# Dr Oliver Mathematics
## AQA Further Maths Level 2
## June 2021 Paper 2
## 2 hours

The total number of marks available is 80.
You must write down all the stages in your working.
You are permitted to use a scientific or graphical calculator in this paper.

1. Expand and simplify (3)
$$5(2x - 1) + 4(11 - x).$$

   Give your answer in the form
$$a(bx + c),$$

   where $a$, $b$, and $c$ are integers greater than 1

2. $5m$ is decreased by 40%.
   The answer is $(m + 1)$.
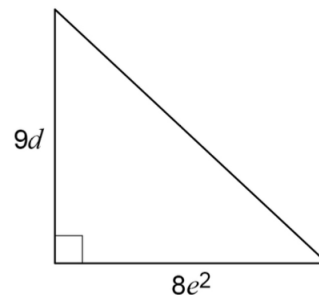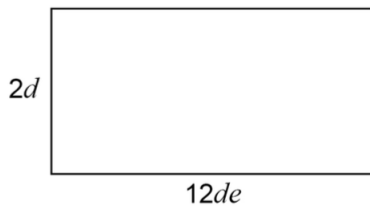
   (a) Work out the value of $m$. (2)

   (b) Solve (2)
$$\sqrt[3]{2w - 10} = 18.$$

3. The rectangle and triangle shown have equal areas. (3)



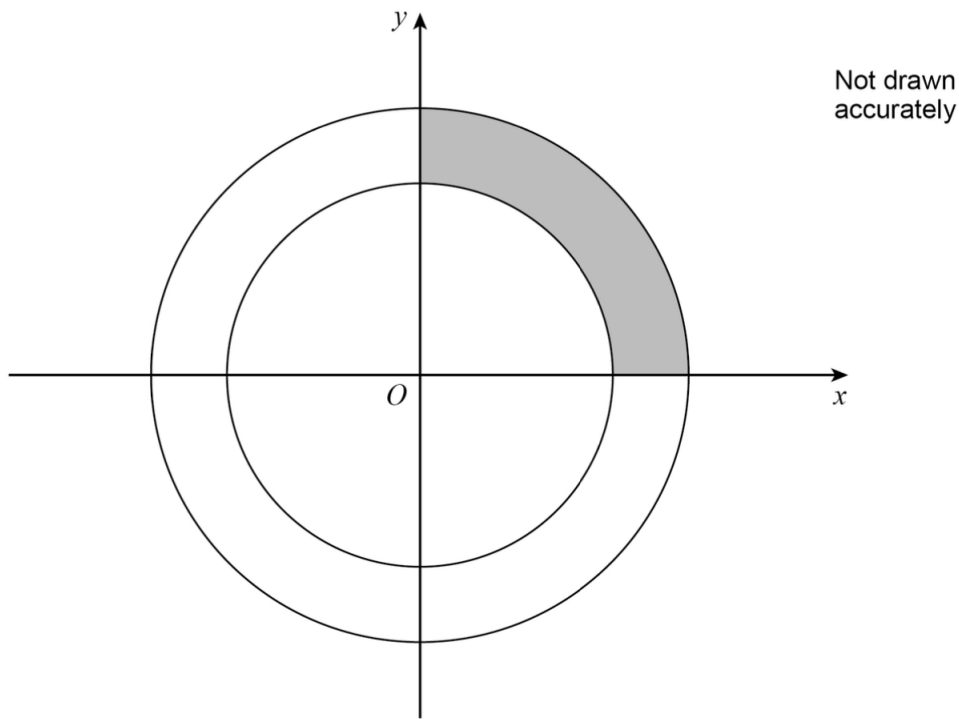Not drawn accurately

   Work out the value of
$$\frac{d}{e}.$$

   Give your answer in its simplest form.

4. The equations of the two circles shown are (3)
$$x^2 + y^2 = 100 \text{ and } x^2 + y^2 = 36.$$

Work out the shaded area.
Give your answer as an integer multiple of $pi$.

