

Dr Oliver Mathematics
Mathematics: National Qualifications N5
2026 Paper 2: Calculator
1 hour 30 minutes

The total number of marks available is 50.

To earn full marks you must show your working in your answers.

1. A van was valued at £22 600.

(4)

Its value depreciated by 28% each year for the next three years.

Calculate the value of the van after three years.

Give your answer correct to 3 significant figures.

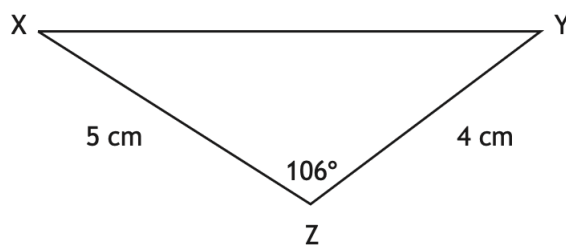
Solution

Well,

$$\begin{aligned}\text{the value of the van} &= (1 - 0.28)^3 \times 22\,600 \\ &= (0.72)^3 \times 22\,600 \\ &= 8\,435.404\,8 \\ &= \underline{\underline{\pounds 8\,440}} \quad (3 \text{ sf}).\end{aligned}$$

2. In triangle XYZ :

(3)



- $XZ = 5$ centimetres.
- $YZ = 4$ centimetres.
- Angle $XZY = 106^\circ$.

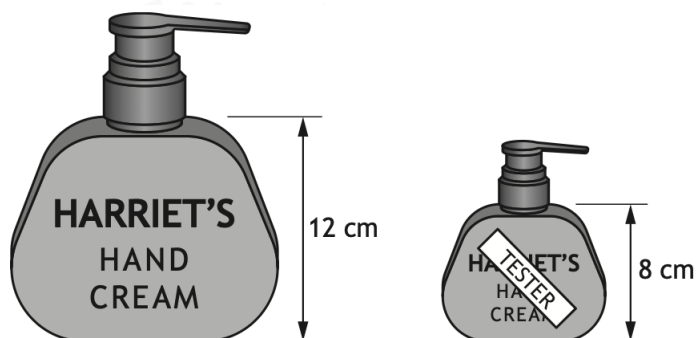
Calculate the length of XY .

Solution

Cosine rule:

$$\begin{aligned} XY^2 &= XZ^2 + YZ^2 - 2 \times XZ \times YZ \times \cos XYZ \\ \Rightarrow XY^2 &= 5^2 + 4^2 - 2 \times 5 \times 4 \times \cos 106^\circ \\ \Rightarrow XY^2 &= 52.025\,494\,23 \text{ (FCD)} \\ \Rightarrow XY &= 7.212\,870\,041 \text{ (FCD)} \\ \Rightarrow \underline{\underline{XY}} &= \underline{\underline{7.21 \text{ cm (3 sf)}}}. \end{aligned}$$

3. Harriet's Hand Cream is available in two sizes of bottles which are mathematically similar. (3)



- The larger bottle has a height of 12 centimetres and a volume of 540 millilitres.
- The tester bottle has a height of 8 centimetres.

Calculate the volume of the tester bottle.

Solution

Well, the length scale factor (LSF) is

$$\frac{8}{12} = \frac{2}{3}$$

and the volume scale factor (VSF) is

$$\left(\frac{2}{3}\right)^3 = \frac{8}{27}.$$

Hence,

$$\begin{aligned}\text{volume of the tester bottle} &= \frac{8}{27} \times 540 \\ &= \underline{\underline{160 \text{ millilitres}}}.\end{aligned}$$

4. For a hobby, Alex makes cups and plates.

To make 5 cups and 6 plates, it takes Alex 45 minutes.

Let c be the number of minutes Alex takes to make a cup and p be the number of minutes Alex takes to make a plate.

- (a) Write down an equation in c and p . (1)

Solution

$$\underline{\underline{5c + 6p = 45}} \quad (1)$$

To make 7 cups and 4 plates, it takes Alex 52 minutes.

