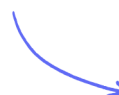


A Level • AQA • Maths

 2 hours  21 questions

Practice Paper 2 (Pure & Mechanics)

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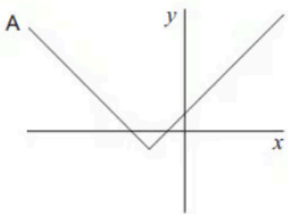
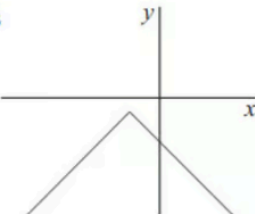
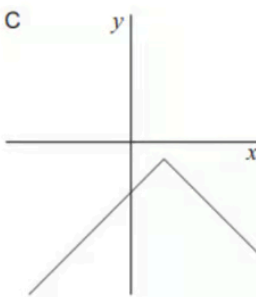
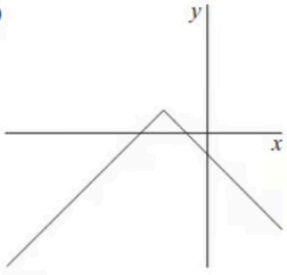


Total Marks /100

1 Identify the graph of the following equation from the options below.

$$y = -|x+2| - 1$$

Tick (✓) **one** box.

A 	B 
☐	☐
C 	D 
☐	☐

(1 mark)

2 Simplify the following expression.

$$\sqrt[3]{a^{\frac{3}{2}} \times a^{\frac{1}{3}}}$$

Circle your answer.

$a^{\frac{11}{2}}$	$a^{\frac{1}{6}}$	$a^{\frac{11}{18}}$	$a^{\frac{1}{18}}$
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(1 mark)

3 Each of these functions has domain $x \in \mathbb{R}$.

Which function has an inverse?

Circle your answer.

$f(x) = x^2$	$f(x) = x^3$	$f(x) = \sin x$	$f(x) = x $
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(1 mark)

4 Given that $x = \frac{1}{2}$ is a root of the function $f(x) = 2x^3 + (p^2 + 1)x^2 - 11x + 4$, find the possible values of p .

(4 marks)

5 (a) Given that $y > 2$, find the general solution to the differential equation

$$\frac{dy}{dx} = x^2(y - 2)$$

(4 marks)

(b) Find the general solution to the differential equation

$$\frac{dy}{dx} = \sin^2 2y$$

giving your answer in the form $x = f(y)$.

(3 marks)

6 (a) (i) Show that $R \cos(x + \alpha) \equiv R \cos \alpha \cos x - R \sin \alpha \sin x$, where R and α are constants.

(ii) Use your result from part (i) to show that $\cos x - \sqrt{3} \sin x \equiv 2 \cos\left(x + \frac{\pi}{3}\right)$.

(4 marks)

(b) Hence solve the equation $\cos x - \sqrt{3} \sin x = 1$ for $0 \leq x \leq 2\pi$.

(3 marks)

- 7 (a) Express $2x^3 + 2x^2 - 12x$ in the form $ax(x + b)(x + c)$, where a , b and c are integers to be found.

(2 marks)

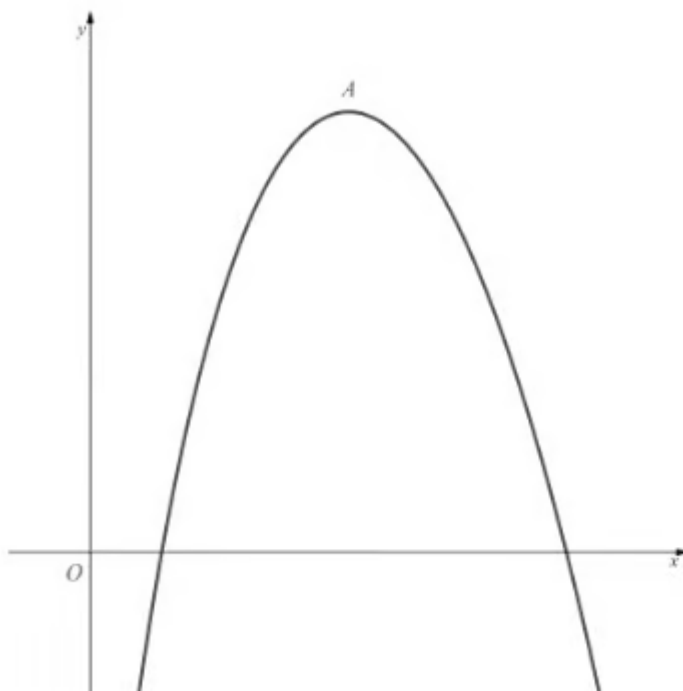
- (b) Hence sketch the graph of $y = 2x^3 + 2x^2 - 12x$, labelling any points where the graph intersects the coordinate axes.

