

1 Solve $3 - \frac{x+1}{2x^2+9x-5} - \frac{2x-1}{x+5} = 1$

Show clear algebraic working.

$$x =$$

(Total for Question 1 is 4 marks)

2 Given that $\frac{20 \times 25^{5n+3}}{4 \times (\sqrt{125})^{4n+2}}$ can be written in the form 5^y

find an expression for y in terms of n .

$y = \dots\dots\dots$

(Total for Question 2 is 4 marks)

3

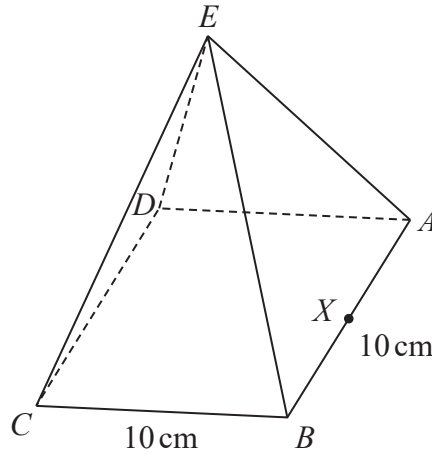


Diagram **NOT**
accurately drawn

The diagram shows a solid right square-based pyramid $ABCDE$
The volume of the pyramid is 1000 cm^3

The pyramid is standing with its square base, $ABCD$, on a horizontal table.
The square base has side 10 cm .

X is the midpoint of the side AB

Calculate the size, in degrees to the nearest degree, of $\angle CEX$

o

(Total for Question 3 is 5 marks)

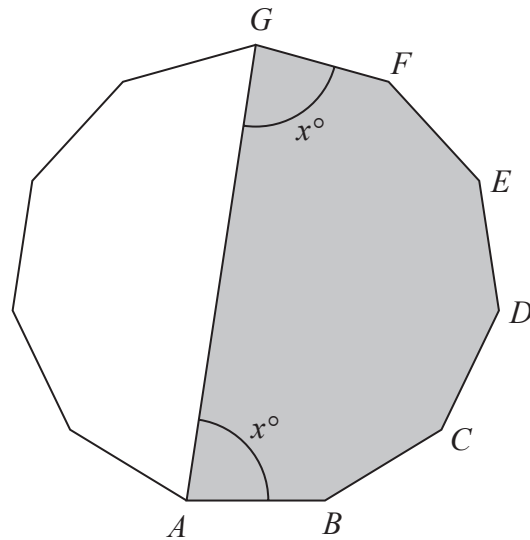


Diagram **NOT**
accurately drawn

The diagram shows a shaded 7-sided shape $ABCDEFG$.

The points A, B, C, D, E, F and G are 7 vertices of a regular polygon with 11 sides.

$$\angle GAB = \angle AGF = x^\circ$$

Calculate the value, to 3 significant figures, of x .
Show your working clearly.

$$x = \dots\dots\dots$$

(Total for Question 4 is 5 marks)

- 5 The two digit number M has tens digit p and units digit q
The two digit number N has tens digit q and units digit p

Given that $N - M = 9$ and that $p + q = 13$

find the value of M

Show clear algebraic working.

$M =$

(Total for Question 5 is 5 marks)

Figure 5 below shows a door stop made from a hollow hemisphere and a hollow right circular cone.

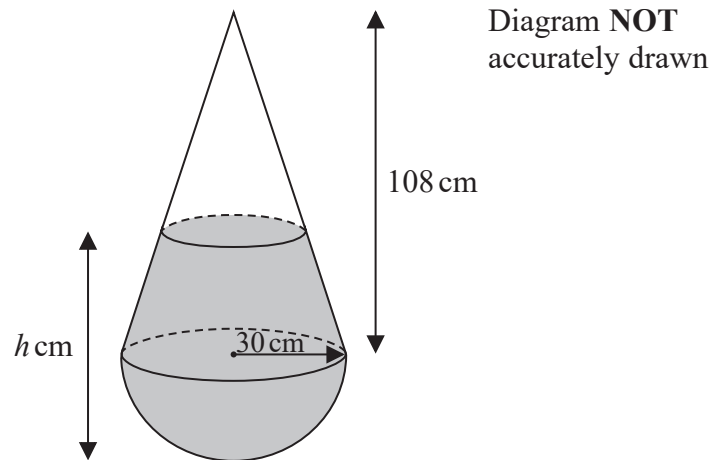


Figure 5

The radius of the base of the cone and the radius of the hemisphere are both 30 cm.
 The centre of the base of the cone coincides with the centre of the hemisphere.
 The height of the cone is 108 cm.

