



National  
Qualifications  
EXEMPLAR PAPER ONLY

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**EP30/H/02**

**Mathematics  
Paper 2**

Date — Not applicable

Duration — 1 hour and 30 minutes

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**Total marks — 70**

Attempt ALL questions.

**You may use a calculator.**

Full credit will be given only to solutions which contain appropriate working.

State the units for your answer where appropriate.

Write your answers clearly in the answer booklet provided. In the answer booklet you must clearly identify the question number you are attempting.

Use **blue** or **black** ink.

Before leaving the examination room you must give your answer booklet to the Invigilator; if you do not you may lose all the marks for this paper.



\* EP30H02 \*

## FORMULAE LIST

### Circle:

The equation  $x^2 + y^2 + 2gx + 2fy + c = 0$  represents a circle centre  $(-g, -f)$  and radius  $\sqrt{g^2 + f^2 - c}$ .

The equation  $(x - a)^2 + (y - b)^2 = r^2$  represents a circle centre  $(a, b)$  and radius  $r$ .

### Scalar Product:

$\mathbf{a} \cdot \mathbf{b} = |\mathbf{a}| |\mathbf{b}| \cos \theta$ , where  $\theta$  is the angle between  $\mathbf{a}$  and  $\mathbf{b}$

or  $\mathbf{a} \cdot \mathbf{b} = a_1 b_1 + a_2 b_2 + a_3 b_3$  where  $\mathbf{a} = \begin{pmatrix} a_1 \\ a_2 \\ a_3 \end{pmatrix}$  and  $\mathbf{b} = \begin{pmatrix} b_1 \\ b_2 \\ b_3 \end{pmatrix}$ .

### Trigonometric formulae:

$$\sin(A \pm B) = \sin A \cos B \pm \cos A \sin B$$

$$\cos(A \pm B) = \cos A \cos B \mp \sin A \sin B$$

$$\sin 2A = 2 \sin A \cos A$$

$$\cos 2A = \cos^2 A - \sin^2 A$$

$$= 2 \cos^2 A - 1$$

$$= 1 - 2 \sin^2 A$$

### Table of standard derivatives:

$f(x)$	$f'(x)$
$\sin ax$ $\cos ax$	$a \cos ax$ $-a \sin ax$

### Table of standard integrals:

$f(x)$	$\int f(x) dx$
$\sin ax$	$-\frac{1}{a} \cos ax + C$
$\cos ax$	$\frac{1}{a} \sin ax + C$

**Total marks – 70**  
**Attempt ALL questions**

**MARKS**

1. A sequence is defined by  $u_{n+1} = -\frac{1}{2}u_n$  with  $u_0 = -16$ .

(a) Determine the values of  $u_1$  and  $u_2$ .

**1**

(b) A second sequence is given by 4, 5, 7, 11, . . . .

It is generated by the recurrence relation  $v_{n+1} = pv_n + q$  with  $v_1 = 4$ .

Find the values of  $p$  and  $q$ .

**3**

(c) Either the sequence in (a) or the sequence in (b) has a limit.

(i) Calculate this limit.

(ii) Why does this other sequence not have a limit?

**3**

2. (a) Relative to a suitable set of coordinate axes, Diagram 1 shows the line  $2x - y + 5 = 0$  intersecting the circle  $x^2 + y^2 - 6x - 2y - 30 = 0$  at the points P and Q.

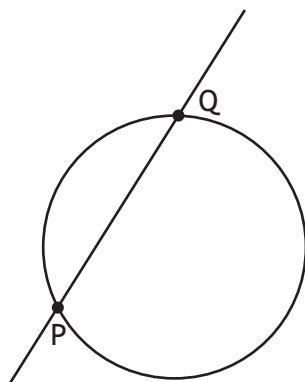


Diagram 1

Find the coordinates of P and Q.

**6**

(b) Diagram 2 shows the circle from (a) and a second congruent circle, which also passes through P and Q.

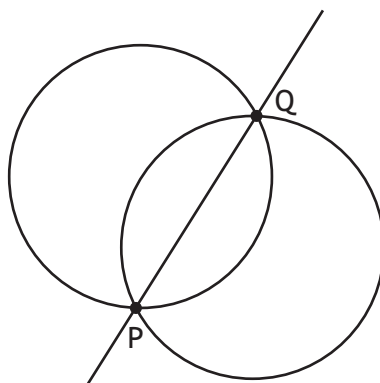


Diagram 2

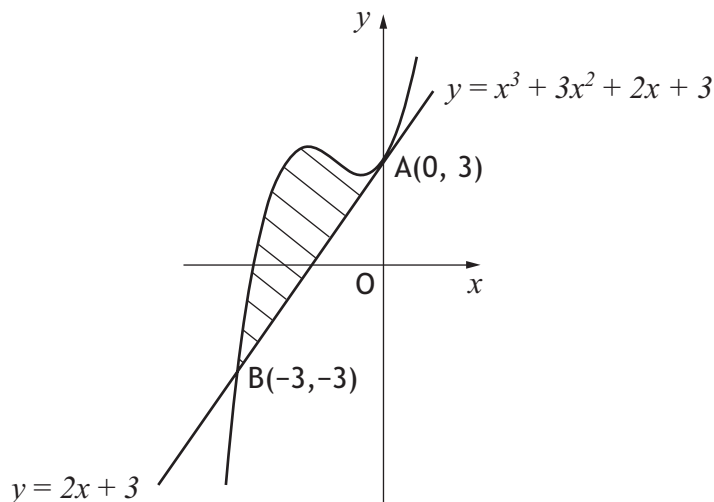
Determine the equation of this second circle.

