

TEST SCHOOL
121/2 MATHEMATICS
Paper 2
Form 4 End Term Examination

Time: 2 ½ Hours

Name: Adm No:
 School: Class:
 Signature: Date:

INSTRUCTIONS TO CANDIDATES

- (a) Write your name and index number in the spaces provided at the top of this page.
- (b) Write your school name, sign and write the date of the examination in the spaces provided above.
- (c) This paper consists of **Two** sections: **Section I** and **Section II**.
- (d) Answer **ALL** questions in Section I and any **five questions** from Section II.
- (e) Marks may be given for correct working, relevant points, and clear presentation.
- (f) Non-programmable silent electronic calculators may be used where necessary.
- (g) KNEC Mathematical Tables may be used.
- (h) This paper consists of **8 printed pages**.
- (i) Candidates should check the question paper to ensure that all the pages are printed as indicated and no questions are missing.
- (j) Candidates should answer the questions in English.

For Examiner's Use Only

SECTION I

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total

SECTION II

17	18	19	20	21	22	23	24	Total	Grand Total

SECTION I

1. A rectangular field measures 120 m by 80 m, measured to the nearest metre. Calculate the maximum possible area of the field and the percentage error in this maximum area.

2. Solve for x : $3^{2x+1} = 27$.

3. Simplify and rationalise the denominator: $\frac{\sqrt{5} + \sqrt{2}}{\sqrt{5} - \sqrt{2}}$.

4. y varies directly as x and inversely as the square of z . Given that $y = 12$ when $x = 6$ and $z = 2$, find y when $x = 9$ and $z = 3$.

5. Solve for x : $\log_{10} x + \log_{10} (x + 3) = 1$.

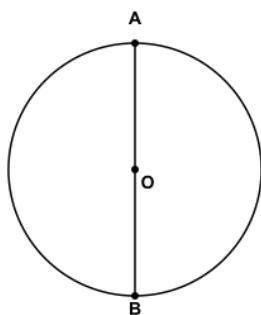
6. Solve the equation $2x^2 - 5x - 3 = 0$ by completing the square.

7. If P varies jointly as q and the square root of r , and $p = 20$ when $q = 5$ and $r = 16$, find the constant of variation k .

8. The third term of a geometric progression is 16 and the sixth term is 128. Find the first term and the common ratio.

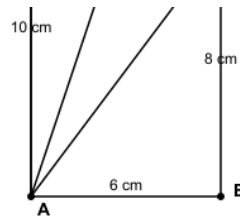
9. Given that $\sin \theta = -\frac{4}{5}$ and θ lies in the third quadrant ($180^\circ < \theta < 270^\circ$), find the exact value of $\cos \theta$.

10. Find the equation of a circle whose centre is $(2, -1)$ and radius 3 units. Express your answer in the form $x^2 + y^2 + ax + by + c = 0$.

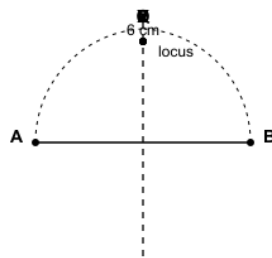


11. Given matrix $A = \begin{pmatrix} 3 & 4 \\ 2 & k \end{pmatrix}$ and $\det(A) = 1$, find the value of k .

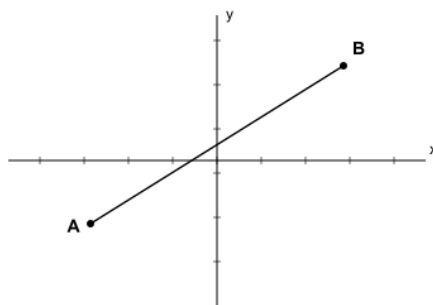
12. The diagram below shows a rectangular prism $ABCDEFGH$ with $AB = 6$ cm, $BC = 8$ cm, and $AE = 10$ cm. Calculate the angle between line AG and the plane $ABCD$.



13. Two points P and Q are 6 cm apart. On the diagram below, construct the locus of points that are equidistant from P and Q and also equidistant from lines PX and QY where PX and QY are perpendicular to PQ at P and Q respectively. Describe the locus.