The door stop rests on horizontal ground with the cone on top of the hemisphere and the axis of symmetry of the door stop vertical.

The door stop contains sand to a height of h cm.

Given that the volume of sand in the door stop is $V \text{ cm}^3$, where $V \text{ cm}^3$ is the volume of the cylinder in Figure 4

Calculate the value of h .

(Total for Question 6 is 6 marks)

7 (a) Simplify $7y^0$ where $y > 0$

.....
(1)

(b) Solve $\frac{2^2 \times 15^{2x} \times 3^{5x(x-3)} \times 3^{x+3} \times 4^{x-1}}{10^{2x}} = 81^3$

$x =$

(5)

(Total for Question 7 is 6 marks)

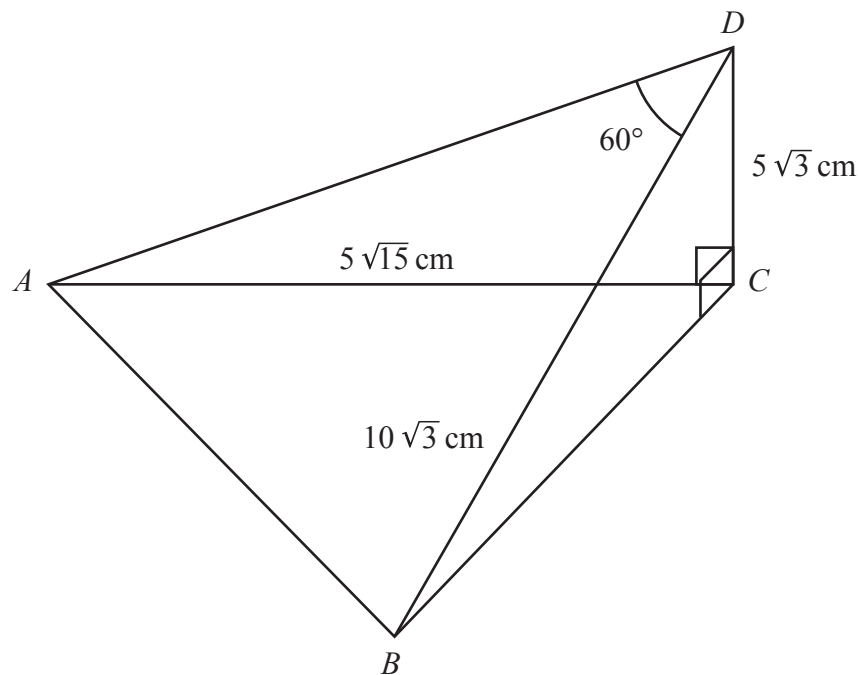


Diagram **NOT**
accurately drawn

The diagram shows a pyramid $ABCD$ with a horizontal triangular base ABC

$$DC = 5\sqrt{3} \text{ cm} \quad DB = 10\sqrt{3} \text{ cm} \quad AC = 5\sqrt{15} \text{ cm}$$

$$\angle ADB = 60^\circ \quad \angle DCA = \angle DCB = 90^\circ$$

(a) Calculate the length, in cm to one decimal place, of AB

..... cm

(3)

(b) Calculate the area, in cm^2 to 3 significant figures, of triangle ABC

..... cm^2
(5)

(Total for Question 8 is 8 marks)

9 Simplify fully

$$\frac{10x + 5y - 2x^2 - xy}{4x^2 - y^2}$$

.....
(Total for Question 9 is 4 marks)

10 There are 20 counters in a bag.

There are 7 red counters.