- (b) Write down an equation in c and p to illustrate this information. (1)

Solution

$$\underline{\underline{7c + 4p = 52}} \quad (2)$$

- (c) Calculate, algebraically, the **total** number of minutes it will take Alex to make 10 cups and 8 plates. (4)

Solution

Do $2 \times (1)$ and $3 \times (2)$:

$$10c + 12p = 90 \quad (3)$$

$$21c + 12p = 156 \quad (4).$$

Do $(4) - (3)$:

$$11c = 66 \Rightarrow c = 6$$

making $c = 6$ in (1):

$$\Rightarrow 5(6) + 6p = 45$$

$$\Rightarrow 30 + 6p = 45$$

$$\Rightarrow 6p = 15$$

$$\Rightarrow p = 2.5.$$

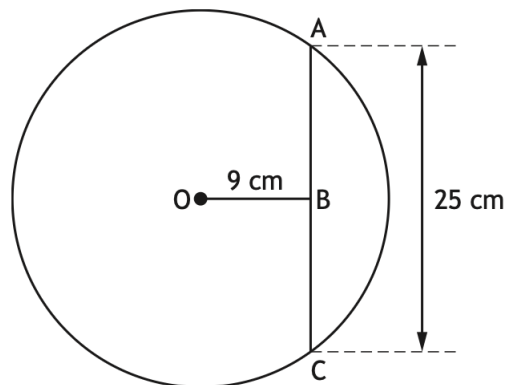
[Check: $7(6) + 4(2.5) = 52 \checkmark$]

Finally,

$$\begin{aligned}\text{total number of minutes} &= 10(6) + 8(2.5) \\ &= 60 + 20 \\ &= \underline{80 \text{ minutes}}.\end{aligned}$$

5. The diagram shows a circle, centre O , with chord AC .

(3)



- AC is 25 centimetres.
- B is the midpoint of AC .
- OB is 9 centimetres.

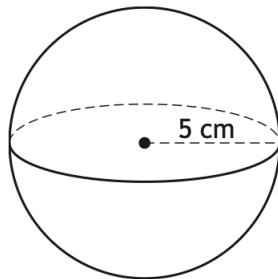
Calculate the length of the radius of the circle.

Solution

Pythagoras' theorem:

$$\begin{aligned}OA^2 &= OB^2 + AB^2 \Rightarrow OA^2 = OB^2 + \left[\frac{1}{2}AC\right]^2 \\&\Rightarrow OA^2 = OB^2 + \left[\frac{1}{2}(25)\right]^2 \\&\Rightarrow OA^2 = 9^2 + 12.5^2 \\&\Rightarrow OA^2 = 237.25 \\&\Rightarrow OA = \frac{1}{2}\sqrt{949} \text{ or } 15.4 \text{ cm (3 sf)}.\end{aligned}$$

6. A sphere has radius 5 centimetres.



- (a) Calculate the volume of the sphere.

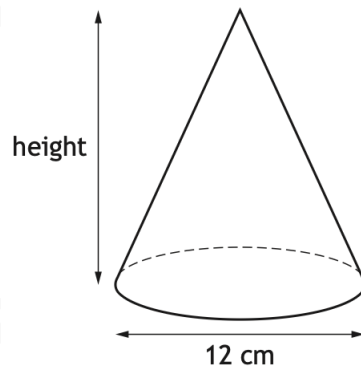
(2)

Solution

Well,

$$\begin{aligned}\text{volume of the sphere} &= \frac{4}{3}\pi r^3 \\&= \frac{4}{3} \times \pi \times 5^3 \\&= \frac{500}{3}\pi \text{ or } 524 \text{ cm}^3 \text{ (3 sf)}.\end{aligned}$$

This cone has the same volume as the sphere.



The base of the cone has diameter 12 centimetres.

(b) Calculate the height of the cone.