5. $SQR$ is a right-angled triangle. (3)

  - $P$ is a point on $SQ$.
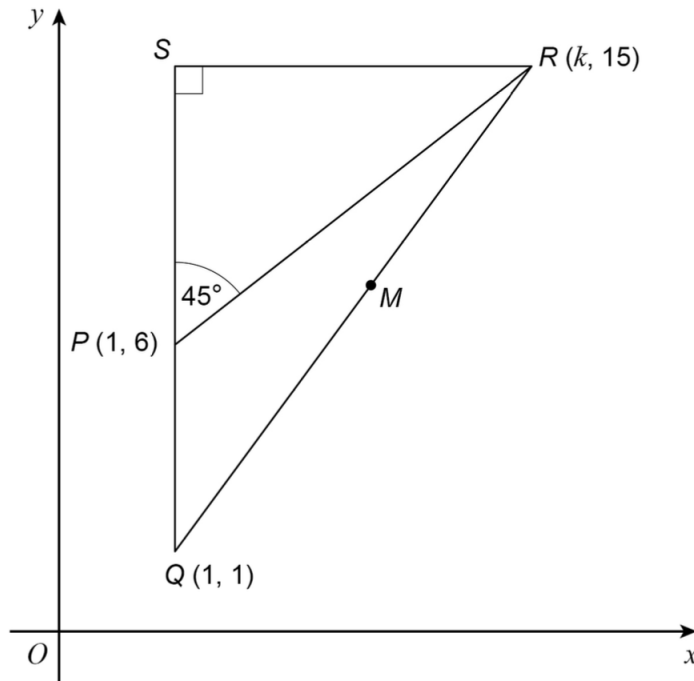  - Angle $SPR = 45°$.
  - $M$ is the midpoint of $QR$.
  - $k$ is a constant.

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Work out the coordinates of $M$.

6. Rearrange (3)
$$y = \sqrt{\frac{x + 2w}{3}}$$

to make $w$ the subject.

7. $a$ is a value greater than 1.

   (a) Work out the value of $m$ for which (2)
   $$(a^m)^4 = (a^5)^{2m}.$$
   $$w^3 x^2 y^5 = w^{13} x^7.$$

   (b) Write $y$ in terms of $w$ and $x$. (2)
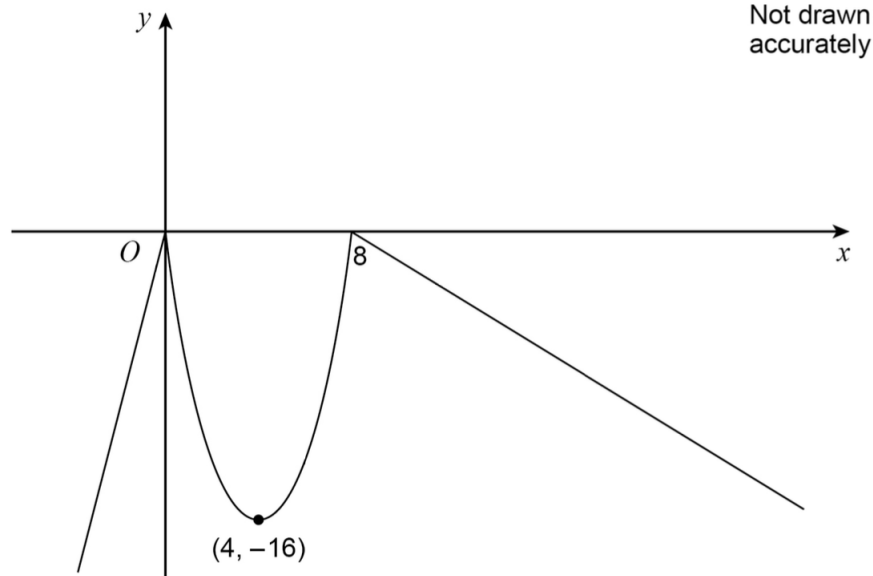   Give your answer in its simplest form.

