1 A train leaves a station, P, and accelerates from rest with a constant acceleration of $0.4\,m\,s^{-1}$ until it reaches a speed of $24\,m\,s^{-1}$. It maintains this speed for 6 minutes. It then decelerates uniformly with a deceleration of $0.2\,m\,s^{-1}$, until it comes to rest at station Q.

a Draw a velocity–time graph of the journey from P to Q, labelling all the relevant times. **[5 marks]**

b Calculate the distance PQ. **[2]**

2 At time $t = 0$ s, a body passes the origin with a velocity of $60\,m\,s^{-1}$, and decelerates uniformly at a rate of $4\,m\,s^{-2}$

a Determine the time at which the body is at rest. **[2]**

b Determine the times at which the body is 400 metres from the origin. **[4]**

3 Points A, B and C lie on a straight line. The distances AB and BC are 80 m and 96 m respectively. A particle moves in a straight line from A to C with an acceleration of $4\,m\,s^{-2}$. It takes 5 seconds to travel from A to B. Work out

a The speed of the particle at A, **[3]**

b The time taken for the particle to travel from B to C **[6]**

4 The displacement, s metres, of a particle, at a time t seconds, is given by the formula $s = t^3 - 9t^2 + 24t$

a Write an expression for the velocity of the particle. **[2]**

b Calculate the times at which the particle is at rest. **[3]**

c Work out the distance travelled by the particle between $t = 0$ s and $t = 5$ s **[5]**

5 A speeding van passes a police car. The van is travelling at $27\,m\,s^{-1}$, and the police car is travelling at $15\,m\,s^{-1}$. From the instant when the van is level with the police car, the police car accelerates uniformly at $3\,m\,s^{-2}$ in order to catch the van. Work out

a The time taken until the police car is level with the van, **[5]**

b The speed of the police car at this time. **[2]**

6 A man on a bicycle accelerates uniformly from rest to a velocity of $10\,m\,s^{-1}$ in 5 seconds. He maintains this speed for 20 seconds, and then decelerates uniformly to rest. His journey takes a total of T seconds.

a Draw a velocity–time graph of his journey. **[3]**

Given that he cycles a total of 265 metres, calculate

b The value of T, **[3]**

c The acceleration for the final stage of his journey. **[2]**

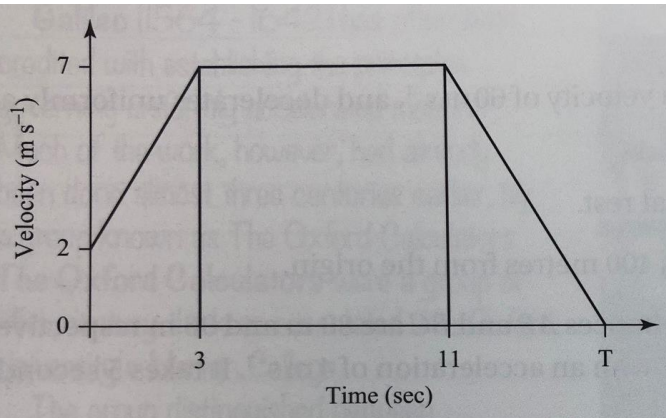
7 A car moving along a straight road with constant acceleration passes points A and B with velocities $10\,m\,s^{-1}$ and $40\,m\,s^{-1}$ respectively. Work out the velocity of the car at the instant when it passes M, the midpoint of AB **[6]**

8 A bus travels on a straight road with a constant acceleration of $0.8\,m\,s^{-2}$. A and B are two points on the road, a distance of 390 metres apart. The bus increases its velocity by $12\,m\,s^{-1}$ in travelling from A to B

a What is the speed of the bus at A? **[5]**

b Work out the time taken for the bus to travel from A to B **[2]**

9



The diagram shows the velocity–time graph of the motion of a runner over a time period of T seconds. During that time, the runner travels a distance of 76 metres.

a Write down the initial speed of the runner. **[1]**

b Work out the value of her initial acceleration. **[2]**

c Describe her motion from $t = 3$ to $t = 11$ **[1]**

d Calculate the value of T **[6]**

10 The acceleration, $a\,\text{m s}^{-2}$, of a particle moving in a straight line is given by the formula $a = 2t - 6$

At time $t = 0$, the particle is moving through the origin with a velocity of $10\,\text{m s}^{-1}$

a Write an expression for the velocity of the particle at time t [4]

b At which times is the particle moving with a velocity of $2\,\text{m s}^{-1}$? [4]

c Write an expression for the displacement of the particle at time t [4]

d Work out the displacement of the particle when $t = 6$ [2]

11 A jogger is running along a straight road with a velocity of $4\,\text{m s}^{-1}$ when she passes her friend who is stationary with a bicycle. Three seconds after the jogger is level with her friend, her friend sets off in pursuit. Her friend accelerates from rest with a constant acceleration of $2\,\text{m s}^{-2}$. When the cyclist has been riding for T seconds, the cyclist and her friend are level.

a Draw a velocity–time graph for $t = 0$ to $t = T + 3$ [3]

b Write down an equation for T [4]

c Solve this equation to find the value of T [3]

d How fast is the cyclist travelling when they draw level? [2]