# Edexcel GCE

## Core Mathematics M1

# Velocity-Time Graphs

**Materials required for examination**
Mathematical Formulae (Green)

**Items included with question papers**
Nil

**Advice to Candidates**

You must ensure that your answers to parts of questions are clearly labelled.
You must show sufficient working to make your methods clear to the Examiner. Answers without working may gain no credit.

1.

**Figure 1**

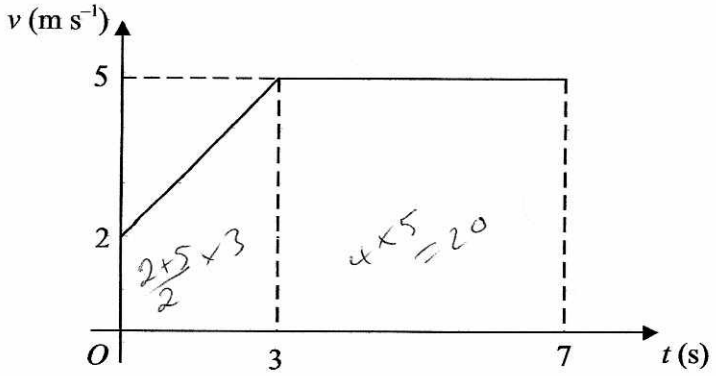



Figure 1 shows the speed-time graph of a cyclist moving on a straight road over a 7 s period. The sections of the graph from $t = 0$ to $t = 3$, and from $t = 3$ to $t = 7$, are straight lines. The section from $t = 3$ to $t = 7$ is parallel to the $t$-axis.

State what can be deduced about the motion of the cyclist from the fact that

($a$) the graph from $t = 0$ to $t = 3$ is a straight line,

**(1)**

($b$) the graph from $t = 3$ to $t = 7$ is parallel to the $t$-axis.

**(1)**

($c$) Find the distance travelled by the cyclist during this 7 s period.

**(4)**

a) constant acceleration

b) constant velocity

c) distance = area under graph

$$\frac{2+5}{2} \times 3 + 4 \times 5$$

$$10.5 + 20$$

$$= 30.5 \text{ m}$$

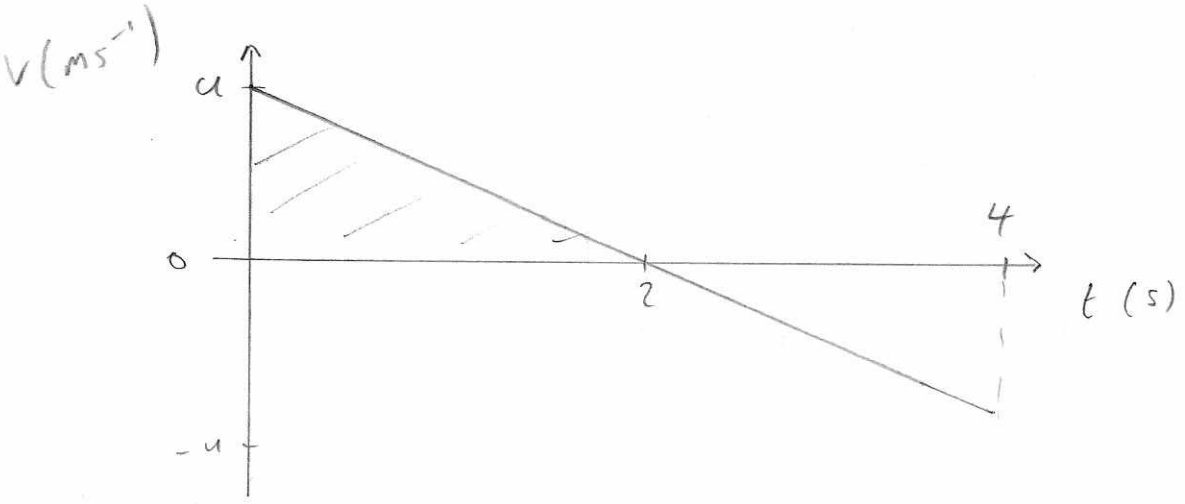
**2.** A small ball is projected vertically upwards from ground level with speed $u$ m s$^{-1}$. The ball takes 4 s to return to ground level.

(*a*) Draw, in the space below, a velocity-time graph to represent the motion of the ball during the first 4 s.

**(2)**

(*b*) The maximum height of the ball above the ground during the first 4 s is 19.6 m. Find the value of $u$.

