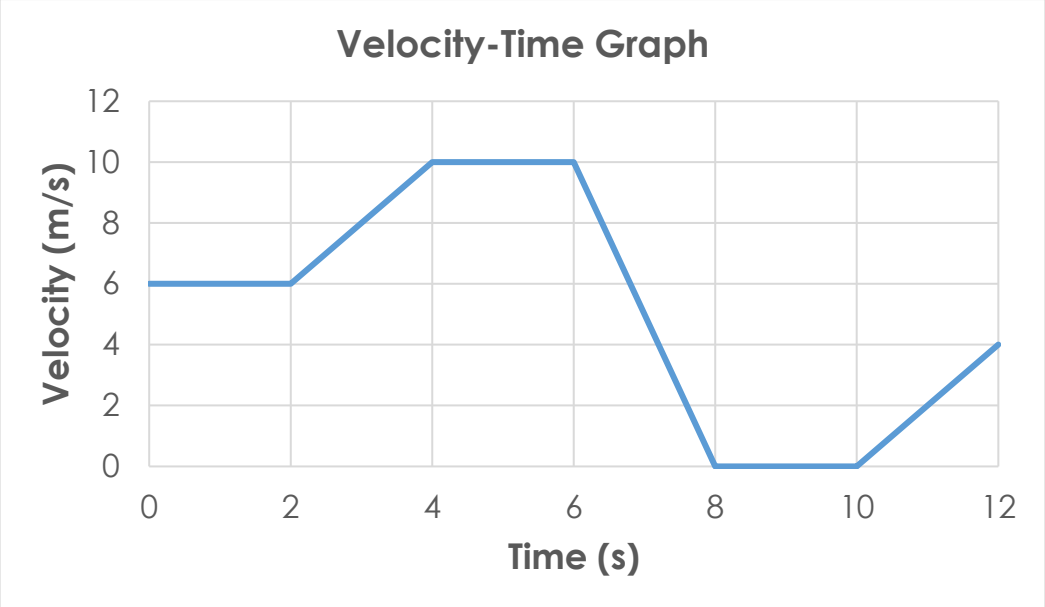
Velocity-Time Graphs Markscheme

1. Use the following velocity-time graph to answer the questions.



a. Describe the motion of this object.

- **Constant speed of 6 m/s for 2 seconds**
- **Object accelerates (uniformly) from 6 m/s to 10 m/s in 2 seconds**
- **Constant speed of 10 m/s for 2 seconds**
- **Object decelerates to a stop within 2 seconds**
- **Object is stationary (velocity = 0 m/s) for 2 seconds**
- **Object accelerates from rest to 4 m/s in another 2 seconds**

b. Calculate the total distance travelled by this object.

Distance travelled = area under the graph

Area under the graph = (2 x 6) + (2 x 6) + (1/2 x 2 x 4) + (2 x 10) + (1/2 x 2 x 10) + (1/2 x 2 x 4)

Area under the graph = 62 m

c. Calculate any values for acceleration for this graph.