The rest of the counters are green or white.

Bernard takes at random 2 counters from the bag.

The probability that Bernard will take 2 white counters is $\frac{1}{19}$

Calculate the probability that Bernard will take 1 green counter and 1 white counter.

(Total for Question 10 is 5 marks)

11 In a region of a country, two types of eagle, type A and type B , can be found.

In 2003 the ratio of the number of type A eagles to the number of type B eagles was $2:5$

In 2015 the ratio of the number of type A eagles to the number of type B eagles was $4:3$

From 2003 to 2015, the number of type A eagles had increased by 16

From 2003 to 2015, the number of type B eagles had decreased by 107

Calculate the number of type B eagles in this region in 2015

.....
(Total for Question 11 is 5 marks)

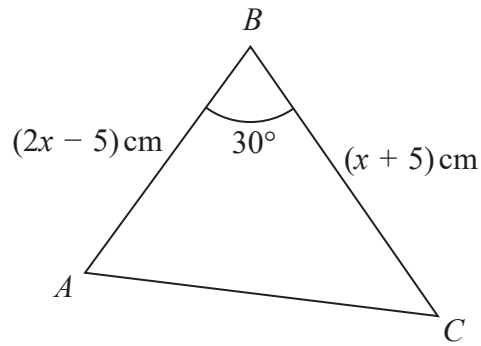


Diagram **NOT**
accurately drawn

The diagram shows $\triangle ABC$ in which

$$AB = (2x - 5) \text{ cm} \quad BC = (x + 5) \text{ cm} \quad \angle ABC = 30^\circ$$

The area of $\triangle ABC$ is 15.75 cm^2

Calculate the length, in cm to 3 significant figures, of AC .

cm

(Total for Question 12 is 6 marks)

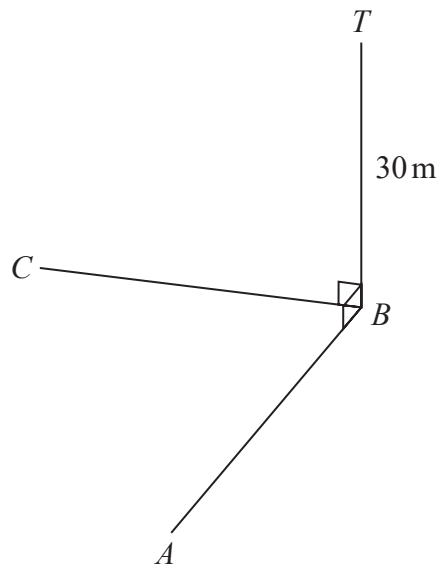


Diagram **NOT**
accurately drawn

Figure 3

Figure 3 shows three points A , B and C on horizontal ground.
A vertical mast BT of height 30m is at point B .

The angle of elevation of T from A is 32°

The angle of elevation of T from C is 25°

The bearing of A from B is 195°

The bearing of C from B is 280°

Calculate the bearing, in degrees to the nearest degree, of C from A .

(Total for Question 13 is 6 marks)

- 14 (a) Express $\frac{\sqrt{98} + \sqrt{18}}{\sqrt{5}}$ in the form \sqrt{a} where a is a number to be found.

Show your working clearly.

(3)

- (b) Given that $\frac{\sqrt{27}}{81^{\frac{4}{3}}} \times \sqrt{3} = 3^x$

find the value of x , giving your answer as a fraction in its simplest form.
Show your working clearly.