(3)

Solution

Now, the radius of the base is

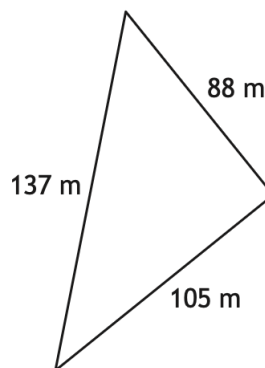
$$\frac{12}{2} = 6$$

and so

$$\begin{aligned}\frac{1}{3}\pi r^2 h &= \frac{500}{3}\pi \Rightarrow \frac{1}{3} \times 6^2 \times h = \frac{500}{3} \\ &\Rightarrow \underline{\underline{h = 13\frac{8}{9} \text{ cm.}}}\end{aligned}$$

7. A triangle has sides of length 88 metres, 105 metres and 137 metres.

(3)



Determine whether the triangle is right-angled.

Justify your answer.

Solution

Well,

$$\begin{aligned}88^2 + 105^2 &= 7\,744 + 11\,025 \\&= 18\,769 \\&= 137^2;\end{aligned}$$

so, the triangle fits Pythagoras' theorem.

Hence, the triangle is right-angled.

8. Solve the equation

$$5 \tan x^\circ + 3 = 4, \text{ for } 0 \leq x < 360.$$

(3)

Solution

Now,

$$\begin{aligned}5 \tan x^\circ + 3 &= 4 \Rightarrow 5 \tan x^\circ = 1 \\&\Rightarrow \tan x^\circ = \frac{1}{5} \\&\Rightarrow x = 11.309\,932\,47, 191.309\,932\,5 \text{ (FCD)} \\&\Rightarrow \underline{\underline{x = 11.3, 191 \text{ (3 sf)}}}.\end{aligned}$$

9. Express

$$\frac{x^2 - 81}{5} \div \frac{x + 9}{2}, x \neq -9,$$

(3)

as a single fraction in its simplest form.

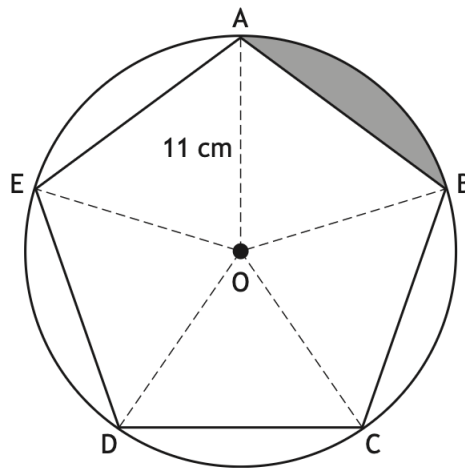
Solution

Difference of two squares:

$$\begin{aligned}\frac{x^2 - 81}{5} \div \frac{x + 9}{2} &= \frac{x^2 - 9^2}{5} \times \frac{2}{x + 9} \\ &= \frac{(x + 9)(x - 9)}{5} \times \frac{2}{x + 9} \\ &= \frac{\cancel{(x + 9)}(x - 9)}{5} \times \frac{2}{\cancel{x + 9}} \\ &= \underline{\underline{\frac{2}{5}(x - 9)}}.\end{aligned}$$

10. The vertices of a regular pentagon, $ABCDE$, lie on a circle, centre O .

(5)



The radius of the circle is 11 centimetres.

Calculate the area of the shaded segment.

Solution

Well,

$$\frac{360}{5} = 72^\circ$$

and

$$\begin{aligned}\text{shaded segment} &= \text{segment} - \text{triangle} \\ &= \left[\frac{72}{360} \times \pi \times 11^2 \right] - \left[\frac{1}{2} \times 11^2 \times \sin 72^\circ \right] \\ &= 18.487\,622\,98 \text{ (FCD)} \\ &= \underline{\underline{18.5 \text{ cm}^2 \text{ (3 sf)}}}.\end{aligned}$$

11. Simplify

(3)

$$\frac{a^{17}}{(3a^4)^3}.$$

Solution

Well,

$$\begin{aligned}\frac{a^{17}}{(3a^4)^3} &= \frac{a^{17}}{27a^{12}} \\ &= \underline{\underline{\frac{1}{27}a^5}}.\end{aligned}$$

12. Express the following in its simplest form:

(2)

$$\cos x^\circ \sin^2 x^\circ + \cos^3 x^\circ.$$

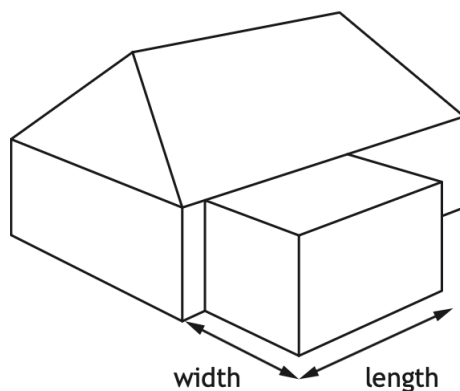
Show your working.