Acceleration = gradient

- **Between 2 and 4 seconds:**

  Gradient = $\frac{\text{Change in y}}{\text{Change in x}}$

  Gradient = $\frac{10-6}{4-2}$

  Acceleration = 2 m/s^2

- **Between 6 and 8 seconds:**

  Gradient = Change in y

  Change in x

  Gradient = 0 - 10

  8 - 6

  Acceleration = -5 m/s²

- **Between 10 and 12 seconds:**

  Gradient = Change in y

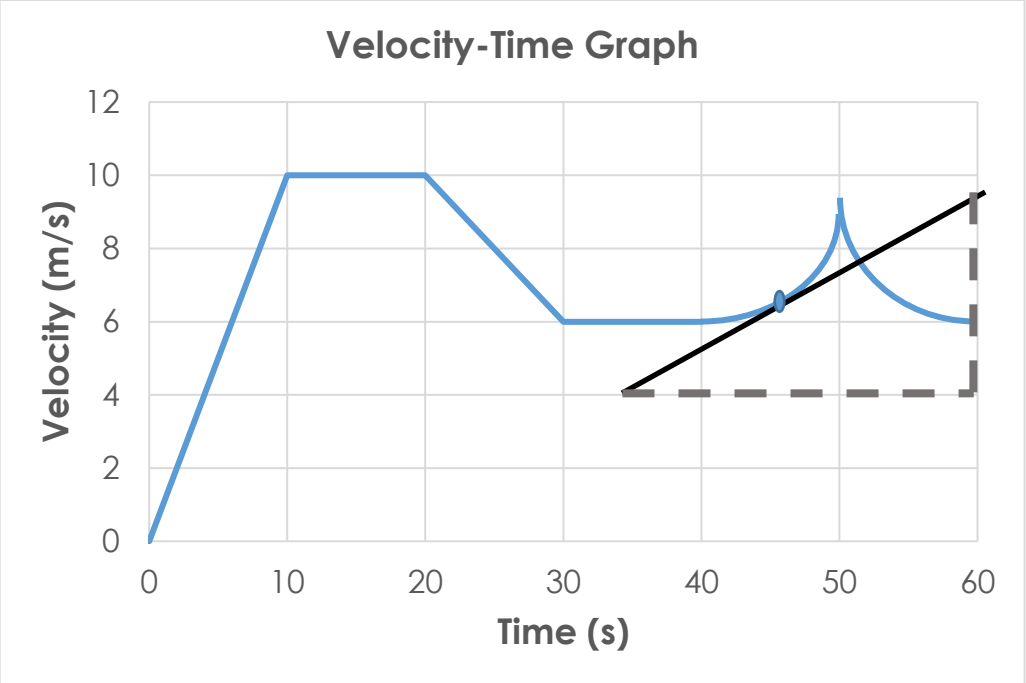
  Change in x

  Gradient = 4 – 0

  12 – 10

  Acceleration = 2 m/s²

2. Use the following velocity-time graph to answer the questions.



a. Describe the motion of this object.

- **Object accelerates from 0 to 10 m/s in 10 seconds**
- **Constant velocity for another 10 seconds**
- **Object decelerates from 10 m/s to 6 m/s in 10 seconds**
- **Constant velocity for another 10 seconds**
- **Increasing acceleration (non-uniform) for 10 seconds**
- **Decreasing deceleration (non-uniform) for 10 seconds**

b. Calculate the distance travelled by this object in the first 40 seconds.

Distance travelled = area under the graph

Area under the graph = (1/2 x 10 x 10) + (10 x 10) + (10 x 6) + (1/2 x 10 x 4)

Area under the graph = 230 m

c. Calculate:

i. The acceleration between 0 and 10 seconds

Gradient = $\frac{\text{Change in y}}{\text{Change in x}}$

Gradient = $\frac{10 - 0}{10 - 0}$

Acceleration = 1 m/s^2

ii. The acceleration between 20 and 30 seconds

Gradient = $\frac{\text{Change in y}}{\text{Change in x}}$

Gradient = $\frac{6 - 10}{30 - 20}$

Acceleration = -0.4 m/s^2

d. Describe how you could calculate the acceleration of this object after 45 seconds.

Draw a tangent to the curve and determine the gradient of the tangent.

e. Use your method from the previous question to calculate the acceleration of this object after 45 seconds.