(3 marks)

8 (a) The diagram below shows a part of the curve with equation $y = f(x)$, where

$$f(x) = 460 - \frac{x^3}{300} - \frac{8100}{x}, \quad x > 0$$

Point A is the maximum point of the curve.



Find $f'(x)$.

(3 marks)

(b) Use your answer to part (a) to find the coordinates of point A .

(4 marks)

9 (a) Show that the equation

$$x = 7e^{-0.2t}$$

can be written as

$$\ln x = \ln 7 - 0.2t$$

(2 marks)

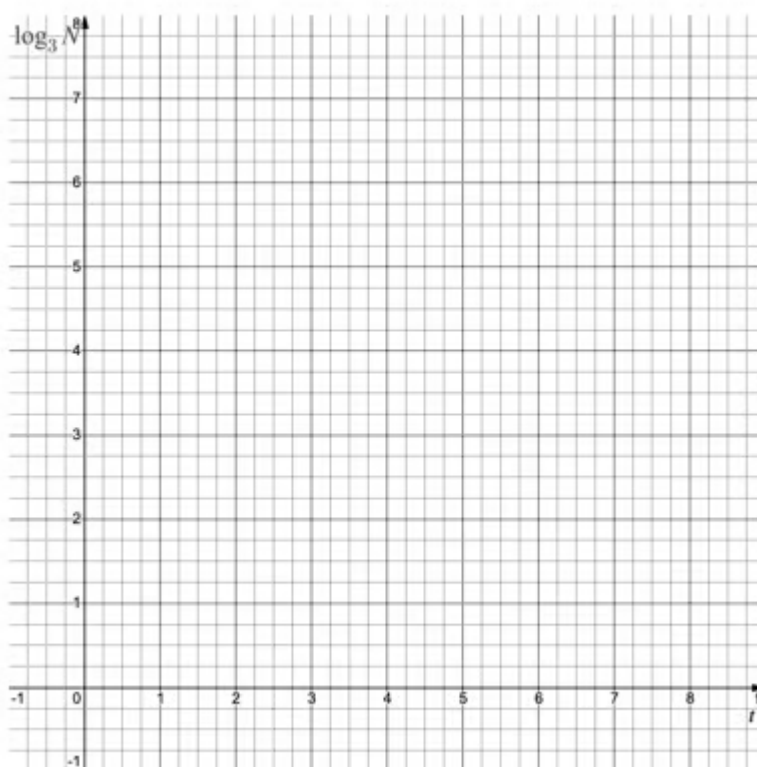
(b) Rewrite the equation $\ln y = 4.1x + \ln 8$ in the form $y = Ae^{kx}$.

(2 marks)

- 10 (a)** An exponential growth model for the number of bacteria in an experiment is of the form $N = N_0 a^{kt}$. N is the number of bacteria and t is the time in hours since the experiment began. N_0 , a and k are constants. A scientist records the number of bacteria at various points over a six-hour period. The results are shown in the table below.

t , hours	0	2	4	6
N , no. of bacteria	100	180	340	620
$\log_3 N$ (3SF)	4.19	4.73	5.31	5.85

Plot the observations on the graph below - plotting $\log_3 N$ against t



(1 mark)

- (b) Using the points (0, 4.19) and (6, 5.85), find an equation for a line of best fit in the form $\log_3 N = mt + \log_3 c$, where m and c are constants to be found.

(2 marks)

- (c) The equation $N = N_0 a^{kt}$ can be written in the form $\log_a N = kt + \log_a N_0$.
Use your answer to part (b) to estimate the values of N_0 , a , and k .

