Calculator Model :

ORCHID PARK SECONDARY SCHOOL

Preliminary Examination 2024

CANDIDATE NAME

CLASS | | | | INDEX NUMBER | | |

MATHEMATICS **4052/02**

Paper 2 **19 August 2024**

Secondary 4 Express / 5 Normal (Academic) **2 hours 15 minutes**

Setter: Mrs. Jay **90 Marks**

Additional materials: NIL

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
Write in dark blue or black pen.
Use a pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions.

If working is needed for any question, it must be shown in the space below the question.
Omission of essential working will result in loss of marks.
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, unless the question requires the answer in terms of π.

The number of marks is given in brackets [ ] at the end of each question or part question.
The total number of marks for this paper is 90.

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Total	

This document consists of **23** printed pages.

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Mathematical Formulae

Compound interest

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

Mensuration

Curved surface area of a cone = πrl

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

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

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

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

Arc length = $r\theta$, where θ is in radians

Sector area = $\frac{1}{2}r^2\theta$, where θ 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

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

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

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Answer **all** the questions.

1 **(a)** **(i)** Express $2x^2 - 6x - 12$ in the form $k(x - a)^2 - b$, where k is an integer.

Answer: ……. [1]

(ii) Hence, solve $2x^2 - 6x - 12 = 0$.

Answer: x = ……. or ……. [2]

(b) Simplify $\frac{3x+1}{2x^2+11x+12} - \frac{1}{x+4}$.

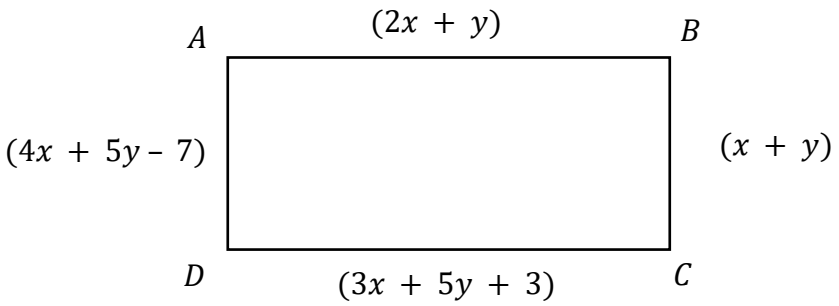
Answer: ……. [3]

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2 In the diagram, *ABCD* is a rectangle. Given that *AB* = $(2x + y)$ cm, *BC* = $(x + y)$ cm, *CD* = $(3x + 5y + 3)$ cm and *AD* = $(4x + 5y - 7)$ cm.

Find the values of *x* and *y*.



Answer: x = …… y = …… [3]

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3 **(a)** By using factorisation, solve $(x - 3)(2x + 8) = -12$.

Answer: x = …… [3]

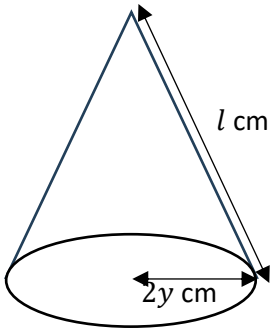
(b) Solve the equation $\frac{4}{2x-3} - \frac{3}{x+2} = 1$.

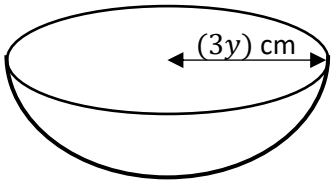
Give your solutions correct to two decimal places.

Answer: x = …… [3]

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4 The diagrams below show a solid hemisphere and a solid cone. The hemisphere has a radius of $3y$ cm. The cone has a radius of $2y$ cm and slanted height l cm.





(a) Show that the total surface area of the solid cone is $2\pi y(l + 2y)$ cm^2. [2]

(b) The total surface area of the solid hemisphere is equal to the total surface area of the solid cone. Find l in terms of y.

Answer: …… [3]

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(c) The volume of the hemisphere is 729 cm^3. Calculate the volume of the cone.

Answer: …… cm^3 [4]

5 The scale of a map is 2 cm : 1 km.

(a) Write this scale in the form 1 : *n* .

