Dr Oliver Mathematics
Mathematics: National Qualifications N5
2025 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. The number of visitors to a zoo in 2024 was 118 750. (3)

   The number of visitors is expected to increase by 4% each year over the next two years.

   Calculate the expected number of visitors in 2026.

   Solution

   Well, the expected number of visitors in 2026 is

   $$118\,750 \times (1.04)^2 = \underline{\underline{128\,440}}.$$

2. A shop sells footballs in the shape of a sphere with diameter 21 centimetres. (3)

   Calculate the volume of the football.
   Give your answer correct to 3 significant figures.

Solution

Well,

$$\text{diameter} = 21 \Rightarrow \text{radius} = 10.5 \text{ cm}.$$

Now,

$$\begin{aligned} \text{volume} &= \tfrac{4}{3} \times \pi \times (10.5)^3 \\ &= 4\,849.048\,261 \text{ (FCD)} \\ &= \underline{\underline{4\,850 \text{ cm}^3 \text{ (3 sf)}}}. \end{aligned}$$

3. The mass of one atom of gold is 3.27×10^{-22} grams. (2)

   The mass of one atom of carbon is 6.1% of the mass of an atom of gold.

   Calculate the mass of one atom of carbon.
   Give your answer in scientific notation.

Solution

Well,

$$\begin{aligned} \text{mass of one atom of carbon} &= \frac{6.1}{100} \times 3.27 \times 10^{-22} \\ &= \underline{\underline{1.994\,7 \times 10^{-23} \text{ g}}}. \end{aligned}$$

4. The weights, in kilograms, of a sample of rugby players in Scotland are shown:

   93 103 99 105 88 106 92

   (a) Calculate the mean and standard deviation of these weights. (4)

Solution

Well,

$$\begin{aligned} \text{mean} &= \frac{93 + 103 + 99 + 105 + 88 + 106 + 92}{7} \\ &= \frac{686}{7} \\ &= \underline{\underline{98 \text{ kg}}}. \end{aligned}$$

Now,

x	93	103	99	105	88	106	92
x^2	8 649	10 609	9 801	11 025	7 744	11 236	8 464

so,

$$\sum x^2 = 67\,528.$$

Finally,

$$\begin{aligned}\text{standard deviation} &= \sqrt{\frac{67\,528 - \frac{686^2}{7}}{6}} \\ &= \sqrt{50} \\ &= \underline{\underline{5\sqrt{2}}}.\end{aligned}$$

A sample of rugby players in France has a mean weight of 105 kilograms and a standard deviation of 5.9 kilograms.

(b) Make two valid comments comparing the weights of the rugby players in the samples from Scotland and France. (2)

Solution

Average: on average the weights of the rugby players in Scotland are lower.
Spread: the weights of the rugby players in Scotland are more varied.

5. Express (2)

$$x^2 + 10x + 19$$

in the form

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

Solution

Well,

coefficient of x : $+10$
half it: $+5$
square it: $(+5)^2 = +25$

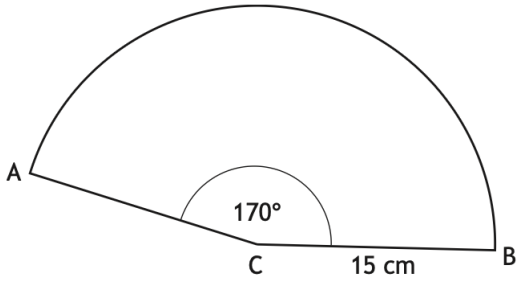
and

$$\begin{aligned} x^2 + 10x + 19 &= [(x^2 + 10x + 25) - 25] + 19 \\ &= (x + 5)^2 - 25 + 19 \\ &= \underline{\underline{(x + 5)^2 - 6}}; \end{aligned}$$

hence, $\underline{\underline{a = 5}}$ and $\underline{\underline{b = -6}}$.

6. A party hat is made in the shape of a cone, as shown. (3)

The piece of card used for making the hat is a sector of a circle, centre C.



The radius of the circle is 15 centimetres and angle ACB is 170°.

Calculate the area of the sector.