(2 marks)

11 (a) The functions $f(x)$ and $g(x)$ are given as follows

$$f(x) = (4 + 3x)^{\frac{1}{2}} \qquad g(x) = (9 - 2x)^{-\frac{1}{2}}$$

Expand $f(x)$, in ascending powers of x up to and including the term in x^2 .

(2 marks)

(b) Expand $g(x)$, in ascending powers of x up to and including the term in x^2 .

(2 marks)

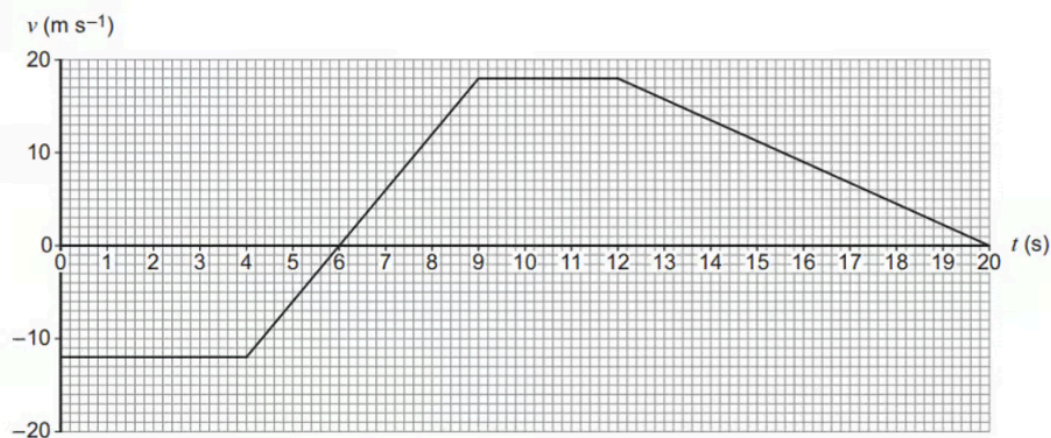
(c) Find the expansion of $\sqrt{\frac{4+3x}{9-2x}}$ in ascending powers of x , up to and including the term in x^2 .

(2 marks)

(d) Find the values of x for which your expansion in part (c) is valid.

(2 marks)

12 The diagram below shows a velocity-time graph for a particle moving with velocity $v \text{ ms}^{-1}$ at time t seconds.



Which statement is **incorrect**?

Tick (✓) **one** box.

The particle had a positive acceleration when $t = 6$	☐
The particle's speed when $t = 3$ was -12 ms^{-1}	☐
The particle was at instantaneous rest when $t = 6$	☐
The particle had a constant speed for $9 \leq t \leq 12$	☐

(1 mark)

13 An object rests on a rough horizontal surface.

The coefficient of friction between the crate and the surface is 0.4.

A forward force acts on the object, parallel to the surface.

When this force is 588 N, the object is on the point of moving.

Find the weight of the crate.

Circle your answer.

1470 N	150 kg	235.2 N	24 kg
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(1 mark)

- 14** A particle, under the action of two constant forces, is moving across a perfectly smooth horizontal surface at a constant speed of 24 ms^{-1} .

The first force acting on the particle is $(280\mathbf{i} + 210\mathbf{j}) \text{ N}$.

The second force acting on the particle is $(p\mathbf{i} - 210\mathbf{j}) \text{ N}$.

Find the value of p .

Circle your answer.

280	-256	256	-280
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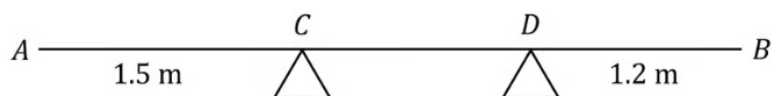
(1 mark)

- 15** A car travelling along a horizontal road passes a point A with velocity 21 m s^{-1} and constant acceleration 0.2 m s^{-2} . Point B is 1.5 km from point A . When the car reaches point B it decelerates uniformly at 3.1 m s^{-2} until it comes to rest.

Find the distance the car travels from the moment it starts to decelerate until it comes to rest. Give your answer to an appropriate degree of accuracy.

