AQA – Kinematics – A2 Mathematics P2

1. June/2021/Paper_7357/2/No.11

A particle's displacement, r metres, with respect to time, t seconds, is defined by the equation

$$r = 3e^{0.5t}$$

Find an expression for the velocity, $v\,\text{m}\,\text{s}^{-1}$, of the particle at time t seconds.

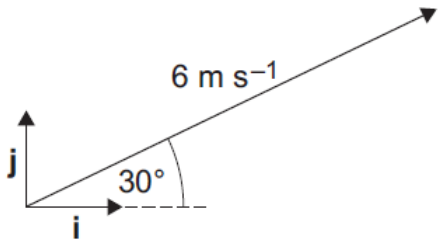
Circle your answer.

[1 mark]

$v = 1.5e^{0.5t}$ $\quad$ $v = 6e^{0.5t}$ $\quad$ $v = 1.5te^{0.5t}$ $\quad$ $v = 6te^{0.5t}$

2. June/2021/Paper_7357/2/No.12

A particle has a speed of $6\,\text{m}\,\text{s}^{-1}$ in a direction relative to unit vectors **i** and **j** as shown in the diagram below.



The velocity of this particle can be expressed as a vector $\begin{bmatrix} v_1 \\ v_2 \end{bmatrix}\,\text{m}\,\text{s}^{-1}$

Find the correct expression for v_2

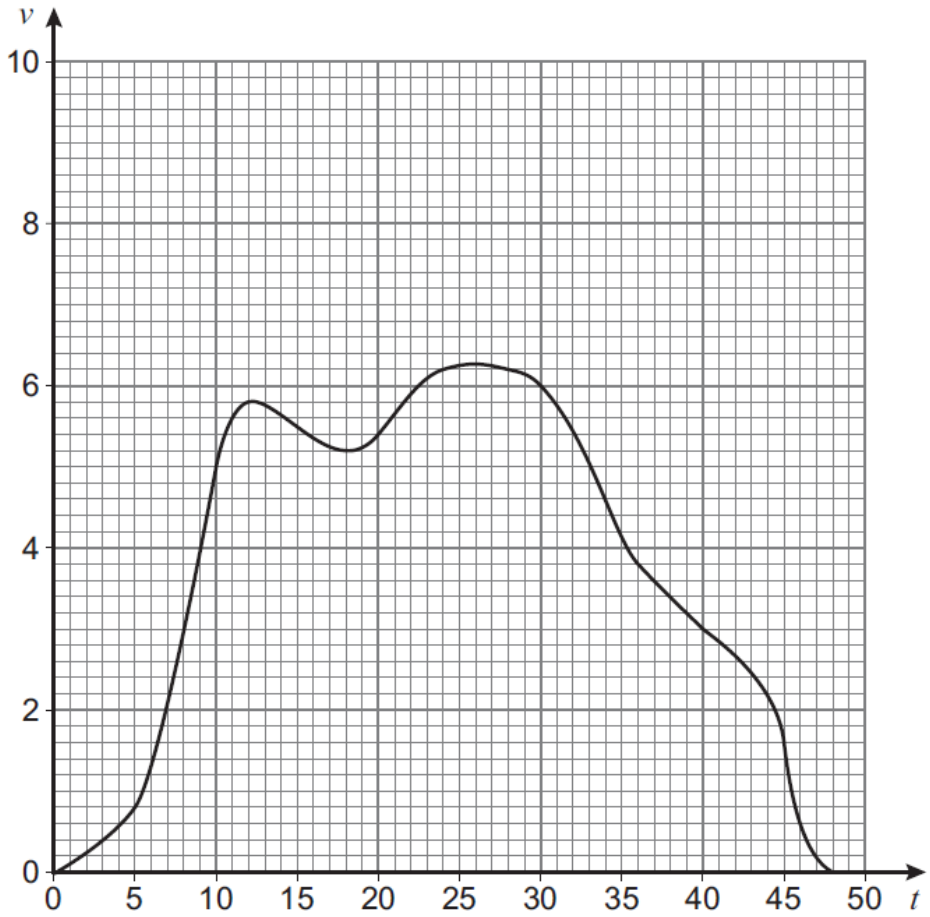
Circle your answer.

[1 mark]

$v_2 = 6\cos 30°$ $v_2 = 6\sin 30°$ $v_2 = -6\sin 30°$ $v_2 = -6\cos 30°$

3. June/2021/Paper_7357/2/No.14

A motorised scooter is travelling along a straight path with velocity $v\,\text{m}\,\text{s}^{-1}$ over time t seconds as shown by the following graph.



Noosha says that, in the period $\mathbf{12 \leq t \leq 36}$, the scooter travels approximately 130 metres.

Determine if Noosha is correct, showing clearly any calculations you have used.

[4 marks]

4. June/2021/Paper_7357/2/No.17

A ball is released from a great height so that it falls vertically downwards towards the surface of the Earth.

(a) Using a simple model, Andy predicts that the velocity of the ball, exactly 2 seconds after being released from rest, is $2g\,\text{m s}^{-1}$

Show how Andy has obtained his prediction.

[2 marks]

(b) Using a refined model, Amy predicts that the ball's acceleration, $a\,\text{m s}^{-2}$, at time t seconds after being released from rest is

$$a = g - 0.1v$$

where $v\,\text{m s}^{-1}$ is the velocity of the ball at time t seconds.

Find an expression for v in terms of t.

[7 marks]

(c) Comment on the value of v for the two models as t becomes large.

[2 marks]

5. June/2021/Paper_7357/2/No.18

Two particles, *P* and *Q*, are projected at the same time from a fixed point *X*, on the ground, so that they travel in the same vertical plane.

P is projected at an acute angle θ° to the horizontal, with speed $u\,\text{m s}^{-1}$

Q is projected at an acute angle $2\theta^\circ$ to the horizontal, with speed $2u\,\text{m s}^{-1}$

Both particles land back on the ground at exactly the same point, *Y*.

Resistance forces to motion may be ignored.

(a) Show that

$$\cos 2\theta = \frac{1}{8}$$

[6 marks]

(b) *P* takes a total of 0.4 seconds to travel from *X* to *Y*.

Find the time taken by *Q* to travel from *X* to *Y*.

[4 marks]

(c) State one modelling assumption you have chosen to make in this question.

[1 mark]

6. June/2021/Paper_7357/2/No.19

Two skaters, Jo and Amba, are separately skating across a smooth, horizontal surface of ice.

Both are moving in the same direction, so that their paths are straight and are parallel to each other.

Jo is moving with constant velocity $(2.8\mathbf{i} + 9.6\mathbf{j})\,\text{m s}^{-1}$

At time $t = 0$ seconds Amba is at position $(2\mathbf{i} - 7\mathbf{j})$ metres and is moving with a constant speed of $8\,\text{m s}^{-1}$

(a) (i) Explain why Amba's velocity must be in the form $k(2.8\mathbf{i} + 9.6\mathbf{j})\,\text{m s}^{-1}$, where k is a constant.

[1 mark]

(a) (ii) Verify that $k = 0.8$

[1 mark]

(b) Find the position vector of Amba when $t = 4$

[3 marks]

(c) At **both** $t = 0$ and $t = 4$ there is a distance of 5 metres between Jo and Amba's positions.

Determine the shortest distance between their two parallel lines of motion.

Fully justify your answer.

[5 marks]