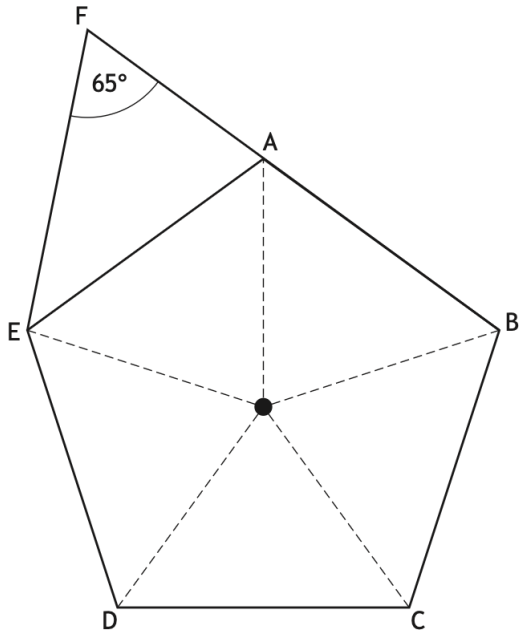
Solution

Now,

$$\text{arc } AB = \frac{170}{360} \times \pi \times 15^2$$
$$= \underline{\underline{\tfrac{425}{4}\pi}}.$$

7. In the diagram, $ABCDE$ is a regular pentagon. (2)

- Angle EFA is $65°$.
- FAB is a straight line.



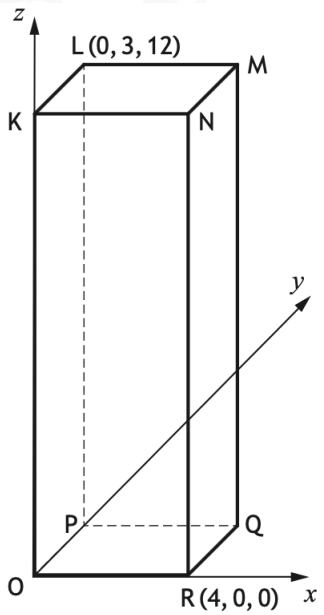
Calculate the size of angle FEA.

Solution

Let O be centre of the regular pentagon. Well,

$$\begin{aligned}\angle\, EAB &= \frac{180(5-2)}{5}\\ &= 108^\circ;\\ \angle\, FAE &= 180 - 108\\ &= 72^\circ;\\ \angle\, FEA &= 180 - (65 + 72)\\ &= \underline{\underline{43^\circ}}.\end{aligned}$$

8. The diagram shows a cuboid, $KLMNOPQR$, relative to the coordinate axes.



- L has coordinates $(0, 3, 12)$.
- R has coordinates $(4, 0, 0)$.

(a) Write down the coordinates of M. (1)

Solution

$\underline{\underline{M(4, 3, 12)}}$

(b) Calculate the length of the space diagonal OM. (3)

Solution

Well,

$$\begin{aligned} OM &= \sqrt{OR^2 + RQ^2 + QM^2} \\ &= \sqrt{4^2 + 3^2 + 12^2} \\ &= \sqrt{16 + 9 + 144} \\ &= \sqrt{169} \\ &= \underline{\underline{13}}. \end{aligned}$$

9. Change the subject of the formula (3)

$$B = \tfrac{1}{4}kc^2 - 3c$$

to k.

Solution

Well,

$$\begin{aligned} B = \tfrac{1}{4}kc^2 - 3c \Rightarrow B + 3c &= \tfrac{1}{4}kc^2 \\ \Rightarrow k &= \underline{\underline{\frac{4(B+3c)}{c^2}}}. \end{aligned}$$

10. On Bob's lorry there are 7 stacks of paving slabs and 3 stacks of edging blocks.

The total weight of these stacks is 2 400 kilograms.

Let p be the weight of a stack of paving slabs and e be the weight of a stack of edging blocks.

(a) Write down an equation in p and e to illustrate this information. (1)

Solution

$\underline{\underline{7p + 3e = 2\,400}}$.

Imran has 3 stacks of paving slabs and 4 stacks of edging blocks on his lorry.

The total weight of these stacks is 1 300 kilograms.

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

Solution

$\underline{\underline{3p + 4e = 1\,300}}$.

Beth has 6 stacks of paving slabs and 5 stacks of edging blocks on her lorry.

