

中正中学 义顺

CHUNG CHENG HIGH SCHOOL (YISHUN)



2025 End-Of-Year Examination Secondary Two General 3

CANDIDATE
NAME

FORM CLASS /
SUBJECT GROUP

 /

INDEX
NUMBER

MATHEMATICS

2 October 2025

2 hours 30 minutes

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on the work you hand in.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use paper clips, glue or correction fluid.

Answer **all** the questions.

The number of marks is given in brackets [] at the end of each question or part question.

If working is needed for any question it must be shown with the answer.

Omission of essential working will result in loss of marks.

You are reminded of the need for clear presentation in your answers. Up to 2 marks may be deducted for improper presentation.

The use of an approved scientific calculator is expected, where appropriate.

If the degree of accuracy is not specified in the question and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.

For π , use either your calculator value or 3.142.

Q1	Q2	Q3	Q4	Q5	Q6	Q7
4	4	5	3	3	2	4
Q8	Q9	Q10	Q11	Q12	Q13	Q14
3	3	3	4	3	5	6
Q15	Q16	Q17	Q18	Q19	Q20	Q21
5	5	4	8	8	9	9
Presentation Deduction				-1 / -2	Total (100)	

1 Simplify

(a) $3(3x-2)+1$,

Answer [1]

(b) $\frac{2x}{3}+x$,

Answer [1]

(c) $3x-2(x-5)$.

Answer [2]

2 (a) Factorise $2x^2+7x-15$.

Answer [2]

(b) Hence factorise completely $2(2y+1)^2+7(2y+1)-15$.

Answer [2]

3 Simplify

(a) $\frac{12a^3b}{7} \div \frac{ac^2}{b^2}$,

Answer [2]

(b) $\frac{9a^2-1}{3a^2+16a+5}$.

Answer [3]

4 Solve $\frac{-2}{x-3} = x$,

Answer $x = \dots\dots\dots$ or $x = \dots\dots\dots$ [3]

5 Given $p = \frac{q - r^2 + 3}{2qr^3}$,

(a) evaluate p when $r = -2$ and $q = 3$.

Answer $p = \dots\dots\dots$ [1]

(b) express q in terms of p and r .

Answer $q = \dots\dots\dots$ [2]

- 6 There are 25 adults and 7 children in the theatre room. After another $2y$ adults and y children entered the theatre room, the probability of selecting a child at random becomes $\frac{2}{7}$. Find the value of y .

Answer $y = \dots\dots\dots$ [2]

- 7 Mrs Chan has a map of Singapore drawn to a scale 1 : 120 000 .
The distance on the map between Bird Paradise and her house is 15 cm.
(a) Calculate the actual distance, in kilometres, between Bird Paradise and her house.

Answer km [2]

- (b) Bird Paradise covers an area of 0.17 km^2 . Calculate the area, in square centimetres, covered by the Bird Paradise on the map.

Answer cm^2 [2]

- 8 Express $\frac{2}{2x-3} - \frac{6-4x}{4x^2-12x+9}$ as a single fraction.

Answer [3]

- 9 In a physics experiment using Hooke's Law, the force F in Newtons (N) required to stretch a spring is directly proportional to its extension x , in metres.
When the spring is stretched by 5 cm, a force of 2.5 N is needed.

(a) Find the equation connecting F and x .

Answer [2]

(b) Hence, calculate the force needed to stretch the same spring by 8 cm.

Answer N [1]

- 10 Given that $\frac{3(x-1)}{2} \leq x+1$, find the greatest possible value of x if x is
(a) a perfect square,

Answer $x =$ [2]

(b) a prime number.

Answer $x =$ [1]

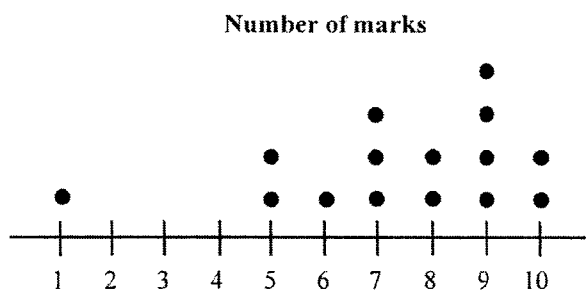
- 11 One solution of the equation $kx^2 + (k+2)x - 2 = 0$ is $x = \frac{1}{3}$.
 (a) Find the value of k .

Answer $k = \dots\dots\dots$ [2]

- (b) Hence, find the other solution of the equation.

Answer $x = \dots\dots\dots$ [2]

- 12 The dot diagram shows the distribution of marks that 15 students from Class A scored in a science quiz. The maximum score is 10 marks.



- (a) Describe the dot diagram shown above.

.....

 [2]

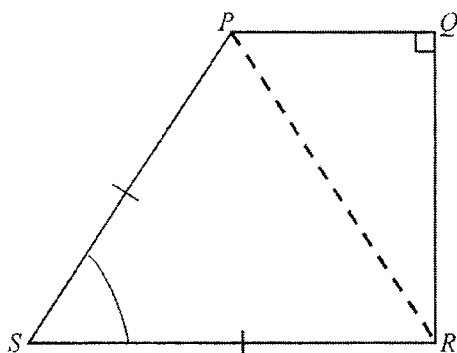
- (b) State the modal mark(s).

Answer mark(s) [1]

- 13 A fraction is equivalent to $\frac{1}{6}$ if 1 is subtracted from the numerator and 3 is added to its denominator. If 2 is added to the numerator and 5 is subtracted from the denominator of the original fraction, the resulting value is $\frac{3}{5}$. Find the original fraction.

Answer [5]

14



The diagram shows a field $PQRS$ on horizontal ground, crossed by a pathway PR .

$RS = SP$, $PQ = 60$ m, $QR = 80$ m and angle $PSR = 73.8^\circ$.

- (a) Show that angle $SPQ = 106.2^\circ$, correct to one decimal place.

Answer

[2]

- (b) Find SR .

Answer m [2]

- (c) Find the shortest distance from Q to PR .

Answer m [2]

- 15 The stem-and-leaf diagram shows the height of 10 students.

15		2	6	9					
16		0	1	1	1	2	5		
17		3							

- (a) Calculate the mean height of these students.

Answer cm [2]

- (b) The height of another student is added to the stem-and-leaf diagram and the mean height of the students increases by 3 cm.

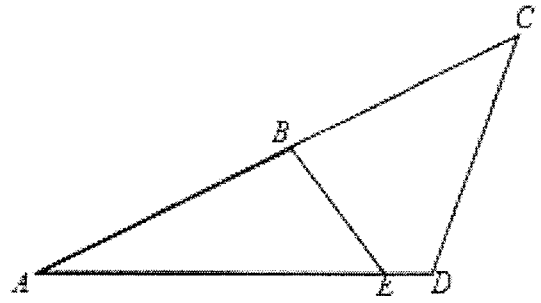
- (i) Calculate the height of the student added.

Answer cm [2]

- (ii) How will the addition of this student's height affect the median?

.....
 [1]

16



Triangle ABE is a reduction of triangle ADC . Given that $BE = 5\text{ cm}$, $DC = 7.5\text{ cm}$, $AE = 8\text{ cm}$ and the perimeter of triangle ADC is 28.5 cm , find the

(a) scale factor of the reduction.