**(3)**




b/ $\frac{u \times 2}{2} = 19.6$ (Area under graph = distance)

$u = 19.6 \text{ ms}^{-1}$

**3.** A car moves along a horizontal straight road, passing two points $A$ and $B$. At $A$ the speed of the car is 15 m s$^{-1}$. When the driver passes $A$, he sees a warning sign $W$ ahead of him, 120 m away. He immediately applies the brakes and the car decelerates with uniform deceleration, reaching $W$ with speed 5 m s$^{-1}$. At $W$, the driver sees that the road is clear. He then immediately accelerates the car with uniform acceleration for 16 s to reach a speed of $V$ m s$^{-1}$ ($V > 15$). He then maintains the car at a constant speed of $V$ m s$^{-1}$. Moving at this constant speed, the car passes $B$ after a further 22 s.

(*a*) Sketch, in the space below, a speed-time graph to illustrate the motion of the car as it moves from $A$ to $B$.

**(3)**

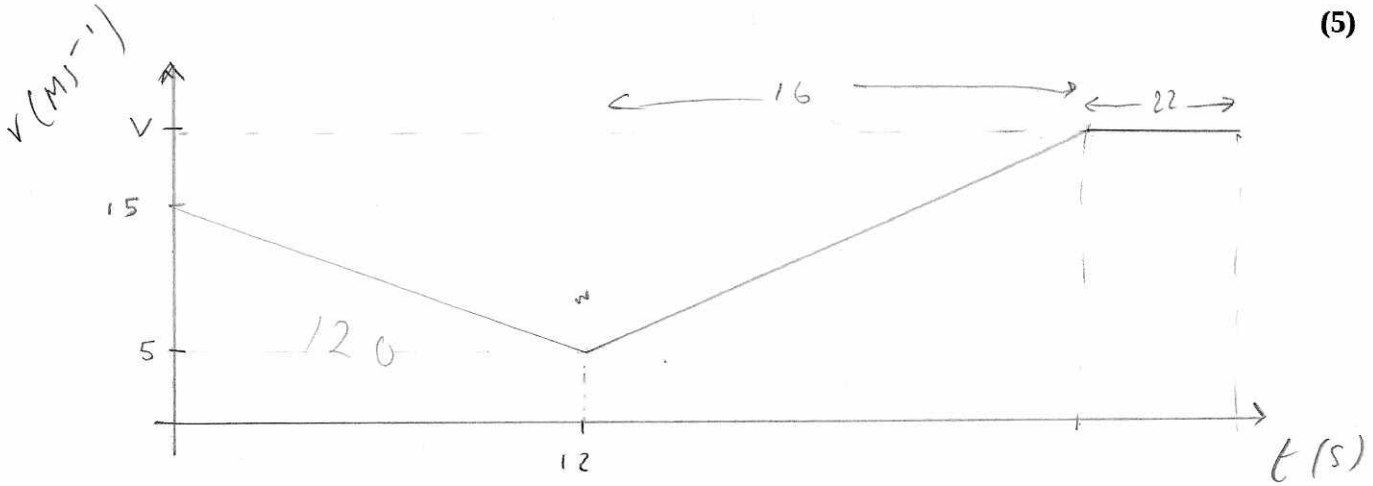
(*b*) Find the time taken for the car to move from $A$ to $B$.

**(3)**

The distance from $A$ to $B$ is 1 km.

(*c*) Find the value of $V$.

**(5)**




b/ $A \rightarrow W$

$$120 = \frac{5+15}{2} \times t$$

$$120 = 10t$$

$$t = 12$$

$$12 + 16 + 22 = 50 \text{ seconds}$$

c/

$$120 + \frac{5+V}{2} \times 16 + 22V = 1000$$

$$40 + 8V + 22V = 880$$

$$30V = 840$$

$$V = 28 \text{ ms}^{-1}$$

**4.** A car is moving along a straight horizontal road. At time $t = 0$, the car passes a point $A$ with speed 25 m s$^{-1}$. The car moves with constant speed 25 m s$^{-1}$ until $t = 10$ s. The car then decelerates uniformly for 8 s. At time $t = 18$ s, the speed of the car is $V$ m s$^{-1}$ and this speed is maintained until the car reaches the point $B$ at time $t = 30$ s.

(*a*) Sketch a speed–time graph to show the motion of the car from $A$ to $B$.