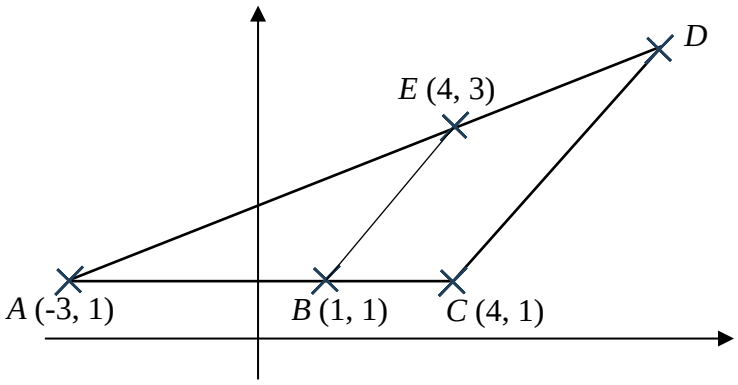
Answer: …… [1]

(b) The area of a park is represented by an area of 456 cm^2 on the map. Calculate the actual area of the land in square kilometres.

Answer: …… [2]

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6 The points A, B, C, D and E are shown in the diagram below such that ABC and AED are straight lines and BE = $\sqrt{8}$ cm.



(a) Without using a calculator, find

(i) sin *ABE*.

Answer: ……. [1]

(ii) cos *ABE*

Answer: ……. [1]

(b) Using your answer in **(a)(i)**, calculate the area of triangle *ABE*

Answer: ……. [2]

(c) Given that triangle *ABE* and triangle *ACD* are similar, calculate the area of triangle *ACD*.

Answer: ……. [2]

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7 **(a)** Complete the table of values for $y = x - \frac{4}{x^2}$.

Values are given to one decimal place where appropriate.

x	-15	-10	-5	-1	1	5	10	15
y	-15.0		-5.2	-5	-3	4.8	10.0	15.0

[1]

(b) On the grid on page 11, draw the graph of $y = x - \frac{4}{x^2}$ for $-15 \leq x \leq 15$.
The graph has an asymptote at $x = 0$ (the graph goes near but do not cut through the y-axis). [3]

(c) **(i)** On the same grid, draw the graph of $2y - 2x = -7$ for $-15 \leq x \leq 15$. [2]

(ii) Write down the x-coordinates of the points where the line intersects the curve.

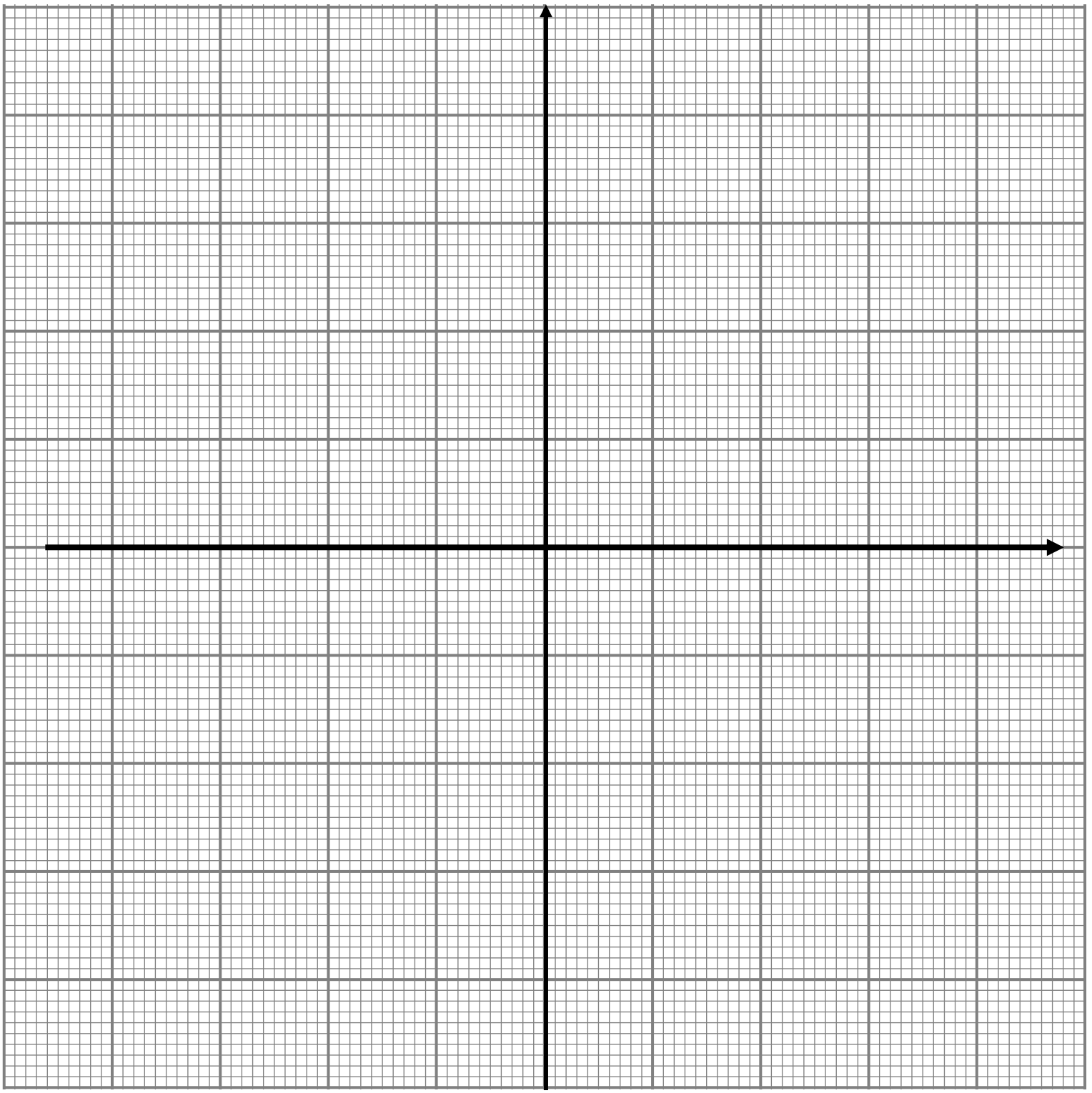
Answer: x = …… or …… [1]