Answer [1]

(b) length of AC ,

Answer cm [2]

(c) length of AB .

Answer cm [2]

- 17 The timings of 30 runners who completed a 3.5 km run were recorded.

12.9	15	20.7	39	13.6	35
42.1	31	35	36.8	22	29.8
33.6	35.7	14.4	46	27.7	23.4
34	15.8	43.6	35	15.8	40
37.2	20.5	27	43.1	48.8	27

- (a) Complete the frequency table below.

Time (x minutes)	Frequency
$10 < x \leq 20$	
$20 < x \leq 30$	8
$30 < x \leq 40$	
$40 < x \leq 50$	5

[2]

- (b) A runner was chosen at random.
Find the probability that the runner's timing was
- (i) not between 20 to 30 minutes inclusive,

Answer [1]

- (ii) more than 30 minutes.

Answer [1]

18 A gift box is in the shape of a right pyramid with square base of side 4 cm less than the vertical height.

- (a) Given that the height of the gift box is x cm, write down an expression, in terms of x , for the side of the gift box.

Answer cm [1]

- (b) The base area of the gift box is 36 cm^2 .
Write down an equation to represent this information and show that it simplifies to

$$x^2 - 8x - 20 = 0$$

[2]

- (c) Solve the equation $x^2 - 8x - 20 = 0$.

Answer $x = \dots\dots\dots$ or $x = \dots\dots\dots$ [2]

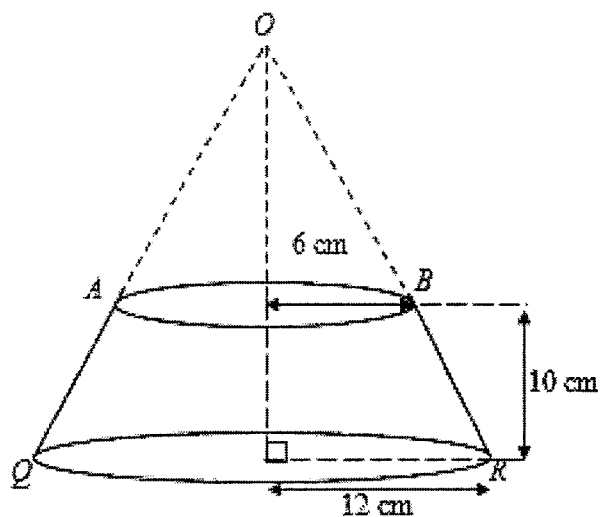
- (d) Explain why one of the solutions in (c) must be rejected.

.....
..... [1]

- (e) Calculate the volume of the gift box.

Answer cm^3 [2]

- 19 The figure below shows a conical frustum $ABRQ$ which is obtained by removing the smaller cone OAB from the larger cone OQR . The base radius of cone OAB is 6 cm and the base radius of cone OQR is 12 cm. The height of the frustum is 10 cm.



- (a) Using similar triangles, show that the height of the cone OAB is 10 cm.

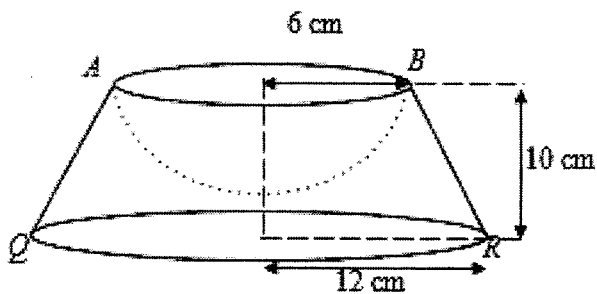
[1]

Answer

- (b) Calculate the total surface area of the conical frustum.

Answer cm^2 [4]

- (c) A solid flowerpot made of clay is modelled by the frustum $ABRQ$ with a hemisphere carved out. Find the amount of clay required to make one flowerpot.



Answer cm^3 [3]

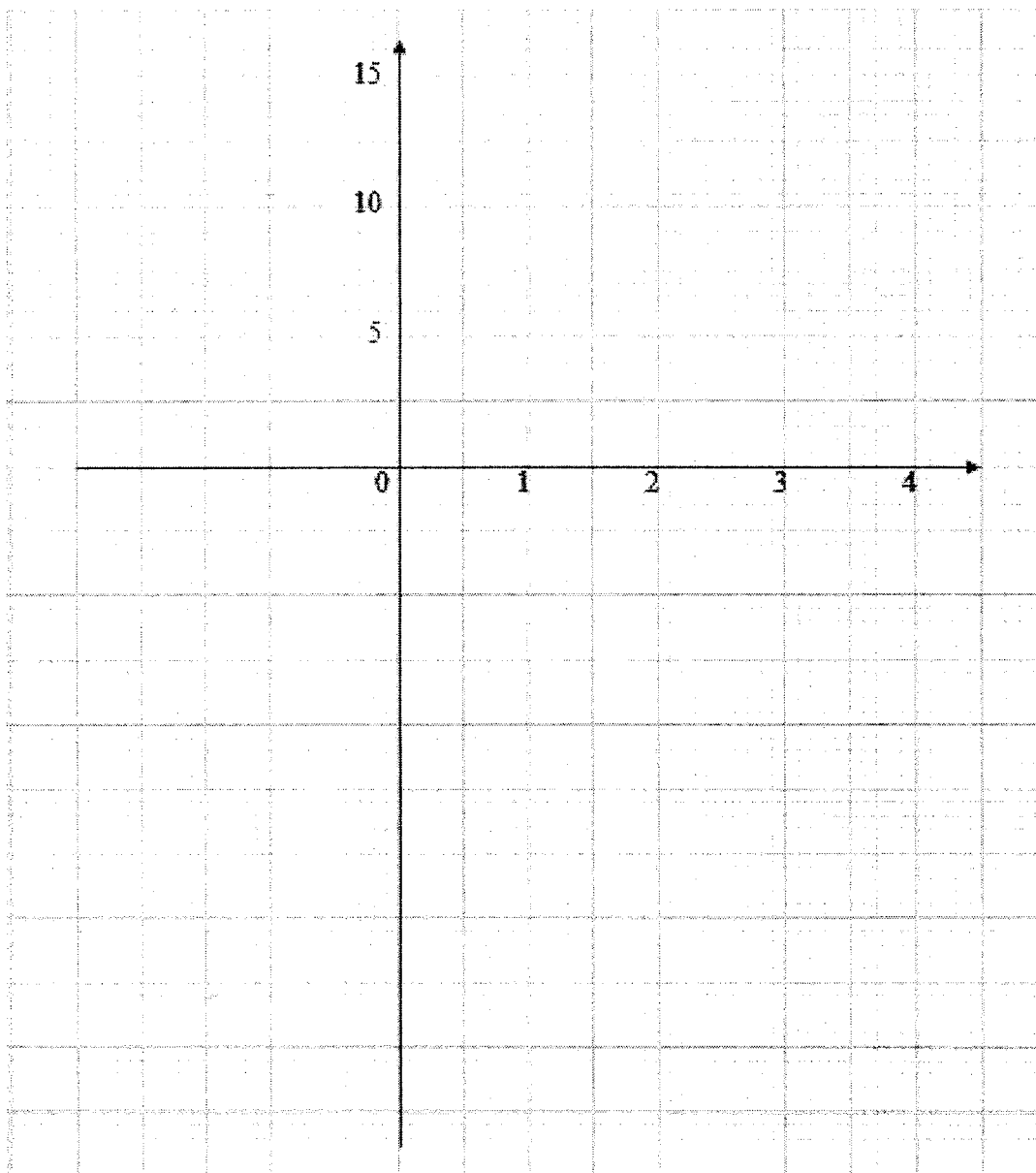
- 20 The variables x and y are connected by the equation $y = 4x^2 - 8x - 21$.

x	-2	-1	0	1	2	3	4
y	11	p	-21	-25	-21	-9	11

Find the value of p .