**6**

3. Find the value of  $p$  such that the equation  $x^2 + (p+1)x + 9 = 0$  has no real roots.

4

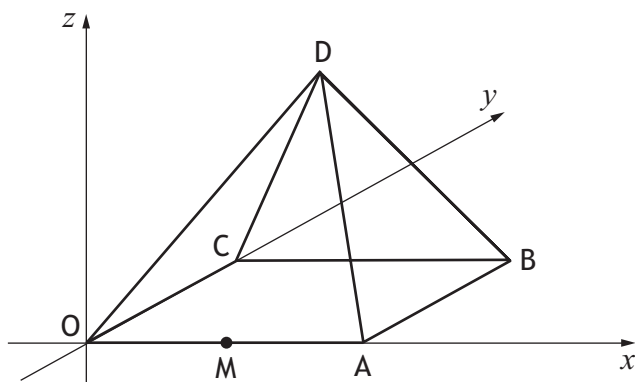
4. The line with equation  $y = 2x + 3$  is a tangent to the curve with equation  $y = x^3 + 3x^2 + 2x + 3$  at  $A(0, 3)$ , as shown.



The line meets the curve again at  $B(-3, -3)$ . Find the area enclosed by the line and the curve.

5

5.  $D, OABC$  is a square-based pyramid as shown.



$O$  is the origin and  $OA = 4$  units.

$M$  is the mid-point of  $OA$ .

$$\overrightarrow{OD} = 2\mathbf{i} + 2\mathbf{j} + 6\mathbf{k}$$

(a) Express  $\overrightarrow{OB}$  in terms of  $\mathbf{i}$  and  $\mathbf{j}$  and  $\mathbf{k}$ .

1

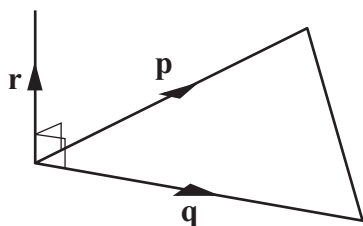
(b) Express  $\overrightarrow{DB}$  and  $\overrightarrow{DM}$  in component form.

3

(c) Find the size of angle  $BDM$ .

5

6. An equilateral triangle with sides of length 3 units is shown.



Vector  $\mathbf{r}$  is 2 units long and is perpendicular to both vectors  $\mathbf{p}$  and  $\mathbf{q}$ .

Calculate the value of the scalar product  $\mathbf{p} \cdot (\mathbf{p} + \mathbf{q} + \mathbf{r})$ .

4

7. The concentration of the pesticide, *Xpesto*, in soil can be modelled by the equation.

$$P_t = P_0 e^{-kt}$$

where:

- $P_0$  is the initial concentration;
- $P_t$  is the concentration at time  $t$ ;
- $t$  is the time, in days, after the application of the pesticide.

Once in the soil, the half-life of a pesticide is the time taken for its concentration to be reduced to one half of its initial value.

- (a) If the half-life of *Xpesto* is 25 days, find the value of  $k$  to 2 significant figures.

4

On all *Xpesto* packaging, the manufacturer states that 80 days after application the concentration of *Xpesto* in the soil will have decreased by over 90%.

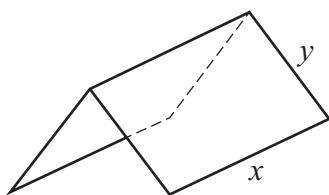
- (b) Is this statement correct? Justify your answer.

4

8. Given that  $\int_{\frac{\pi}{8}}^a 5 \sin\left(4x - \frac{\pi}{2}\right) dx = \frac{10}{4}$ ,  $0 \leq a < \frac{\pi}{2}$ , calculate the value of  $a$ .

6

9. A manufacturer is asked to design an open-ended shelter, as shown:



The frame of the shelter is to be made of rods of two different lengths:

- $x$  metres for top and bottom edges;
- $y$  metres for each sloping edge.

The total length,  $L$  metres, of the rods used in a shelter is given by:

$$L = 3x + \frac{48}{x}$$

To minimise production costs, the total length of rods used for a frame should be as small as possible.

- (a) Find the value of  $x$  for which  $L$  is a minimum.

5

The rods used for the frame cost £8.25 per metre.

The manufacturer claims that the minimum cost of a frame is less than £195.

- (b) Is this claim correct? Justify your answer.

2

10. Acceleration is defined as the rate of change of velocity.

An object is travelling in a straight line. The velocity,  $v$  m/s, of this object,  $t$  seconds after the start of the motion, is given by  $v(t) = 8\cos(2t - \frac{\pi}{2})$ .

(a) Find a formula for  $a(t)$ , the acceleration of this object,  $t$  seconds after the start of the motion.

3

(b) Determine whether the velocity of the object is increasing or decreasing when  $t = 10$ .

2

(c) Velocity is defined as the rate of change of displacement.

Determine a formula for  $s(t)$ , the displacement of the object, given that  $s(t) = 4$  when  $t = 0$ .

3

[END OF EXEMPLAR QUESTION PAPER]