(iii) These values of x in part (ii) are the solutions of the equation $Ax^2 + B = 0$.

Find the value of A and the value of B.

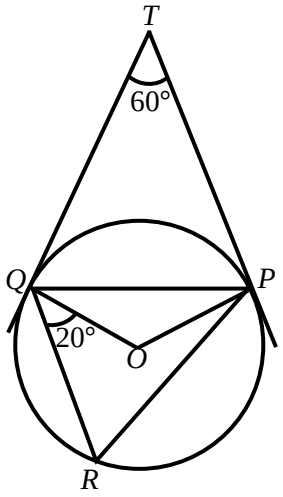
Answer: A = …… B = …… [1]

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8 P, R and Q are points on the circle with centre, O.
PT and QT are tangents to the circle at P and Q respectively.
$\angle PTQ = 60°$ and $\angle OQR = 20°$.



Writing your reasons clearly, find

(a) $\angle TQP$,

Answer: $\angle TQP =$ ..... ° [2]

(b) $\angle PRQ$,

Answer: $\angle PRQ =$ ..... ° [1]

(c) $\angle OPR$,

Answer: $\angle OPR =$ ..... ° [1]

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(d) If the radius of the circle is 5 cm, find the area of the major segment *QRP* of the circle.

Answer: ..…….…… cm^2 [3]

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9 *ABCD* is a parallelogram. *A* is the point $(-6, -2)$ and *B* is the point $(-4, -7)$.
$\overrightarrow{BC} = \begin{pmatrix} 8 \\ -2 \end{pmatrix}$.

(a) Find the length of the line *AB*.

Answer: ..…… units [2]

(b) Find the equation of the line *CD*.

Answer: ..…… [3]

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(c) X is the point where the diagonals of the parallelogram intersect.

(i) Find $\overrightarrow{XC}$.

Answer: $\overrightarrow{XC} =$ (……) [2]

(ii) Find the position vector of X.

Answer: ……. [2]

(d) P is the point on BC such that $\frac{BP}{PC} = \frac{2}{1}$.

Find the ratio of the area of $\frac{\Delta ABP}{\Delta ACP}$.

Answer: ……. [1]

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10 The table below summarises the times taken by female participants to complete a 10 km race.

Time (*t* min)	$30 \leq t < 40$	$40 \leq t < 50$	$50 \leq t < 60$	$60 \leq t < 70$	$70 \leq t < 80$
Freq	20	39	16	20	x

(a) Given that the estimated mean time is 50.1 min, show that the value of x is 5. [2]

(b) Calculate an estimate of the standard deviation.

Answer: ..…….…….… min [1]

(c) The mean time for male participants to complete the race was 45.3 min and the standard deviation was 12.6 min. Make 2 comparisons between the times for male and female participants.

……

……

……

……

…… [2]

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11 The first four terms in a sequence of numbers are given below.

$T_1 = 3^2 + 5 = 14$

$T_2 = 4^2 + 8 = 24$

$T_3 = 5^2 + 11 = 36$

$T_4 = 6^2 + 14 = 50$

(a) Find T_5.

Answer: ..…….…….…. [1]

(b) Explain why the value of T_n must be even for all values of n.