Answer $p = \dots\dots\dots$ [1]

- (a) On the grid, draw the graph of $y = 4x^2 - 8x - 21$ for $-2 \leq x \leq 4$.



[3]

- (c) On the same grid, draw the line $4x + y = -13$ for $-2 \leq x \leq 3$. [2]

- (d) Using your graph,

- (i) write down the coordinates of the points of intersection of the line and the curve.

Answer (.....,)

(.....,) [2]

- (ii) A triangle is formed by the points of intersection points in (d)(i) and $(3, -9)$.
Calculate the area of this triangle.

Answer units² [1]

- 21 Jason works part-time at a bubble tea shop and collected data about the number of drinks sold during different hours on a Saturday. He wants to analyse the data to help his manager optimise staff deployment.

Here are the number of drinks sold each hour from 11 am to 9 pm:

15, 18, 25, 42, 38, 42, 36, 42, 28, 25

- (a) (i) Calculate the median number of drinks sold per hour.

Answer drinks [2]

- (ii) The manager defines peak hours as times when the number of drinks sold are greater than the median. Calculate the mean number of drinks sold during peak hours.

Answer drinks [2]

- (b) During peak hours, each drink generates a profit of \$3 to the bubble tea shop. Jason estimates that an additional staff member can increase the number of drinks sold by 25% during peak hours. Every staff member earns \$15 per hour.

Would you recommend Jason proposing to the manager to hire an additional staff member during peak hours? Justify your answer using appropriate calculations.

.....
.....
..... [5]



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4		4		5		3		3		2		4	
Q8		Q9		Q10		Q11		Q12		Q13		Q14	
3		3		3		4		3		5		6	
Q15		Q16		Q17		Q18		Q19		Q20		Q21	
5		5		4		8		8		9		9	
						Presentation Deduction	-1 / -2		Total (100)				

This document consists of 21 printed pages.

Mathematical Formulae*Compound interest*

$$\text{Total amount} = P \left(1 + \frac{r}{100} \right)^n$$

Mensuration

$$\text{Curved surface area of a cone} = \pi r l$$

$$\text{Surface area of a sphere} = 4\pi r^2$$

$$\text{Volume of a cone} = \frac{1}{3} \pi r^2 h$$

$$\text{Volume of a sphere} = \frac{4}{3} \pi r^3$$

$$\text{Area of triangle } ABC = \frac{1}{2} ab \sin C$$

$$\text{Arc length} = r\theta, \text{ where } \theta \text{ is in radians}$$

$$\text{Sector area} = \frac{1}{2} r^2 \theta, \text{ where } \theta \text{ is in radians}$$

Trigonometry

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$a^2 = b^2 + c^2 - 2bc \cos A$$

Statistics

$$\text{Mean} = \frac{\sum fx}{\sum f}$$

$$\text{Standard deviation} = \sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f} \right)^2}$$

1 Simplify

(a) $3(3x-2)+1,$

$$= 9x-6+1$$

$$= 9x-5$$

Comments:

Generally well done except a handful of students who made careless mistake(s) and left their final answer as '9x-7' or '9x-3'.

Answer [1]

(b) $\frac{2x}{3} + x,$

$$\frac{2x}{3} + \frac{3x}{3}$$

$$= \frac{5x}{3} \text{ or } \frac{5}{3}x$$

Comments:

Generally well done except a handful of students who left their final answer as

- '5x' (with no denominator)
- $1\frac{2}{3}x$ (mixed fraction)

Answer [1]

(c) $3x-2(x-5).$

$$3x-2(x-5)$$

$$= 3x-2x+10$$

$$= x+10$$

Comments: (Common mistakes)

- Students expand $-2(x-5)$ wrongly. Answer given: $-2x-10$ or $-2x+5$.

- A handful of students misinterpreted the question and add in additional bracket on their own.

Question become $(3x-2)(x-5)$. M1 is still awarded if they expand $-2(x-5)$ correctly.

Answer [2]

- 2 (a) Factorise $2x^2 + 7x - 15$.

	$2x$	-3
x	$2x^2$	$-3x$
5	$10x$	-15

OR

$$2x^2 + 7x - 15 = (2x - 3)(x + 5)$$

$$\begin{aligned} 2x^2 + 7x - 15 \\ = (2x - 3)(x + 5) \end{aligned}$$

Answer [2]

- (b) Hence factorise completely $2(2y+1)^2 + 7(2y+1) - 15$.

$$\begin{aligned} \text{Let } x &= 2y + 1 \\ (2x - 3)(x + 5) &= (2(2y + 1) - 3)((2y + 1) + 5) \\ &= (4y - 1)(2y + 6) \\ &= 2(4y - 1)(y + 3) \end{aligned}$$

Comments:

- Majority of students left their answer as $(4y - 1)(2y + 6)$ without realising that they have to further factorise out 2.
- Quite a handful of students did not use answer from part (a). They did not know that $x = 2y + 1$ and went ahead to expand the whole expression. No marks awarded if they did not use answer from part (a).

Answer [2]

- 3 Simplify

(a) $\frac{12a^3b}{7} \div \frac{ac^2}{b^2},$

$$\begin{aligned} &= \frac{12a^3b}{7} \times \frac{b^2}{ac^2} \\ &= \frac{12a^3b^3}{7ac^2} \\ &= \frac{12a^2b^3}{7c^2} \end{aligned}$$

Answer [2]

5

(b) $\frac{9a^2 - 1}{3a^2 + 16a + 5}$

$$\begin{aligned}\frac{9a^2 - 1}{3a^2 + 16a + 5} &= \frac{(3a+1)(3a-1)}{(3a+1)(a+5)} \\ &= \frac{3a-1}{a+5}\end{aligned}$$

Comments: (Common mistakes)

- Some students factorise $9a^2 - 1$ wrongly and wrote $9a^2 - 1 = (3a-1)^2$
- Quite a handful of students factorise $3a^2 + 16a + 5$ wrongly and wrote $3a^2 + 16a + 5 = (3a+1)(a-5)$

Answer [3]

4 Solve $\frac{-2}{x-3} = x$.

$$\begin{aligned}\frac{-2}{x-3} &= x \\ -2 &= x^2 - 3x \\ x^2 - 3x + 2 &= 0 \\ (x-2)(x-1) &= 0 \\ x &= 2 \quad \text{or} \quad x = 1\end{aligned}$$

Comments: (Common mistakes)

- Penalise 1 mark if students show the below workings. (missing $(x+1)(x+2)$)
 $x^2 - 3x + 2 = 0$
 $x = 2 \quad \text{or} \quad x = 1$
- Quite a handful of students factorise $x^2 - 3x + 2 = 0$ wrongly and wrote $(x+1)(x+2) = 0$ which result in their final answer as $x = -1$ or $x = -2$

Answer $x = \dots\dots\dots$ or $x = \dots\dots\dots$ [3]

5 Given $p = \frac{q-r^2+3}{2qr^3}$,

(a) evaluate p when $r = -2$ and $q = 3$.

$$\begin{aligned}p &= \frac{q-r^2+3}{2qr^3} \\ p &= \frac{(3)-(-2)^2+3}{2(3)(-2)^3} \\ p &= -\frac{1}{24}\end{aligned}$$

Comments: (Common mistakes)

- Some students went on to round off their final exact answer to 3 s.f.