8. A function f is given by (4)
$$f(x) = \begin{cases} 4x, & x < 0, \\ x^2 - 8x, & 0 \leqslant x \leqslant 8, \\ 16 - 2x, & x > 8. \end{cases}$$

A sketch of $y = f(x)$ is shown.



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Work out **all** the values of $x$ for which

$$f(x) = -12.$$

9. (a) Circle the expression that is equivalent to (1)

$$\frac{1}{a} + \frac{1}{b}:$$

$$\frac{2}{a+b} \qquad \frac{ab}{b+a} \qquad \frac{2}{ab} \qquad \frac{b+a}{ab}.$$

(b) Simplify fully (3)

$$\frac{6c^4 - c^3}{36c^2 - 1}.$$

10. The radius of a sphere, in cm, is $\frac{3}{2}k$. (3)

The volume of the sphere, in cm$^3$, is $972\pi$.

> Volume of a sphere $= \dfrac{4}{3}\pi r^3$    where $r$ is the radius

Work out the value of $k$.

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11. Expand and simplify fully (3)
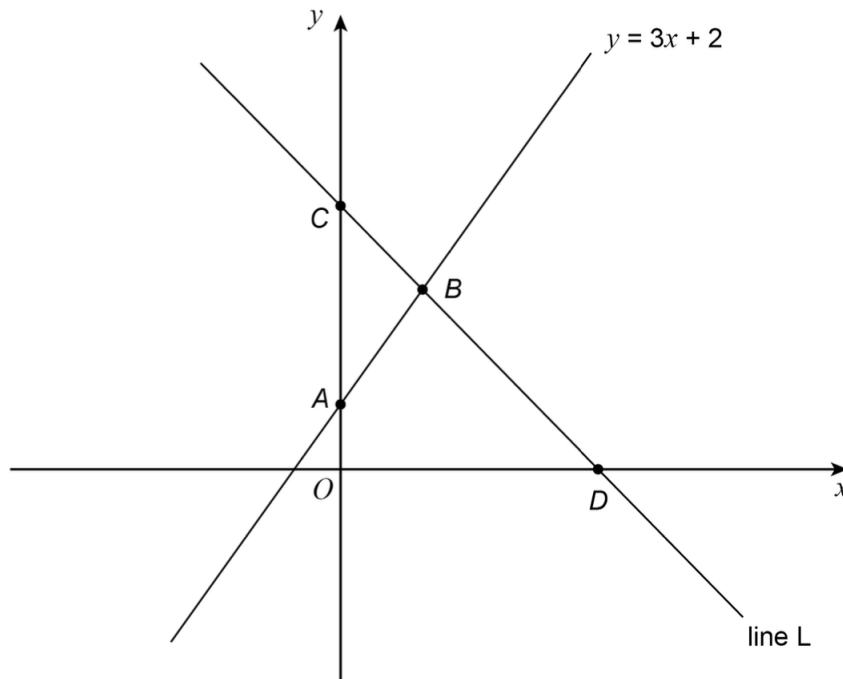$$(5x + 3y^2)(4x - y^2).$$

12. $A$ and $B$ are points on the line (5)
$$y = 3x + 2.$$

- $B$, $C$, and $D(5, 0)$ are points on the line L.
- $OA : AC = 1 : 4.$



y = 3x + 2

Not drawn accurately

line L

Work out the $x$-coordinate of $B$.

13. $P$ is the point on the curve (4)
$$y = ax^3 + 10x^2,$$
where $x = 2$.

The gradient of the **normal** to the curve at $P$ is $-\frac{1}{4}$.

Work out the value of $a$.