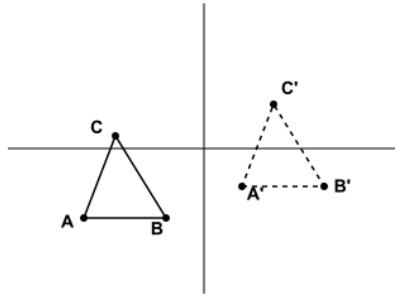


14. Find the area bounded by the curve $y = x^2 + 2$, the x -axis, and the lines $x = 1$ and $x = 3$.



15. Two points X and Y on the equator have longitudes 30°E and 60°E respectively. Taking the radius of the Earth as 6370 km, calculate the distance between X and Y along the equator in kilometres. (Use $\pi = \frac{22}{7}$)

16. A transformation T is represented by the matrix $\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$. A point $P(3, -2)$ is transformed under T to P' . (a) Determine the coordinates of P' . (b) .



Determinen the coordinates of P'

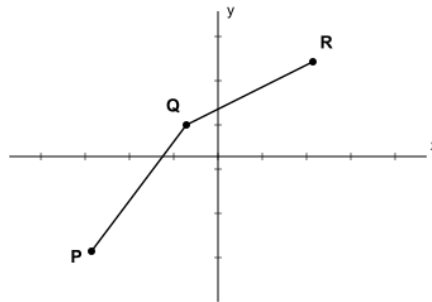
Describe fully the transformation T

SECTION II

Answer any five questions from this section.

17. The table below shows the distribution of masses (in kg) of 80 students. (a) (3 marks) (b) (4 marks) (c) (3 marks) Give your answers correct to 2 decimal places. [10 marks]

Mass (kg)	40-44	45-49	50-54	55-59	60-64	65-69	70-74
Frequency	4	10	18	22	14	8	4



Calculate the mean mass.

Calculate the variance and standard deviation of the masses.

Using a cumulative frequency curve (ogive), estimate the median mass.

18. A businesswoman deposits Ksh 200,000 in a bank account that pays compound interest at a rate of 12% per annum, compounded monthly. She also starts a second account by depositing Ksh 100,000 at the beginning of each year for 5 years in a different bank that offers a simple interest rate of 10% per annum. (a) (3 marks) (b) (4 marks) (c) (3 marks) Give your answers to the nearest shilling. [10 marks]

Calculate the amount in the first account after 3 years.

Calculate the total amount in the second account after 5 years.

Find the difference in the amounts from the two accounts after 5 years.

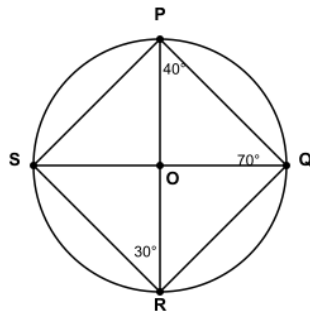
19. (a) (3 marks) (b) (3 marks) (c) (4 marks) [10 marks]

Expand $(1 + 2x)^6$ up to the term in x^3 .

Use your expansion to estimate the value of $(1.02)^6$ correct to 4 significant figures.

Find the coefficient of x^4 in the expansion of $(1 + 3x)(1 - 2x)^5$.

20. In the diagram below, O is the centre of the circle. P , Q , R and S are points on the circumference. $\angle PQR = 70^\circ$, $\angle PRS = 30^\circ$, and $\angle QPR = 40^\circ$. (a) (3 marks) (b) (3 marks) (c) (4 marks) [10 marks]

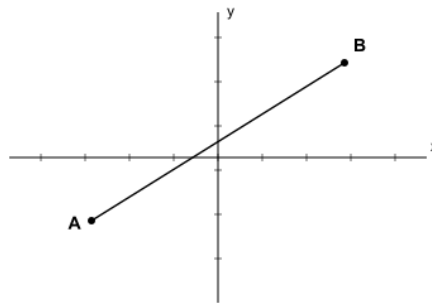


Calculate $\angle QRS$.

Calculate $\angle PQS$.

Show that $\angle PSR = 110^\circ$.

21. Consider the function $y = 3\sin(2x) - 1$ for $0^\circ \leq x \leq 360^\circ$. (a) (3 marks) (b) Clearly label the axes and key points. (4 marks) (c) (3 marks) [10 marks]

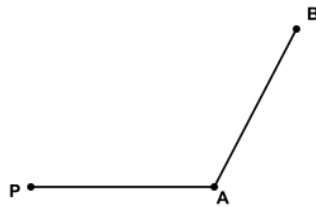


State the amplitude, period and phase shift.