Answer $p = \dots\dots\dots$ [1]

6

(b) express q in terms of p and r .

$$p = \frac{q - r^2 + 3}{2qr^3}$$

$$2pqr^3 = q - r^2 + 3$$

$$q(2pr^3 - 1) = 3 - r^2$$

$$q = \frac{3 - r^2}{(2pr^3 - 1)} \text{ or } q = \frac{r^2 - 3}{1 - 2pr^3}$$

Comments: (Common mistakes)

Quite a handful of students show the below working(s).

$$q = \frac{-r^2 + 3}{(2pr^3 - 1)}$$

$$q = -\frac{r^2 + 3}{(2pr^3 - 1)}$$

Answer $q = \dots\dots\dots$ [2]

- 6 There are 25 adults and 7 children in the theatre room. After another $2y$ adults and y children entered the theatre room, the probability of selecting a child at random becomes $\frac{2}{7}$.

Find the value of y .

$$P(\text{child}) = \frac{\text{number of children}}{\text{Total number of people}}$$

$$\frac{7 + y}{25 + 7 + 2y + y} = \frac{2}{7}$$

$$49 + 7y = 64 + 6y$$

$$y = 15$$

Comments: (Common mistakes)

Quite a handful of students did not include the number of children into the total number of people in a theatre room (for the 1st method)

OR

$$\frac{7 + y}{25 + 2y} = \frac{2}{5}$$

$$5(7 + y) = 2(25 + 2y)$$

$$35 + 5y = 50 + 4y$$

$$y = 15$$

Answer $y = \dots\dots\dots$ [2]

- 7 Mrs Chan has a map of Singapore drawn to a scale 1 : 120 000 .
The distance on the map between Bird Paradise and her house is 15 cm.
(a) Calculate the actual distance, in kilometres, between Bird Paradise and her house.

$$\begin{aligned} 1 &: 120\,000 \\ 1\text{ cm} &: 1.2\text{ km} \\ 15\text{ cm} &: 18\text{ km} \end{aligned}$$

Comments: Well done

Answer km [2]

- (b) Bird Paradise covers an area of 0.17 km^2 . Calculate the area, in square centimetres, covered by the Bird Paradise on the map.

$$\begin{aligned} 1\text{ cm} &: 1.2\text{ km} \\ 1\text{ cm}^2 &: (1.2)^2\text{ km}^2 \\ 1\text{ cm}^2 &: 1.44\text{ km}^2 \\ \frac{1.44\text{ km}^2}{0.17\text{ km}^2} &= \frac{144}{17} \\ \frac{1\text{ cm}^2}{\frac{144}{17}} &= 0.118\text{ cm}^2\text{ (3sf)} \quad \text{or} \quad \frac{17}{144}\text{ cm}^2 \end{aligned}$$

Comments:

- A handful of students round off their final answer wrongly and gave their answer as '0.12'.
- Some managed to find area scale but left the map area answer as $\frac{144}{17}$ instead of $\frac{17}{144}$

Answer cm^2 [2]

- 8 Express $\frac{2}{2x-3} - \frac{6-4x}{4x^2-12x+9}$ as a single fraction.

$$\begin{aligned} &= \frac{2}{(2x-3)} - \frac{6-4x}{(2x-3)(2x-3)} \\ &= \frac{2(2x-3) - 6 + 4x}{(2x-3)(2x-3)} \\ &= \frac{8x-12}{(2x-3)(2x-3)} \\ &= \frac{4(2x-3)}{(2x-3)(2x-3)} \\ &= \frac{4}{2x-3} \end{aligned} \quad \text{OR} \quad \begin{aligned} &= \frac{2}{(2x-3)} - \frac{2(3-2x)}{(2x-3)(2x-3)} \\ &= \frac{2}{(2x-3)} + \frac{2(2x-3)}{(2x-3)(2x-3)} \\ &= \frac{2}{(2x-3)} + \frac{2}{(2x-3)} \\ &= \frac{4}{2x-3} \quad [\text{A1}] \end{aligned}$$

Comments:

- Majority could factorise $4x^2 - 12x + 9 = (2x-3)^2$ but did not change the sign of $4x$ into positive sign when they combined as a single fraction.

$$\frac{2(2x-3) - 6 - 4x}{(2x-3)(2x-3)}$$

- Some did not simplify their answers further and left their answer as $\frac{8x-12}{(2x-3)(2x-3)}$

Answer [3]

- 9 In a physics experiment using Hooke's Law, the force F in Newtons (N) required to stretch a spring is directly proportional to its extension x , in metres.

When the spring is stretched by 5 cm, a force of 2.5 N is needed.

- (a) Find the equation connecting F and x .

$$F = kx$$

$$2.5 = k \left(\frac{5}{100} \right)$$

$$k = 50$$

$$\therefore F = 50x$$

Answer [2]

- (b) Hence, calculate the force needed to stretch the same spring by 8 cm.

$$F = 50x$$

$$F = 50(0.08)$$

$$F = 4\text{N}$$

Answer N [1]

Comments:

- Many students did not read the question carefully that x is in metres and did not convert 5 cm into 0.05 m in part (a)
- A few students did not use the given variable F and use the units N instead.
- Some students did not present their working properly and did not put bracket when substituting the value of x , i.e. $2.5 = k \ 5$
- For part (b), students generally did not convert 8cm to 0.08m and used the wrong equation found in part (a) to calculate part(b).

- 10 Given that $\frac{3(x-1)}{2} \leq x+1$, find the greatest possible value of x if x is

- (a) a perfect square,

$$\frac{3(x-1)}{2} \leq x+1$$

$$3x-3 \leq 2x+2$$

$$x \leq 5$$

$x = 4$ is the greatest perfect square.

- (b) a prime number.

$x = 5$ is the greatest prime number.

Comments: Generally well done for part (a) and (b) except that

- Some students made mistake in the inequality sign for the following step.

$$\text{E.g. } \frac{3(x-1)}{2} \leq x+1$$

$$2x+2 \leq 3x-3$$

- Some expanded wrongly, e.g. $3x-3 \leq 2x+1$
- A minority of students did not know what is a perfect square.

Answer $x =$ [1]

- 11 One solution of the equation $kx^2 + (k+2)x - 2 = 0$ is $x = \frac{1}{3}$.