14.
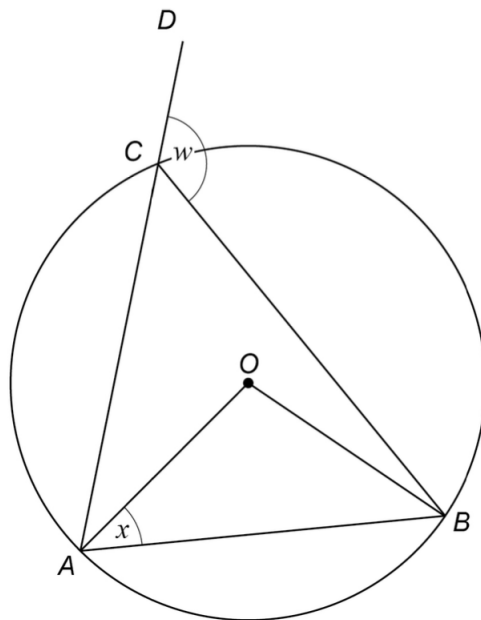$$\mathbf{A} = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}.$$

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(a) Describe geometrically the single transformation represented by $\mathbf{A}$.  (1)

$$\mathbf{B} = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}.$$

(b) Describe geometrically the single transformation represented by $\mathbf{B}^2$.  (2)

15. $A$, $B$, and $C$ are points on a circle, centre $O$.  (5)

- $ACD$ is a straight line.
- Angle $BCD = w$.



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Prove that
$$w = x + 90°.$$
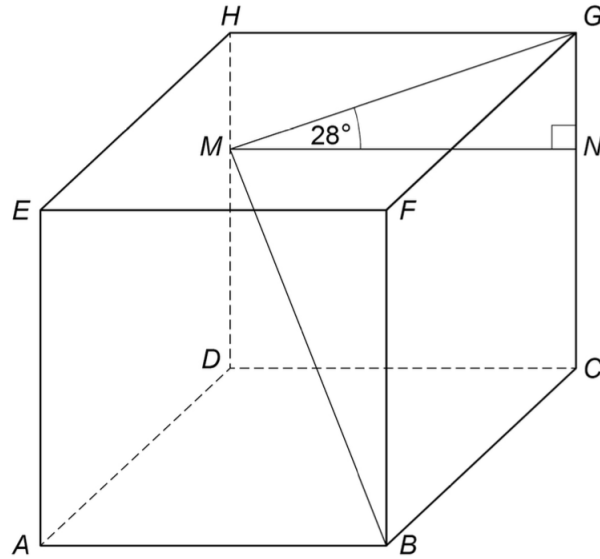
16. The coefficient of $x^4$ in the expansion of  (3)

$$(a + 2x)^6$$

is $1\,500$.

Work out the two possible values of $a$.

17. $ABCDEFGH$ is a cube with side length 32 cm.  (5)
$M$ and $N$ are points on $DH$ and $CG$ respectively.

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Work out the size of the angle that the line $BM$ makes with the plane $ABCD$.

18. (5)
$$y = 12x + \frac{3}{x}.$$

Show that $y$ has a minimum value when $x = 0.5$.

19.
$$f(x) = (x + 2)^3.$$

g is a function such that
$$g\,f(x) = (x + 2)^{12}.$$

   (a) Work out an expression for $g(x)$. (1)

$$h(x) = x^2 + 5.$$

m is a function such that
$$h\,m(x) = 4x^2 + 5.$$

   (b) Work out an expression for $m\,h(x)$. (2)

20. Show that (4)
$$\frac{2\sin x + \cos x}{\tan x} - \frac{1}{\sin x}$$

can be written in the form
$$a\cos x + b\sin x,$$

where $a$ and $b$ are integers.

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21.                                                                                                          (6)

$$3x^2 + 2bx + 8a$$

can be written in the form

$$3(x + a)^2 + b + 2.$$

Work out the two possible pairs of values of $a$ and $b$.