(c) Calculate the **total weight** of the stacks of paving slabs and edging blocks on Beth's lorry. (4)

Solution

Well,

$$7p + 3e = 2\,400 \quad (1)$$
$$3p + 4e = 1\,300 \quad (2).$$

Do $4 \times (1)$ and $3 \times (2)$:

$$28p + 12e = 9\,600 \quad (3)$$
$$9p + 12e = 3\,900 \quad (4).$$

Do $(3) - (4)$:

$$19p = 5\,700 \Rightarrow p = 300$$

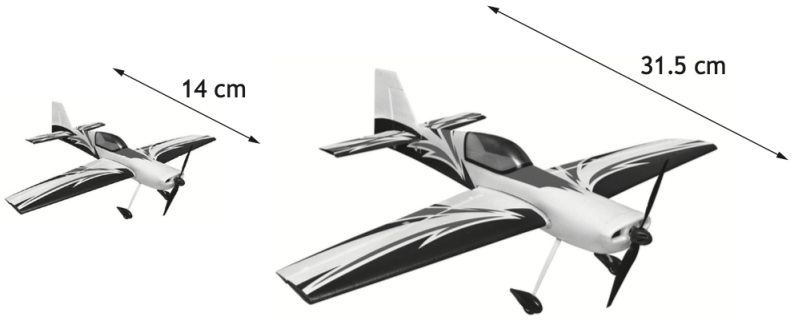
insert this into (1):

$$\begin{aligned} 7(300) + 3e = 2\,400 &\Rightarrow 2\,100 + 3e = 2\,400 \\ &\Rightarrow 3e = 300 \\ &\Rightarrow e = 100. \end{aligned}$$

Finally,

$$\begin{aligned} \text{total weight} &= (6 \times 300) + (5 \times 100) \\ &= 1\,800 + 500 \\ &= \underline{\underline{2\,300 \text{ kg}}}. \end{aligned}$$

11. Two model aircraft are mathematically similar. (3)



- The small model is 14 centimetres long, and the area of one wing is 24 square centimetres.
- The large model is 31.5 centimetres long.

Calculate the **area** of one wing of the large model.

Solution

The Length Scale Ratio (LSR) is

$$\frac{31.5}{14} = 2.25$$

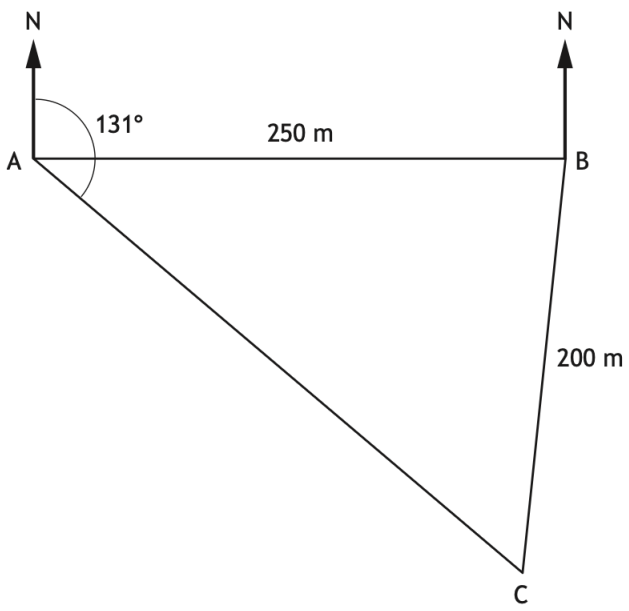
and the Area Scale Ratio (ASR) is

$$2.25^2 = 5.062\,5.$$

Finally,

$$\begin{aligned} \text{one wing of the large model} &= 24 \times 5.062\,5 \\ &= \underline{\underline{121.5 \text{ square centimetres}}}. \end{aligned}$$

12. In the diagram A, B, and C represent the positions of three checkpoints in an orienteering course. (4)



- B is 250 metres east of A.
- The bearing of C from A is 131°.
- C is 200 metres from B.

Calculate the bearing of C from B.
Do not use a scale drawing.