(a) Find the value of k .

$$kx^2 + (k+2)x - 2 = 0$$

$$k\left(\frac{1}{3}\right)^2 + (k+2)\left(\frac{1}{3}\right) - 2 = 0$$

$$\frac{1}{9}k + \frac{1}{3}k + \frac{2}{3} - 2 = 0$$

$$\frac{4}{9}k = \frac{4}{3}$$

$$k = 3$$

Comments: Generally quite badly done

- Quite a number of students did not put bracket when substituting the value of k as $\frac{1}{3}$ into the equation. E.g. $k \frac{1^2}{3}$ or $k \left(\frac{1^2}{3}\right)$
- For part (b), some put their answer as $x = \frac{1}{3}$ instead of other solution $x = -2$

Answer $k = \dots\dots\dots$ [2]

(b) Hence, find the other solution of the equation.

$$3x^2 + (3+2)x - 2 = 0$$

$$3x^2 + 5x - 2 = 0 \quad [\text{M1 / ECF M1}]$$

$$(3x-1)(x+2) = 0$$

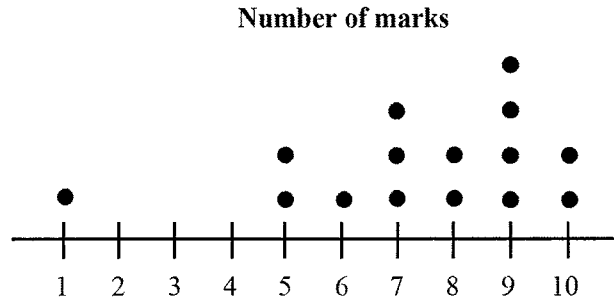
$$x = \frac{1}{3} \quad \text{or} \quad x = -2 \quad [\text{A1}]$$

Comments:

- some put their answer as $x = \frac{1}{3}$ instead of other solution $x = -2$

Answer $x = \dots\dots\dots$ [2]

- 12 The dot diagram shows the distribution of marks that 15 students from Class A scored in a science quiz. The maximum score is 10 marks.



- (a) Describe the dot diagram shown above.

- Data ranges from 1 mark to 10 marks.
- The distribution is spread across with a cluster at 9 marks.
- There is an outlier of 1 mark.

Comments:

- The key/specific words students need to use to describe the dot diagram are “range”, “cluster” and “outlier”.
- Some students used their own words to explain which was not clear enough or not to the point such as “most of the marks are around 5 to 10”, “highest is 9”, “most people got 9 marks”.

.....

.....

..... [2]

- (b) State the modal mark.

mode = 9 marks

Comments:

Generally well done.

Answer [1]

- 13 A fraction is equivalent to $\frac{1}{6}$ if 1 is subtracted from the numerator and 3 is added to its denominator. If 2 is added to the numerator and 5 is subtracted from the denominator of the original fraction, the resulting value is $\frac{3}{5}$. Find the original fraction.

Let x and y be the value in the numerator and denominator respectively.

$$\frac{x-1}{y+3} = \frac{1}{6} \text{ -----(1)}$$

$$6x-6 = y+3$$

$$y = 6x-9 \text{ -----(3)}$$

$$\frac{x+2}{y-5} = \frac{3}{5} \text{ -----(2)}$$

$$5x+10 = 3y-15$$

$$3y = 5x+25 \text{ -----(4)}$$

$$y = 6x-9 \text{ -----(3)}$$

$$(3) \times 3: 3y = 18x-27 \text{ -----(5)}$$

$$3y = 5x+25 \text{ -----(4)}$$

$$(5)-(4): 0 = 13x-52$$

$$x = 4$$

Substitute $x = 4$ into (3):

$$y = 6x-9$$

$$y = 6(4)-9$$

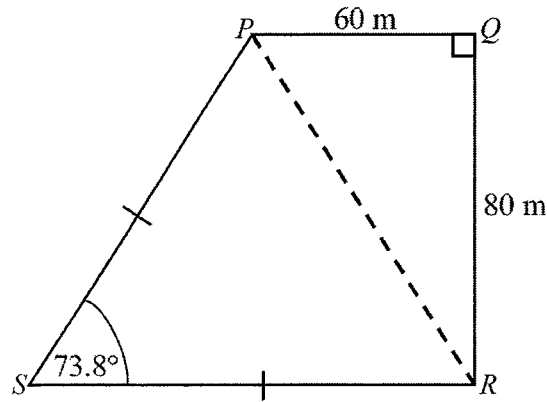
$$y = 15$$

$$\therefore \frac{x}{y} = \frac{4}{15}$$

Comments:

- Majority of the students did not label the equations they formed and did not show the steps clearly for the substitution/elimination method.
- Some students did not define their variables at the start.
- Some students used Guess and Check method but failed to define and explain their working clearly.

Answer [5]



The diagram shows a field $PQRS$ on horizontal ground, with a pathway PR .
 $RS = SP$, $PQ = 60$ m, $QR = 80$ m and angle $PSR = 73.8^\circ$.

- (a) Show that angle $SPQ = 106.2^\circ$, correct to one decimal place.

Answer

$$\begin{aligned}\angle SPR &= \frac{180^\circ - 73.8^\circ}{2} \quad (\text{Isosceles } \Delta) \\ &= 53.1^\circ\end{aligned}$$

$$\tan(\angle RPQ) = \frac{80}{60}$$

$$\angle RPQ = \tan^{-1}\left(\frac{80}{60}\right)$$

$$\begin{aligned}\angle SPQ &= \tan^{-1}\left(\frac{80}{60}\right) + 53.1^\circ \\ &= 106.2^\circ \quad (1\text{dp})\end{aligned}$$

OR

$$\begin{aligned}\angle SPQ &= 90^\circ + (180^\circ - 90^\circ - 73.8^\circ) \\ &= 106.2^\circ \quad (\text{shown}) \quad (\angle \text{ sum of } \Delta)\end{aligned}$$

Comments: Very well done except a few students did not read the question carefully to give their final answer in 1 decimal place.

[2]

- (b) Find SR .

Method 1

Let $PM = 80$ m be perpendicular to SR

$$\tan(73.8^\circ) = \frac{80}{SM}$$

$$SM = \frac{80}{\tan(73.8^\circ)}$$

$$\begin{aligned}SR &= \frac{80}{\tan(73.8^\circ)} + 60 \\ &= 83.2 \text{ m} \quad (3\text{sf})\end{aligned}$$

Method 2

Let X be the midpoint of PR .

$$\begin{aligned}\angle XSR &= 73.8^\circ \div 2 = 36.9^\circ \\ &(\text{property of isosceles } \Delta)\end{aligned}$$

$$\sin(36.9^\circ) = \frac{50}{SR}$$

$$\begin{aligned}SR &= \frac{50}{\sin 36.9^\circ} \\ &= 83.3 \text{ m}\end{aligned}$$

Answer m [2]

Alternative solutions

$RX = 100 \div 2 = 50\text{m}$ where X is the midpoint of PR .

$$\frac{RX}{SR} = \cos 53.1^\circ$$

$$SR = \frac{50}{\cos 53.1^\circ} = 83.3\text{m}$$

OR

$$\frac{PM}{SP} = \sin 73.8^\circ \text{ where } M \text{ is the midpoint of } SR$$

$$SR = SP = \frac{80}{\sin 73.8^\circ} = 83.3\text{m}$$

Comments:

Part (b) was quite badly done and a common mistake made by some students that they assumed $\angle QSR = \frac{1}{2} \angle PSR$ which was a wrong concept.