**(3)**

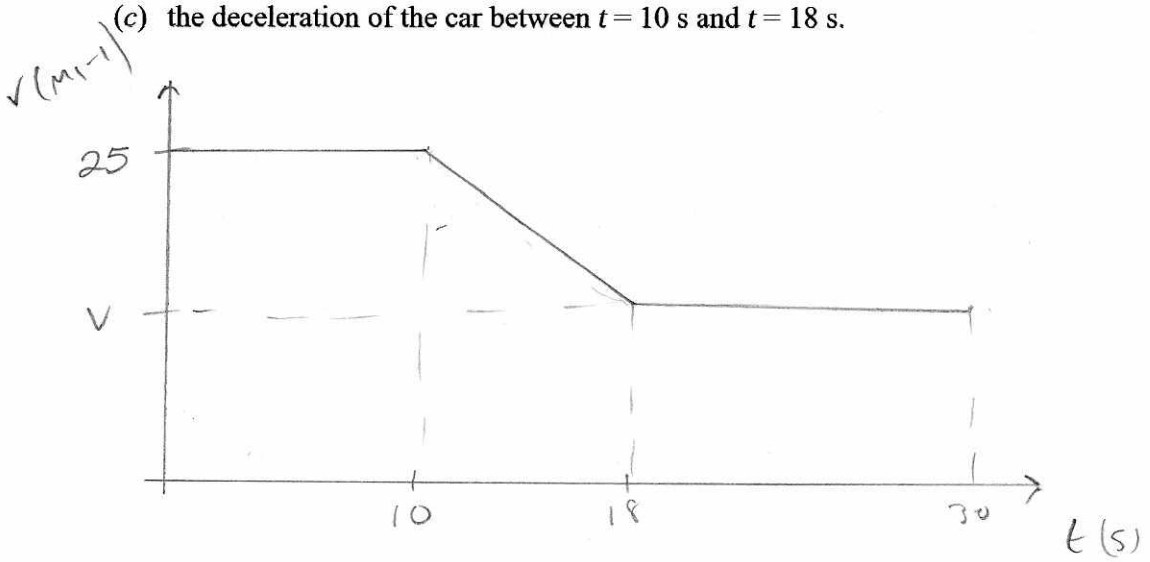
Given that $AB = 526$ m, find

(*b*) the value of $V$,

**(5)**

(*c*) the deceleration of the car between $t = 10$ s and $t = 18$ s.

**(3)**




b/ $526 = 30V + \frac{10+18}{2} \times (25-V)$

$526 = 30V + 14(25-V)$

$526 = 30V + 350 - 14V$

$176 = 16V$

$V = 11\ ms^{-1}$

[acceleration = gradient $\frac{\Delta y}{\Delta x}$]

c/ $\frac{25-11}{8} = \frac{7}{4}\ ms^{-2}$

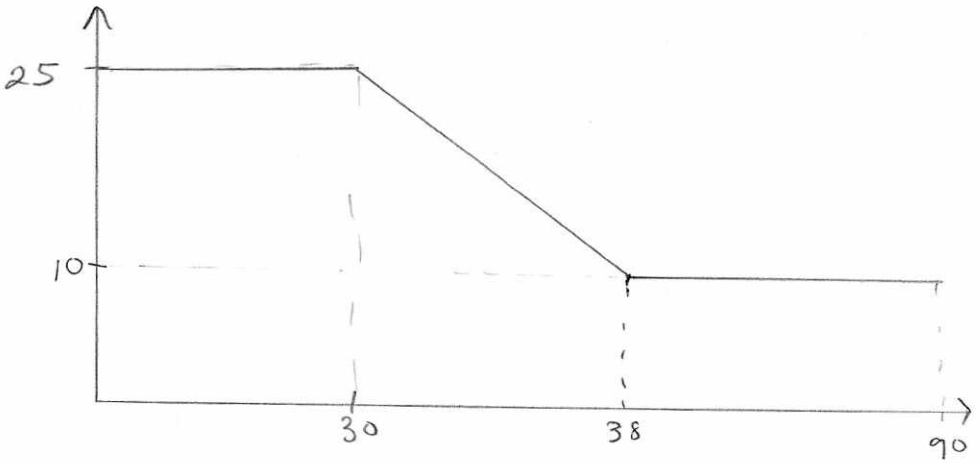
**5.** A car is moving along a straight horizontal road. The speed of the car as it passes the point $A$ is 25 m $s^{-1}$ and the car maintains this speed for 30 s. The car then decelerates uniformly to a speed of 10 m $s^{-1}$. The speed of 10 m $s^{-1}$ is then maintained until the car passes the point $B$. The time taken to travel from $A$ to $B$ is 90 s and $AB$ = 1410 m.

($a$) Sketch a speed-time graph to show the motion of the car from $A$ to $B$.

**(2)**

($b$) Calculate the deceleration of the car as it decelerates from 25 m $s^{-1}$ to 10 m $s^{-1}$.

**(7)**




$$1410 = 900 + \frac{30+t}{2} \times 15$$

$$510 = \frac{30+t}{2} \times 15$$

$$68 = 30 + t$$

$$t = 38$$

b/ deceleration $= \frac{\text{change in } y}{\text{change in } x}$

$$= \frac{15}{8}$$

$$= 1.875 \text{ ms}^{-2}$$