Solution

Well,

$$\angle BAC = 131 - 90 = 41^\circ.$$

Sine rule:

$$\frac{\sin ACB}{AB} = \frac{\sin BAC}{BC} \Rightarrow \frac{\sin ACB}{250} = \frac{\sin 41^\circ}{200}$$
$$\Rightarrow \sin ACB = \frac{250 \sin 41^\circ}{200}$$
$$\Rightarrow \angle ACB = 55.092\,180\,72 \text{ (FCD)}$$
$$\Rightarrow \angle ABC = 83.907\,819\,28 \text{ (FCD)}$$
$$\Rightarrow \text{bearing} = 180 + (90 - 83.907\ldots)$$
$$\Rightarrow \text{bearing} = 186.092\,180\,7 \text{ (FCD)}$$
$$\Rightarrow \text{bearing} = \underline{\underline{186^\circ \text{ (3 sf)}}}.$$

13. Solve the equation (3)

$$\frac{5x+1}{2} = \frac{4x}{3} + 1.$$

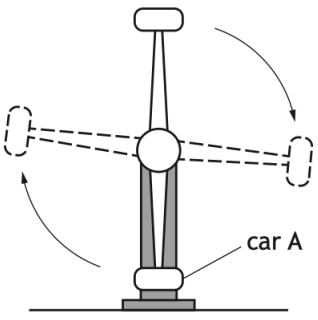
Solution

Multiply the whole the equation by 6:

$$\begin{aligned} \frac{5x+1}{2} = \frac{4x}{3} + 1 &\Rightarrow 3(5x+1) = 2(4x) + 6 \\ &\Rightarrow 15x + 3 = 8x + 6 \\ &\Rightarrow 7x = 3 \\ &\Rightarrow \underline{\underline{x = \tfrac{3}{7}}}. \end{aligned}$$

14. A ride at a theme park has a car attached to each end of a rotating arm. (4)

The starting position of car A is shown in the diagram.



As the arm rotates clockwise, the height, h metres, of car A above the ground in each rotation is given by

$$h = 10 - 8\cos x^\circ,\ 0 \leqslant x < 360,$$

where x° is the angle the arm has turned from car A's starting position.

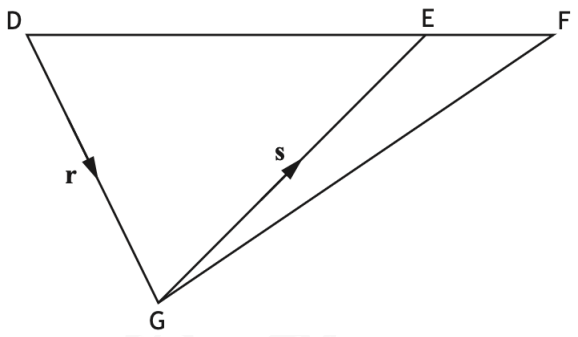
Calculate the two values of x for which the height of car A is 13 metres above the ground.

Solution

Well,

$$\begin{aligned} 10 - 8\cos x^\circ = 13 &\Rightarrow -8\cos x^\circ = 3 \\ &\Rightarrow \cos x^\circ = -\tfrac{3}{8} \\ &\Rightarrow x = 112.024\,312\,8,\ 247.975\,687\,2 \text{ (FCD)} \\ &\Rightarrow \underline{\underline{x = 112,\ 248 \text{ (3 sf)}}}. \end{aligned}$$

15. In the diagram, $\overrightarrow{DG}$ and $\overrightarrow{GE}$ are represented by the vectors $\mathbf{r}$ and $\mathbf{s}$ respectively, and $\overrightarrow{DE} = 3\overrightarrow{EF}$. (2)



Express $\overrightarrow{GF}$ in terms of $\mathbf{r}$ and $\mathbf{s}$.
Give your answer in its simplest form.

Solution

Well,

$$\begin{aligned}\overrightarrow{DF} &= \tfrac{4}{3}\overrightarrow{DE}\\ &= \tfrac{4}{3}(\overrightarrow{DG}+\overrightarrow{GE})\\ &= \tfrac{4}{3}(\mathbf{r}+\mathbf{s})\\ &= \tfrac{4}{3}\mathbf{r}+\tfrac{4}{3}\mathbf{s},\end{aligned}$$

and

$$\begin{aligned}\overrightarrow{GF} &= \overrightarrow{GD}+\overrightarrow{DF}\\ &= -\overrightarrow{FD}+\overrightarrow{DF}\\ &= -\mathbf{r}+\tfrac{4}{3}\mathbf{r}+\tfrac{4}{3}\mathbf{s}\\ &= \underline{\underline{\tfrac{1}{3}\mathbf{r}+\tfrac{4}{3}\mathbf{s}}}.\end{aligned}$$