(c) Find the shortest distance from Q to PR .

Method 1

$$PR = \sqrt{60^2 + 80^2} \text{ (Pythagoras' Theorem)}$$

$$= 100 \text{ m}$$

$$\frac{1}{2}(60)(80) = \frac{1}{2}(100)(h)$$

$$h = 48 \text{ m}$$

Method 2

$$\sin \left(\tan^{-1} \left(\frac{80}{60} \right) \right) = \frac{h}{60}$$

$$h = 48 \text{ m} \quad [\text{A1}]$$

Answer m [2]

Comments:

Generally well done for part (c), most of them used the area of triangle method to find the shortest distance from Q to PR .

- 15 The stem-and-leaf diagram shows the height of 10 students.

15		2	6	9			
16		0	1	1	1	2	5
17		3					

Key: 15 | 2 means 152 cm

- (a) Calculate the mean of these students.

$$\bar{x} = \frac{152 + 156 + 159 + 160 + (161 \times 3) + 162 + 165 + 173}{3 + 6 + 1}$$

$$= 161 \text{ cm}$$

Answer cm [2]

- (b) The height of another student is added to the stem-and-leaf diagram and mean increases by 3 cm.

- (i) Calculate the height of the student added.

Let x be the height added.

$$\frac{1610 + x}{11} = 161 + 3$$

$$1610 + x = 1804$$

$$x = 194 \text{ cm}$$

Answer cm [2]

- (ii) How will the addition of this student's height affect the median?

Median remains unchanged. [B1/ ECF based on (i) answer]

Answer [1]

Comments:

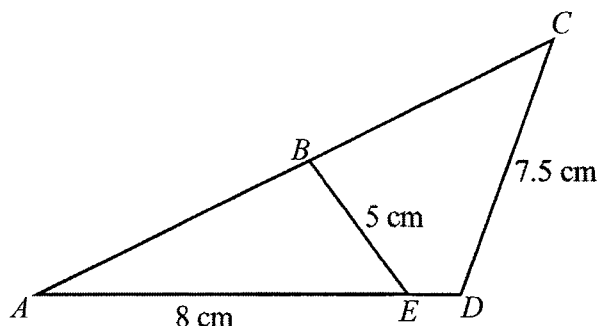
(a) Those that didn't get this correct got careless somewhere in summing up the heights

(bi) Some students forgot to multiply the new average by 11 and instead multiplied by 10, resulting in the wrong answer

(bii) Quite a handful of students got this question wrong.

Common mistakes:

- Even though most were able to realise that the value did not change, they chose to only talk about how the position changed and not address that the value didn't change
- Some wrote "Median will not be affected by much" which is rejected as it will not be affected at all and remains unchanged.
- Some thought Median would increase as the new student added was significantly taller than the initial 10.



Triangle ABE is a reduction of triangle ADC . Given that $BE = 5$ cm, $DC = 7.5$ cm, $AE = 8$ cm and the perimeter of triangle ADC is 28.5 cm, find the

- (a) scale factor of the reduction,

$$\begin{aligned} \text{scale factor} \\ \frac{BE}{DC} &= \frac{5}{7.5} \\ &= \frac{2}{3} \end{aligned}$$

- (b) length of AC ,

$$\begin{aligned} \frac{AE}{AC} &= \frac{2}{3} \\ \frac{8}{AC} &= \frac{2}{3} \\ AC &= 12 \text{ cm} \end{aligned}$$

Comments:

Most students were able to see that the scale factor is $\frac{2}{3}$.

Common mistakes:

- Not simplifying the fraction
- Giving the answer in ratio instead 1:1.5 or 2:3
- Not realizing that reduction scale factor means <1 and gave the wrong order which is $\frac{3}{2}$.

Comments:

Very few did not manage to get this answer correct because of a different scale factor in (a). Awarded ECF.

Answer cm [2]

- (c) length of AB .

Method 1

$$\begin{aligned} AD &= 28.5 - 12 - 7.5 \\ AD &= 9 \\ \frac{AB}{AD} &= \frac{2}{3} \\ \frac{AB}{9} &= \frac{2}{3} \\ AB &= 6 \text{ cm} \end{aligned}$$

Method 2

$$\begin{aligned} \frac{\text{Perimeter of } ABE}{\text{Perimeter of } ADC} &= \frac{2}{3} \\ \frac{\text{Perimeter of } ABE}{28.5} &= \frac{2}{3} \\ \text{Perimeter of } ABE &= 19 \\ AB &= 19 - 5 - 8 \\ AB &= 6 \text{ cm} \end{aligned}$$

Comments:

Few did not manage to get this correct. Those that got this wrong got confused as to which two corresponding sides are similar.

Answer cm [2]

17 The timings of 30 runners who completed a 3.5 km run were recorded.

12.9	15	20.7	39	13.6	35
42.1	31	35	36.8	22	29.8
33.6	35.7	14.4	46	27.7	23.4
34	15.8	43.6	35	15.8	40
37.2	20.5	27	43.1	48.8	27

(a) Complete the frequency table below.

Comments:

A few students fail to realise that 40 is within the range $30 < x \leq 40$ and wrote 10 instead of 11.

Time (x minutes)	Frequency
$10 < x \leq 20$	6
$20 < x \leq 30$	8
$30 < x \leq 40$	11
$40 < x \leq 50$	5

[2]

- (b) A runner was chosen at random.
Find the probability that the runner's timing was
- (i) not between 20 to 30 minutes inclusive,

Comments:

Some did not read the "not between" and gave $\frac{4}{15}$ instead for (bi). Some students also did not give their fractions in the simplest form for both (bi) and (bii)

$$P(\text{not } 20 < x \leq 30) = 1 - \frac{4}{15} \\ = \frac{11}{15}$$

OR

$$P(\text{not } 20 < x \leq 30) = \frac{6 + 11 + 5}{30} \\ = \frac{11}{15}$$

Answer [1]

- (ii) more than 30 minutes.

$$P(>30 \text{ minutes}) = \frac{16}{30} \\ = \frac{8}{15}$$

Answer [1]

- 18 A gift box is in the shape of a right pyramid with square base side of 4 cm less than the vertical height.

- (a) Given that the height of the gift box is x cm, write down an expression, in terms of x , for the side of the gift box.

$$(x - 4) \text{ cm}$$

Comments:

Only a few got this question wrong. These people did not understand the question and tried finding the volume or even used Pythagoras Theorem.

[1]

- (b) The base area of the gift box is 36 cm^2 .
Write down an equation to represent this information and show that it simplifies to

$$x^2 - 8x - 20 = 0$$

$$(x - 4)^2 = 36$$

$$x^2 - 8x + 16 = 36$$

$$x^2 - 8x + 16 - 36 = 0$$

$$x^2 - 8x - 20 = 0 \quad (\text{shown})$$

Comments:

Very few students got this wrong and these are the students that could not solve (a). Students tend to expand first separately before forming the equation which isn't wrong but is something that can be improved on.