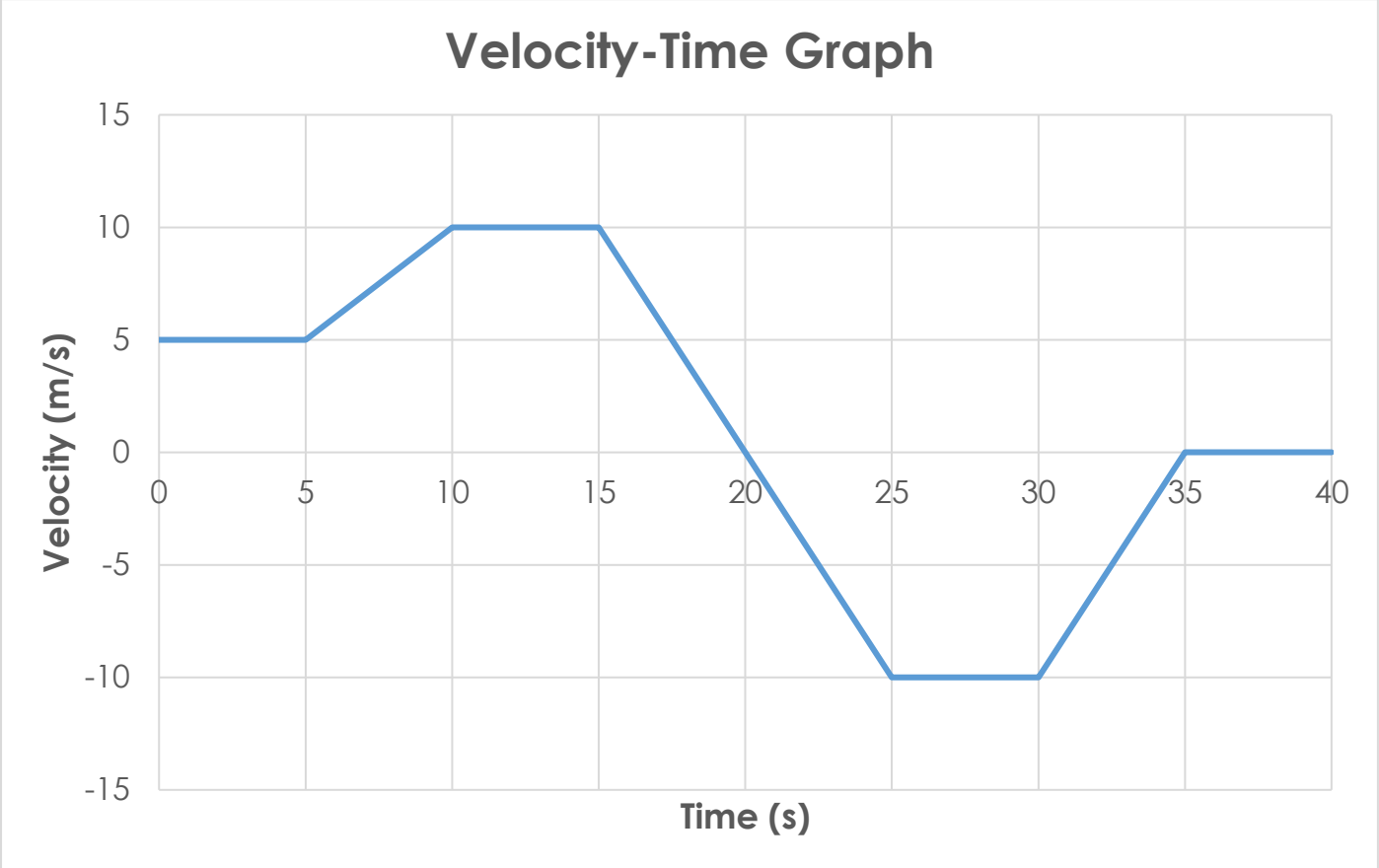
Tangent drawn on graph (these answers will vary depending on how the tangent has been drawn because it is not on square paper, but should be within 0.2 m/s^2)

Gradient = $\frac{\text{Change in y}}{\text{Change in x}}$

Gradient = $\frac{9 - 4}{60 - 35}$

Acceleration = 0.2 m/s^2

3. Use the following velocity-time graph to answer the questions.



a. Describe the motion of this object.

- **Constant speed of 5 m/s for 5 seconds**
- **Object accelerates (uniformly) from 5 m/s to 10 m/s in 5 seconds**
- **Constant speed of 10 m/s for 5 seconds**
- **Object decelerates (uniformly) from 10 m/s to rest in 5 seconds**
- **Object accelerates (uniformly) from rest to 10 m/s in the opposite direction for 5 seconds**
- **Constant speed of 10 m/s in the opposite direction for 5 seconds**
- **Object decelerates to rest in another 5 seconds**
- **Object is stationary for 5 seconds**

b. Calculate the total distance travelled by this object.

Distance travelled = area under the graph

Area under the graph = (5 x 5) + (5 x 5) + (1/2 x 5 x 5) + (5 x 10) + (1/2 x 5 x 10) + (1/2 x 10 x 5) + (5 x 10) + (1/2 x 5 x 10)

Area under the graph = 237.5 m

c. Calculate the final displacement of the object.

Displacement = area under the graph (with direction factored in)

Area under the graph = (5 x 5) + (5 x 5) + (1/2 x 5 x 5) + (5 x 10) + (1/2 x 5 x 10) + (1/2 x (-10) x 5) + (5 x (-10)) + (1/2 x 5 x (-10))

Displacement = 37.5 m forwards from original position.

d. Calculate:

i. The acceleration between 5 and 10 seconds

Gradient = $\frac{\text{Change in y}}{\text{Change in x}}$

Gradient = $\frac{10 - 5}{10 - 5}$

Acceleration = 1 m/s²

ii. The acceleration between 15 and 20 seconds

Gradient = $\frac{\text{Change in y}}{\text{Change in x}}$

Gradient = $\frac{0 - 10}{20 - 15}$

Acceleration = -2 m/s² (slowing down)

iii. The acceleration between 20 and 25 seconds

Gradient = $\frac{\text{Change in y}}{\text{Change in x}}$

Gradient = $-\frac{10 - 0}{25 - 20}$

Acceleration = -2 m/s² (accelerating in the opposite direction)

iv. The acceleration between 30 and 35 seconds

Gradient = $\frac{\text{Change in y}}{\text{Change in x}}$

Gradient = $\frac{0 - (-10)}{35 - 30}$

Acceleration = 2 m/s² (decelerating in opposite direction, double negative)