(3)

(Total for Question 14 is 6 marks)

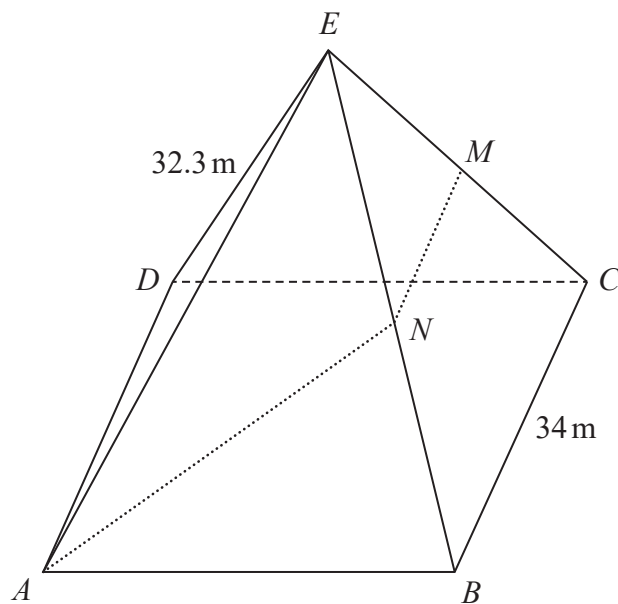


Diagram **NOT**
accurately drawn

The diagram shows a solid right pyramid $ABCDE$ with a square base $ABCD$ on a horizontal plane. The vertex E of the pyramid is vertically above the centre of the base.

$$BC = 34 \text{ m} \quad EA = EB = EC = ED = 32.3 \text{ m}$$

The point M is the midpoint of CE and the point N is the midpoint of BE .

Given that $AN + NM = x$ metres

(a) calculate the value, to 2 significant figures, of x .

$$x = \dots\dots\dots$$

(b) Calculate the size, to the nearest degree, of angle BAN .

.....
(2)

(Total for Question 15 is 8 marks)

- 16** Egan cycled 168 km at an average speed of x km/h,
Rohan cycled the 168 km at an average speed that was 2 km/h less than Egan's average speed.
Given that it took Rohan 12 minutes longer than Egan to cycle the 168 km,
calculate the value of x

$x = \dots\dots\dots$

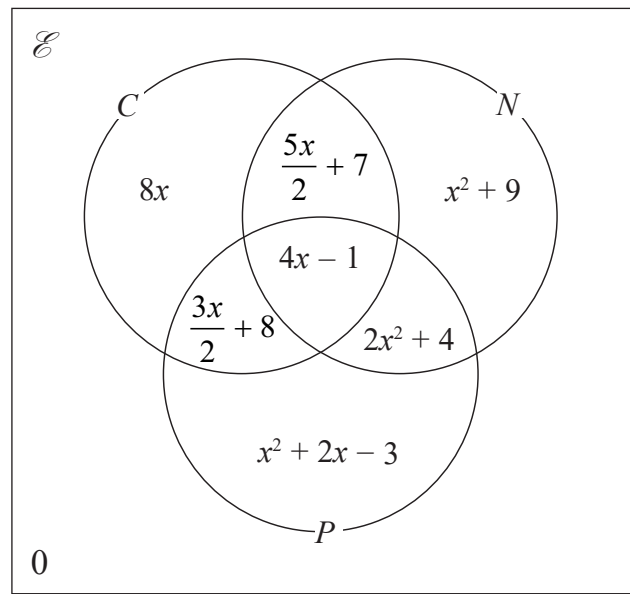
(Total for Question 16 is 7 marks)

17 The principal of a college wishes to introduce three new evening classes.

The classes are Cake decorating (C), Needlework (N) and Photography (P).

In a survey, 160 people who attend evening classes at the college were asked which of these new evening classes they would like to attend.

Information about the results of the survey is shown in the Venn diagram. The expression in terms of x , where x is a positive integer, in each subset represents the number of people in that subset.



(a) (i) Show that $2x^2 + 9x - 68 = 0$

(ii) Hence find the value of x .

(4)

One of the people surveyed is selected at random.

Given that this person would like to attend Photography,

(b) calculate the exact value of the probability that this person would also like to attend Cake decorating but not Needlework.

(2)

(Total for Question 17 is 6 marks)

18 The functions f and g are such that

$$f : x \mapsto 2x^2 - 4x + 1 \quad \text{where } x > 1$$

$$g : x \mapsto \frac{20}{5 + x}$$

(a) State the value of x that must be excluded from any domain of g

(1)

(b) Find the value of k such that $g(k) = 8$

(3)

(c) Find $fg(-3)$

(2)

(d) Find the inverse of the function f in the form $f^{-1} : x \mapsto \dots$
Simplify your answer.