- (c) Solve the equation $x^2 - 8x - 20 = 0$.

$$x^2 - 8x - 20 = 0$$

$$(x - 10)(x + 2) = 0$$

$$x = 10 \quad \text{or} \quad x = -2$$

Comments: Generally well done.

Common mistakes:

- Not writing out factor form
- Factor form has the wrong signs
- Some students wrote out the factor form but not " $= 0$ ". Not penalized for this.

- (d) Explain why one of the solutions in (c) must be rejected.

$x = -2$ is rejected because
length/height cannot be negative.

Comments: Most were able to get this correct.

Common mistakes:

- Not specifying length/height
- "Measurement cannot be negative"
- "Cm cannot be negative"
- "One of the solutions will result in lower accuracy"

- (e) Calculate the volume of the gift box.

$$\text{vol} = \frac{1}{3} \times \text{base area} \times h$$

$$= \frac{1}{3} \times 36 \times 10$$

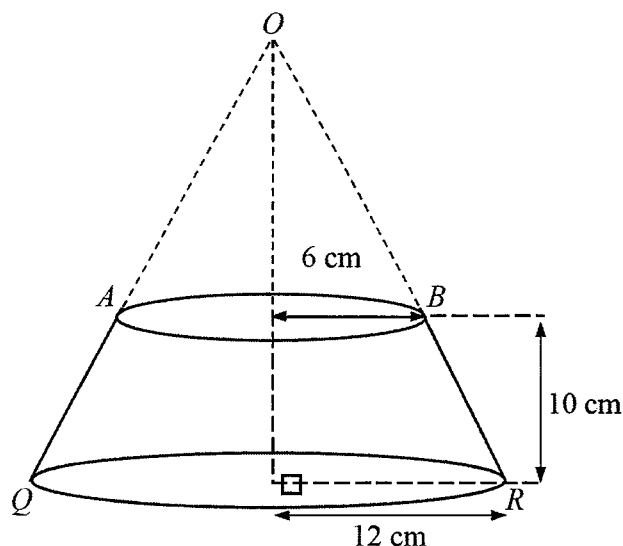
$$= 120 \text{ cm}^3$$

Comments:

Very few got this wrong as they are unsure of the formula to find volume of a pyramid.

Answer cm^3 [2]

- 17 The figure below shows a conical frustum $ABRQ$ which is obtained by removing the smaller cone OAB from the larger cone OQR . The base radius of cone OAB is 6 cm and the base radius of cone OQR is 12 cm. The height of the frustum is 10 cm.



- (a) Using similar triangles, show that the height of the cone OAB is 10 cm. [1]

Answer

$$\begin{aligned} \frac{6}{12} &= \frac{h}{h+10} & \text{or} & \quad \frac{6}{12} = \frac{10}{OM} \\ 6h + 60 &= 12h & OM &= \frac{120}{6} \\ 6h &= 60 & OM &= 20 \\ h &= 10 \text{ cm (shown)} & \text{Height of cone } OAB &= 20 - 10 = 10 \text{ cm} \end{aligned}$$

- (b) Calculate the total surface area of the conical frustum.

Slanted length of cone, l

$$l_{\text{small cone}} = \sqrt{6^2 + 10^2} \text{ (pythagoras' theorem)}$$

$$l_{\text{small cone}} = \sqrt{136}$$

Slanted length of cone, l

$$l_{\text{big cone}} = \sqrt{12^2 + 20^2} \text{ (pythagoras' theorem)}$$

$$l_{\text{big cone}} = \sqrt{544}$$

$$\begin{aligned} \pi r l_{\text{big cone}} - \pi r l_{\text{small cone}} + \pi r_{\text{big}}^2 + \pi r_{\text{small}}^2 \\ = \pi(12)(\sqrt{544}) - \pi(6)(\sqrt{136}) + \pi(12)^2 + \pi(6)^2 \\ = 12\pi\sqrt{544} - 6\pi\sqrt{136} + 180\pi \\ = 1220 \text{ cm}^2 \text{ (3sf)} \end{aligned}$$

Comments:

Major Mistakes:

- [CSA of big cone + base area] – [CSA of small cone + base area]
- Using vertical height to calculate S.A instead of finding L using Pythagoras' theorem.
- Calculating surface area **without** the area of the top of the frustum.
- Leaving final answer in 1 dp / 5 sf

Accept: Round off to nearest whole number – given (P)

Answer cm² [4]

- (c) A solid flowerpot made of clay is modelled by the frustum $ABRQ$ with a hemisphere carved out. Find the amount of clay required to make one flowerpot.

$$\begin{aligned} & \frac{1}{3}\pi(12)^2(20) - \frac{1}{3}\pi(6)^2(10) - \frac{1}{2}\left(\frac{4}{3}\pi(6)^3\right) \\ &= 960\pi - 120\pi - 144\pi \\ &= 696\pi \\ &= 2190 \text{ cm}^3 \text{ (3sf)} \end{aligned}$$

Comments:

Major Mistakes:

- Using surface area answer in (b) in intermediate. These students failed to realise that question is asking for volume.
- Calculating volume of hemisphere only. Students are confused between volume and capacity of the flowerpot.
- Excluding $\frac{1}{2}$ in volume of hemisphere.
- Leaving final answer in 1 dp / 5 sf

Accept: Round off to nearest whole number – given (P)

Answer cm³ [3]

- 19 The variables x and y are connected by the equation $y = 4x^2 - 8x - 21$.

x	-2	-1	0	1	2	3	4
y	11	p	-21	-25	-21	-9	11

- (a) Find the value of p .