……

……

…… [1]

(c) Show that the nth term of the sequence, T_n, is given by $n^2 + 7n + 6$. [2]

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(d) T_p and T_{p+1} are consecutive terms in the sequence. Find and simplify an expression, in terms of p for $T_{p+1} - T_p$.

Answer: ..……..……..… [2]

(e) Explain why two consecutive terms of the sequence cannot have a difference of 4.

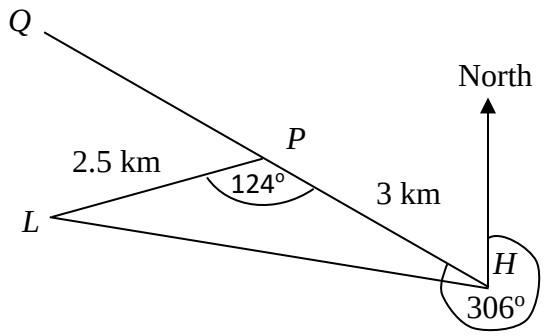
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…… [2]

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12 The diagram shows the positions of a harbour, *H*, a lighthouse, *L*, and two buoys *P* and *Q*. *HPQ* is a straight line. The bearing of *P* from *H* is 306°. *HP* = 3 km, *PL* = 2.5 km and angle *HPL* = 124°.



(a) Find the bearing of

(i) H from P,

Answer: ..…….…….…. [2]

(ii) L from P.

Answer: ..…….…….…. [1]

(b) A helicopter is 500 m vertically above *P*. Find the angle of elevation from *L* to the helicopter.

Answer: ..…….…….…. [1]

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(c) Calculate HL.

Answer: ..……..……..… [2]

(d) A ship sailed from the harbour along the line HPQ at an average speed of 4.5 m/s. At 0809 hours, it reached a point X which is nearest to the lighthouse.

Find the time it left the harbour. Correct your answer to the nearest minute.

Answer: ..……..……..… [3]

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13 In a shooting game, the player has to shoot with a gun to capture a monster. The bullet from the gun has to land on a circular target on the monster so that a net will open up. The circular target has four different sizes.

Target 1 is a big circle;

Target 2 is three quarters of the area of Target 1;

Target 3 is half of the area of Target 1;

Target 4 is one quarter of the area of Target 1.

(a) Sam estimates that the probability that he hits Target 1 is about 0.88. Given that the probability of hitting the circular target is proportional to its area, show that the probability that Sam hits Target 2 and Target 4 is estimated to be 0.66 and 0.44 respectively.

Answer: ..…….…..… [2]

Even if the bullet hits the circular target, the monster might not be captured as it can break free from the net. The probability of successfully capturing the monster depends on the area and colour of the circular target, and the type of bullet that the player uses.

Information that the players need is given below.

Estimated probability of Sam hitting the target.

	Target 1	**Target 2**	**Target 3**	**Target 4**
Probability of Sam hitting the target	0.88	0.66	0.44	0.22

In-built multipliers for capturing monster if the monster has been hit.

Targets of different sizes	**Target 1**	**Target 2**	**Target 3**	**Target 4**
Multiplier for capturing monster	0.7	0.8	0.95	0.5

Targets of different colours	**Green**	**Yellow**	**Orange**	**Red**
Multiplier for capturing monster	0.9	0.7	0.5	0.4

Types of bullets	**Hollow Point**	**Soft Point**	**Flat Nose**
Multiplier for capturing monster	0.6	0.7	0.9

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To calculate this probability, in-built multipliers are assigned to each of these three factors. For example, if a player uses a hollow point bullet and captures a monster with a yellow Target 3, the probability of successfully capturing the monster is given by $0.6 \times 0.7 \times 0.95 = 0.399$.

(b) Show that the estimated probability that Sam will hit and capture a monster with an orange Target 4 using a Flat Nose Bullet is 0.0495.

[2]

In the game, the target changes colour from green to yellow to orange to red and finally back to green. Each change occurs every second. In addition, the target also changes its size from Target 1 to 2 to 3 to 4 and then back to Target 1. Each change also occurs every second. For example, if a monster appears with a yellow Target 3, it will change to an orange Target 4 in the next second, and then a red Target 1 in the following second.

(c) At time $t = 0$ seconds, Sam sees a monster with a red Target 2. He only has one Soft Point Bullet. State the colour, Target size and find the maximum probability and the number of seconds Sam should take to shoot at the monster in order to maximise his chance of hitting and capturing it. Justify your decision and show your calculations clearly.

[6]

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~~~~~ END OF PAPER II ~~~~~

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