(4)

The function h is defined for all values of x as

$$h : x \mapsto \frac{ax + b}{3}$$

where a and b are constants.

Given that

$$h(2) = 4$$

$$f^{-1}h(1.7) = 2.5$$

(e) find the value of a and the value of b
Show clear algebraic working.

(5)

(Total for Question 18 is 15 marks)

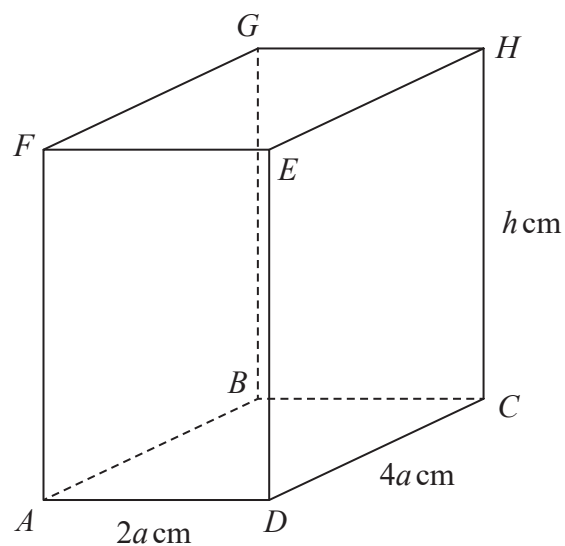


Diagram **NOT**
accurately drawn

The diagram shows a cuboid $ABCDEFGH$ in which

$$AD = 2a \text{ cm}$$

$$DC = 4a \text{ cm}$$

$$CH = h \text{ cm}$$

Given that $AC = (2\sqrt{a})BH$ and that $\angle HAC = 45^\circ$

find the value of a .

$$a = \dots\dots\dots$$

(Total for Question 19 is 6 marks)

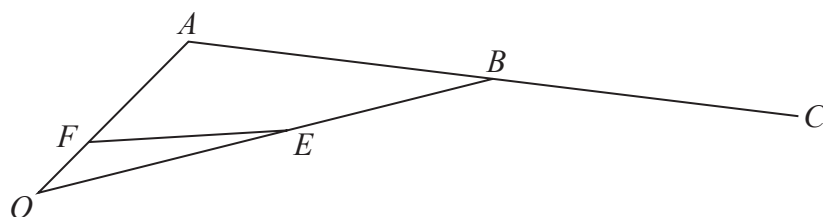


Diagram **NOT**
accurately drawn

Figure 6

Figure 6 shows triangle OAB .

The point E lies on OB such that $OE : OB = 1 : 2$

The point F lies on OA such that $\vec{OF} = \frac{1}{5} \vec{OA}$

Given that $\vec{OA} = \mathbf{a}$ and $\vec{OB} = \mathbf{b}$

(a) find \vec{FE} in terms of \mathbf{a} and \mathbf{b}

(2)

The point C is such that ABC is a straight line and $AB = BC$.

(b) Show that F , E and C are not collinear.

(4)

Given that ABG and FEG are straight lines,

(c) find \vec{OG} in terms of \mathbf{a} and \mathbf{b}

(5)

(Total for Question 20 is 11 marks)

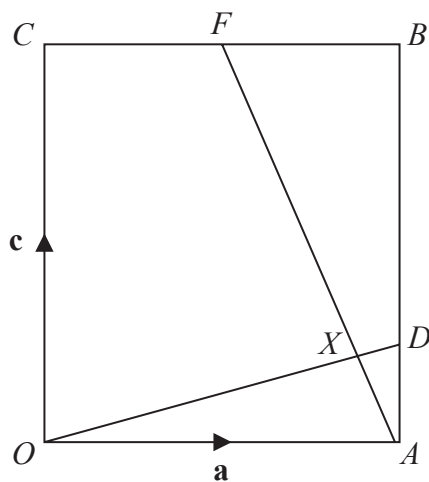


Diagram **NOT**
accurately drawn

Figure 3

Figure 3 shows a rectangle $OABC$ in which $\vec{OA} = \mathbf{a}$ and $\vec{OC} = \mathbf{c}$