$$p = 4(-1)^2 - 8(-1) - 21$$

$$p = -9$$

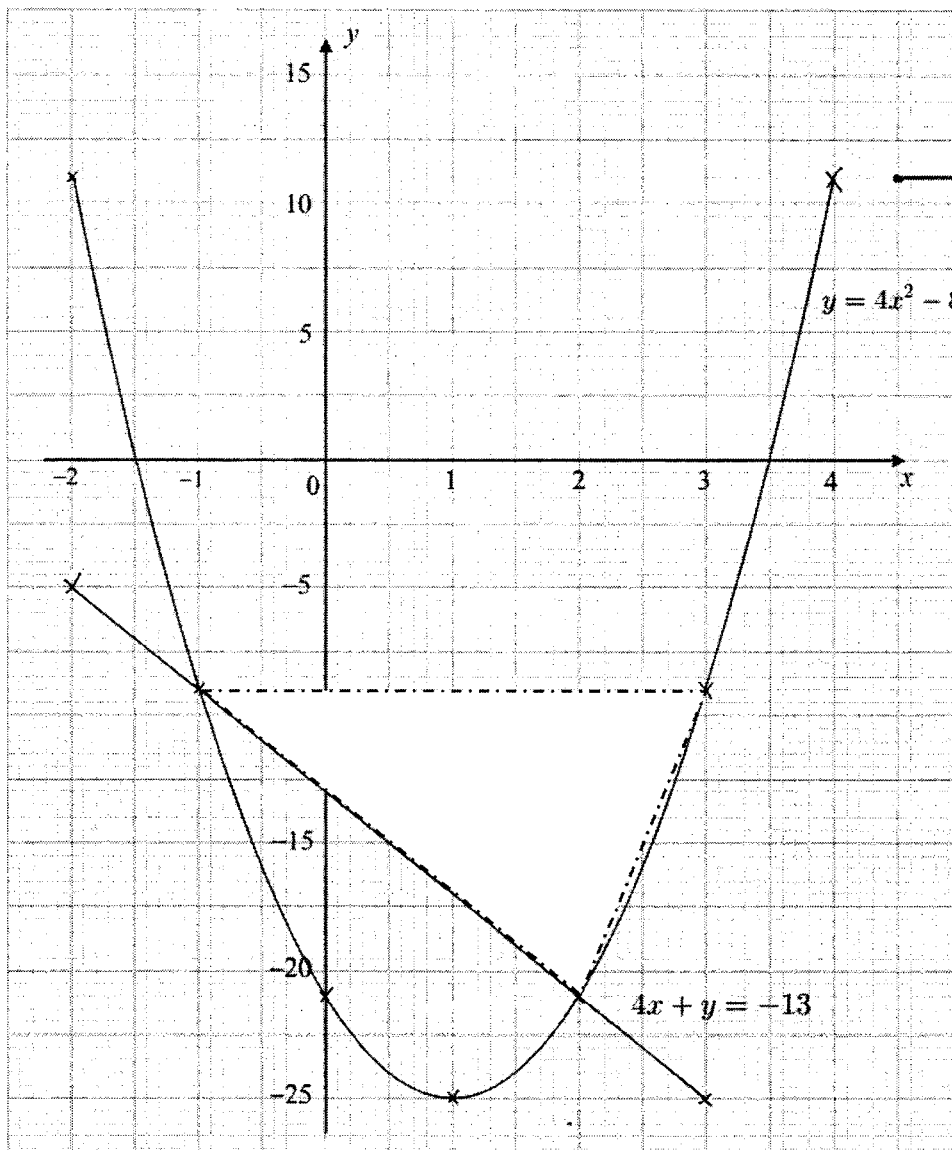
Comments:

Generally well done.

Some calculation error.

..... [1]

- (b) On the grid, draw the graph of $y = 4x^2 - 8x - 21$ for $-2 \leq x \leq 4$.



Comments:

Many plotted here instead.

All 7 points plotted correctly
6 points plotted correctly
Smooth curve

Comments:

Handful of students who plotted wrongly, did not read scale carefully.

Some students drew their graph too pointy – deducted 1 mark

- (c) On the same grid, draw the line $4x + y = -13$ for $-2 \leq x \leq 3$. [2]

Calculation of at least two coordinates.

Line with negative gradient intersecting two points.

Comments:

Calculation error resulting to a positive gradient linear graph.

Range of line was not adhered.

- (d) Using your graph,

- (i) write down the coordinates of the points of intersection of the line and the curve.

$(-1, -9)$

$(2, -21)$

Comments:

No other answers were accepted because this can be checked via simultaneous equation or via substitution.

Answer (.....,)

(.....,) [2]

- (ii) A triangle is formed by the points of intersection in (d)(i) and $(3, -9)$.
Calculate the area of this triangle.

$$\frac{1}{2}(4)(12) = 24 \text{ cm}^2$$

Comments:

Very badly done. Students generally measured the length of the triangles instead of using the scale given on the graph.

Some answers include negative areas.

Some students mistook $(3, -25)$ as one of the intersection points.

Answer units² [1]

- 20 Jason works part-time at a bubble tea shop and collected data about the number of drinks sold during different hours on a Saturday. He wants to analyze the data to help his manager optimize staff deployment.

Here are the number of drinks sold each hour from 11 am to 9 pm:

15, 18, 25, 42, 38, 42, 36, 42, 28, 25

- (a) (i) Calculate the median number of drinks sold per hour.

15, 18, 25, 25, 28, 36, 38, 42, 42, 42

$$\begin{aligned}\text{Position} &= \frac{10+1}{2} \\ &= 5.5 \\ \text{median} &= \frac{28+36}{2} \\ &= 32\end{aligned}$$

Comments:

Very badly done. Students did not rearrange the data before extracting the correct median position.

A handful of students calculated mean instead of median.

Answer [2]

- (ii) The manager defines peak hours as times when the number of drinks sold are greater the median. Calculate the mean number of drinks sold during peak hours.

Peak hours: 36, 38, 42, 42, 42

$$\begin{aligned}\text{Mean} &= \frac{(36+38+42+42+42)}{5} \\ &= 40 \text{ drinks}\end{aligned}$$

Comments:

Generally well done to those who attempted.

ECF 1m if students used wrong part (a) answer.

Answer [2]

- (b) During peak hours, each drink generates a profit of \$3 to the bubble tea shop. Jason estimates that an additional staff member can increase the number of drinks sold by 25% during peak hours. Every staff member earns \$15 per hour.

Would you recommend Jason proposing to the manager to hire an additional staff member during peak hours? Justify your answer using appropriate calculations.

$$25\% \uparrow \text{ drinks sold} = \frac{25}{100} \times 200 = 50$$

$$\text{Revenue} \rightarrow \$3 \times 50 = \$150$$

$$\text{Cost for additional staff} \rightarrow \$15 \times 5\text{h} = \$75$$

$$\text{Net profit} \rightarrow \$150 - \$75 = \$75$$

OR

$$\text{Sales for 5h} \rightarrow \$3 \times 200 = \$600$$

$$25\% \uparrow \text{ drinks} \rightarrow 200 \times 1.25 = 250$$

$$\text{New sales} \rightarrow 250 \times \$3 = \$750$$

$$\text{Additional staff to pay} \rightarrow \$15 \times 5 = \$75$$

$$\text{Net profit} \rightarrow \$150 - \$75 = \$75$$

OR

$$\text{Drinks} \uparrow 25\% \text{ per hr} \rightarrow 40 \times 0.25 = 10$$

$$\text{Additional revenue per hr} \rightarrow 10 \times \$3 = \$30$$

$$\text{Profit earned per hr} \rightarrow \$30 - \$15$$

OR

$$\text{Drinks} \uparrow 25\% = \uparrow \text{ profit per hr} \rightarrow \$3 \times 1.25 = \$3.75$$

$$\text{Additional revenue per hr} \rightarrow 40 \times \$3.75 = \$150$$

$$\text{Profit earned per hr} \rightarrow \$150 - \$3 \times 40 = \$30$$

$$\text{Net profit} \rightarrow \$30 - \$15 = \$15$$

Jason should propose to the manager to hire an additional staff member during peak hours as it generates positive net profit.

Answer

..... [5]

Comments:

Common errors:

- Included Jason when calculating the amount to pay staff
- It is stated in the question that one additional staff is added, a handful of students concluded that more than 1 staff can be added; not answering the question.
- Net profit is only when student take new sales – old sales figure – additional amount to pay staff.
- ECF up to 4 marks is given if 42 was used in calculations.

QUESTION is a mixture of proportion, statistics and profit and loss general knowledge.

Many students could not comprehend the main objective of the question and answered in long sentences thinking that the calculations can be explained in words rather than in calculations.