Solution

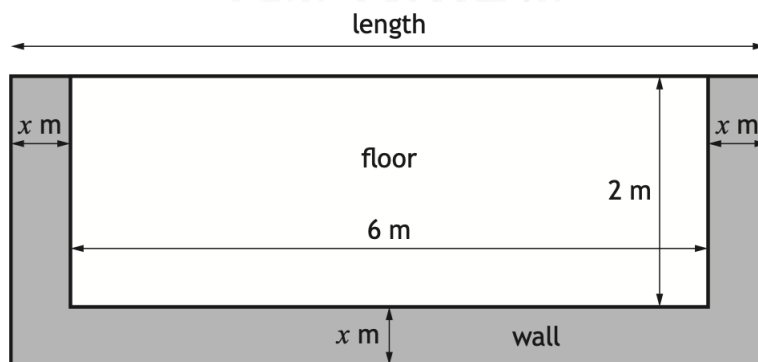
Now,

$$\begin{aligned}\cos x^\circ \sin^2 x^\circ + \cos^3 x^\circ &= \cos x^\circ \sin^2 x^\circ + \cos x^\circ \cos^2 x^\circ \\ &= \cos x^\circ (\sin^2 x^\circ + \cos^2 x^\circ) \\ &= \underline{\underline{\cos x^\circ}}.\end{aligned}$$

13. An extension with a rectangular base is being added to the rear of a house.



The diagram below shows a plan of the rectangular base of the extension.



- The length of the floor is 6 metres and the width of the floor is 2 metres.
 - There is a wall x metres thick on three sides of the extension.
- (a) Write down an expression for the length of the extension in terms of x . (1)

Solution

$$\underline{\underline{2x + 6.}}$$

The total area of the rectangular base of the extension is 17 square metres.

- (b) Show that (2)

$$2x^2 + 10x - 5 = 0.$$

Solution

Now, the vertical length is $(x + 2)$ m.

Now,

$\times$	x	$+2$
$2x$	$2x^2$	$+4x$
$+6$	$+6x$	$+12$

and we have

$$(x + 2)(2x + 6) = 17 \Rightarrow 2x^2 + 10x + 12 = 17$$

$$\Rightarrow \underline{\underline{2x^2 + 10x - 5 = 0}},$$

as required.

- (c) Calculate x , the thickness of the wall.
Give your answer correct to two decimal places.

(4)

Solution

Finally, we complete the square:

$$\begin{array}{ll} \text{add to:} & +5 \\ \text{half it:} & +2.5 \\ \text{square it:} & (+2.5)^2 = +6.25 \end{array}$$

and so

$$\begin{aligned} 2x^2 + 10x - 5 &= 0 \Rightarrow 2(x^2 + 5x - 2.5) = 0 \\ &\Rightarrow x^2 + 5x - 2.5 = 0 \\ &\Rightarrow x^2 + 5x = 2.5 \\ &\Rightarrow x^2 + 5x + 6.25 = 2.5 + 6.25 \\ &\Rightarrow (x + 2.5)^2 = 8.75 \\ &\Rightarrow x + 2.5 = \pm\sqrt{8.75} \\ &\Rightarrow x = -2.5 + \pm\sqrt{8.75}. \end{aligned}$$

But $x > 0$ (why?) so

$$\begin{aligned}x &= -2.5 + \sqrt{8.75} \\&= 0.458\,039\,891\,5 \text{ (FCD)} \\&= \underline{\underline{0.46 \text{ m (2 dp)}}}.\end{aligned}$$