(5 marks)

- 16** In the diagram below AB is a uniform beam of length 4 m. It rests horizontally on two supports placed at points C and D , such that $AC = 1.5 \text{ m}$ and $DB = 1.2 \text{ m}$ as shown:



A stone of mass 10 kg is placed at point B and the beam is on the point of tilting. That stone is removed, and another stone of mass $m_A \text{ kg}$ is placed at point A which causes the beam to begin tilting.

Given that the stones may be modelled as particles, show that $m_A > k$, where k is the largest possible constant for which that inequality must be true.

(6 marks)

- 17 (a)** A horse running across a large area of open countryside starts to gallop with constant acceleration $(0.6\mathbf{i} + 0.4\mathbf{j}) \text{ m s}^{-2}$. After 12 seconds of galloping the horse has velocity $(8\mathbf{i} + 10\mathbf{j}) \text{ m s}^{-1}$.

Find the displacement of the horse at the end of its 12 second gallop.

(2 marks)

- (b)** Find the change in speed of the horse between the start and end of its 12 second gallop.

(4 marks)

- 18** It takes 6 minutes for a particle to travel $\left(\frac{5.94}{13.86}\right)$ km with constant acceleration. The particle's velocity at the start of the 6 minutes is one-tenth of its velocity at the end. Find the acceleration of the particle.

(6 marks)

19 (a) A bullet train has a maximum acceleration of 0.72 m s^{-2} .

One such train leaves a station at time $t = 0$ seconds and its displacement, $s \text{ m}$, from the station is modelled using the equation

$$s = \frac{3}{200}t^3 \quad 0 \leq t \leq 8$$

Show that it takes 8 seconds for the bullet train to reach its maximum acceleration.

(4 marks)

- (b)** After reaching its maximum acceleration the bullet train continues to accelerate at that rate until its velocity reaches its maximum of 75 m s^{-1} .

How long does it take for this increase in velocity to happen?

(3 marks)

- (c)** Once reaching its maximum velocity, the bullet train continues at this velocity for 10 minutes. Find the displacement of the train from the station at this time, giving your answer in kilometres to 3 significant figures.

(3 marks)

- 20 (a)** Once an aircraft reaches its cruising height (at time $t = 0$ hours) its acceleration is modelled by

$$\mathbf{a} = (4t^3 - 6t^2)\mathbf{i} + (0.9t^2 - 1)\mathbf{j} \text{ km h}^{-2}$$

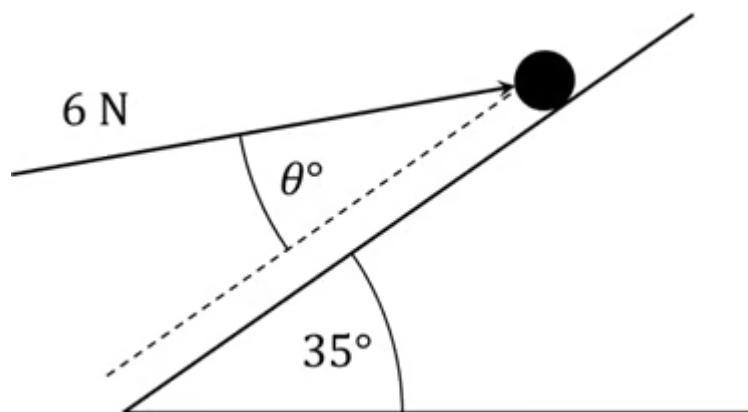
Given that the velocity of the aircraft at $t = 5$ hours is $\mathbf{v} = 400\mathbf{i} + 40\mathbf{j} \text{ km h}^{-1}$, find the velocity of the aircraft in terms of t .

(3 marks)

- (b)** Find the speed of the aircraft when it first reaches its cruising height.

(2 marks)

- 21** A particle of mass 0.5 kg is at rest on a rough plane which is inclined at 35° to the horizontal. The particle is being acted upon by a force of 6 N, directed at an angle of θ° to the plane. The line of action of the force is in the same vertical plane as the line of greatest slope of the inclined plane.



Given that the coefficient of friction between the particle and the plane is 0.4, and that the particle is on the point of slipping up the plane, find the value of θ .

(9 marks)