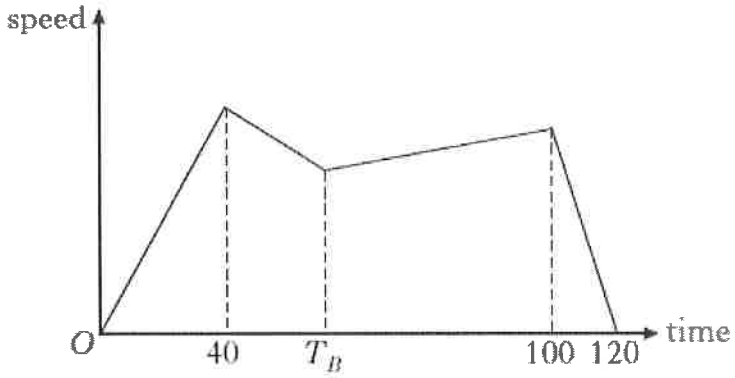
4)

An athlete runs a 200 metre race, along a straight horizontal track, in 30 seconds. She accelerates uniformly from rest for 4 seconds, reaching a maximum speed of $V\,\mathrm{m\,s^{-1}}$. She runs at this speed for 24 seconds before decelerating uniformly for the final 2 seconds, finishing the race with speed $(V-6)\,\mathrm{m\,s^{-1}}$.

Sketch the speed-time graph for the race and calculate the value of V. 4

5)

The speed-time graph of the motion of a car as it travels along a straight road is shown below. The car accelerates from O and passes markers on the road at A, B, C before stopping at D after 120 seconds. The car passes A after 40 seconds, B after T_B seconds, and C after 100 seconds.



The speed of the car between A and B is given by $v_1(t) = -\frac{1}{2}t + 45$ $(40 \leq t \leq T_B)$ and between B and C by $v_2(t) = \frac{1}{8}t + \frac{15}{2}$ $(T_B \leq t \leq 100)$, where the speed is measured in metres per second and time t is measured in seconds from the beginning of the motion.

(*a*) Calculate the speed of the car at B. 3

(*b*) Calculate the distance between B and D. 3