F is the midpoint of CB and D is the point on AB such that $AD:DB = 2:3$

(a) Find

- (i) \vec{CF} in terms of \mathbf{a} (ii) \vec{AD} in terms of \mathbf{c}

(2)

The lines OD and AF intersect at the point X

Given that $\vec{OX} = \lambda \vec{OD}$ and $\vec{AX} = \mu \vec{AF}$, where λ and μ are scalars,

(b) find the value of λ and the value of μ

(7)

Given that $OX:XD = n:1$

(c) find the value of n

(1)

Given also that $|\mathbf{a}| = 12 \text{ cm}$ and $|\mathbf{c}| = 12.5 \text{ cm}$,

(d) find the area, in cm^2 , of quadrilateral $XDBF$

(4)

(Total for Question 21 is 14 marks)

22 The function f is defined by

$$f(x) = 4 - \frac{7}{x+3}$$

(a) Write down the value of x that must be excluded from any domain of function f (1)

(b) Find $f(-1)$ (1)

The function g is defined as

$$g : x \mapsto 2x^2 + 4x - 1 \text{ where } x \geq -1$$

Given that $fg^{-1}(x) = 1.2$

(c) find the value of x (7)

The function h is defined as

$$h : x \mapsto x + 2 \text{ for all values of } x \geq -3$$

Given that the function m is such that $m(x) = gh(x) + 3$

(d) express $m(x)$ in the form $a(x + b)^2$ where a and b are integers. (4)

(e) Find the domain of m^{-1} (2)

(Total for Question 22 is 15 marks)

- 23** Some college students were each asked which of the subjects Mathematics (M), Physics (P) and Chemistry (C) they were studying.

Here is some information about their answers.

$$n(M \cap P) = 21$$

$$n(M \cap C) = 24$$

$$n(P \cap C) = 25$$

$$n(M) = 43$$

$$n(P) = 50$$

$$n([M \cup P \cup C]') = 25$$

$$n([M \cup P]' \cap C) = 8$$

$$n(M \cap P \cap C) = x, \text{ where } x \text{ is a positive integer.}$$

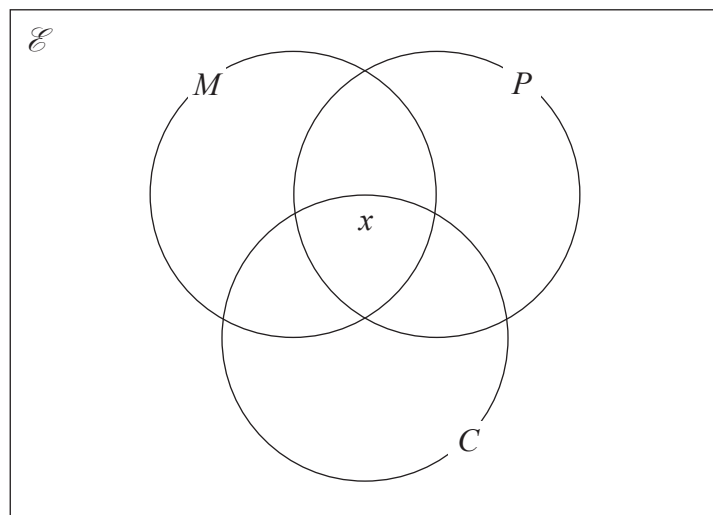
- (a) Use all the given information to complete the Venn diagram on the opposite page, giving the number of elements in each appropriate subset, in terms of x where necessary. (4)

Given that $n(C) = 40$

- (b) find the total number of college students that were asked. (4)

One of these college students is to be chosen at random.
Given that the college student studies Chemistry,

- (c) find the probability that this student also studies Physics. (2)



(Total for Question 23 is 10 marks)