Sketch the graph of the function for the given interval.

Determine the range of the function.

22. Vectors $\vec{a}$, $\vec{b}$ and $\vec{c}$ are such that $\vec{a} = \begin{pmatrix} 2 \\ -1 \\ 3 \end{pmatrix}$, $\vec{b} = \begin{pmatrix} 4 \\ 0 \\ -2 \end{pmatrix}$ and $\vec{c} = \begin{pmatrix} 1 \\ 5 \\ -1 \end{pmatrix}$. (a) (3 marks) (b) (4 marks) (c) (3 marks) [10 marks]

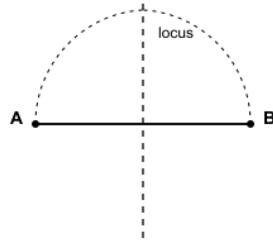


Find $|\vec{a} + \vec{b} - \vec{c}|$.

Given that point P divides the line segment joining $A(1, 2, 3)$ and $B(4, -1, 6)$ in the ratio $2 : 1$ externally, find the coordinates of P .

Show that vectors $\vec{a}$ and $\vec{b}$ are perpendicular.

23. A particle moves in a straight line such that its displacement s metres from a fixed point O after t seconds is given by $s = t^3 - 6t^2 + 9t + 5$, for $t \geq 0$. (a) (3 marks) (b) (3 marks) (c) (2 marks) (d) (2 marks) [10 marks]



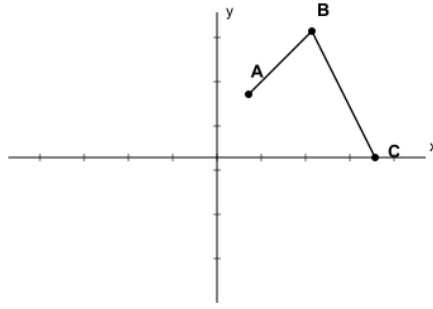
Determine the velocity of the particle when $t = 2$ seconds.

Find the time(s) when the particle is at rest.

Calculate the acceleration of the particle when $t = 1$ second.

Find the total distance travelled in the first 4 seconds.

24. A circle passes through the points $A(1, 2)$, $B(3, 4)$ and $C(5, 0)$. (a) (5 marks) (b) (3 marks) (c) (2 marks) [10 marks]



Find the equation of the circle in the form $x^2 + y^2 + ax + by + c = 0$.

Determine the centre and radius of the circle.

Show that the line $y = x - 2$ is a tangent to the circle.

121/2 MATHEMATICS MARKING SCHEME

Form 4 Paper 2

SECTION I (50 marks)

1. A rectangular field measures 120 m by 80 m, measured to the nearest metre. (4 marks)

Calculate the maximum possible area of the field and the percentage error in this maximum area.

Correctly identifies upper bounds: length = 120.5 m, width = 80.5 m [1]

Calculates maximum area: $120.5 \times 80.5 = 9700.25 \text{ m}^2$ [1]

Calculates absolute error: $9700.25 - 9600 = 100.25 \text{ m}^2$ [1]

Calculates percentage error: $(100.25/9600) \times 100 \approx 1.04\%$ [1]

Alternative method/answer:

Upper bound area = $(120.5)(80.5) = 9700.25 \text{ m}^2$, measured area = 9600 m^2 , absolute error = 100.25 m^2 , percentage error = $(100.25/9600) \times 100\% \approx 1.04\%$

2. Solve for x: $3^{2x+1} = 27$. (2 marks)

Writes 27 as 3^3 and equates exponents: $2x+1 = 3$ [1]

Solves to get $x = 1$ [1]

Alternative method/answer:

$3^{(2x+1)} = 27 \rightarrow 3^{(2x+1)} = 3^3 \rightarrow 2x+1 = 3 \rightarrow x = 1$

3. Simplify and rationalise the denominator: $(\sqrt{5} + \sqrt{2})/(\sqrt{5} - \sqrt{2})$. (4 marks)

Multiplies numerator and denominator by conjugate $(\sqrt{5} + \sqrt{2})$ [1]

Numerator: $(\sqrt{5} + \sqrt{2})^2 = 5 + 2\sqrt{10} + 2 = 7 + 2\sqrt{10}$ [1]

Denominator: $(\sqrt{5})^2 - (\sqrt{2})^2 = 5 - 2 = 3$ [1]

Final simplified expression: $(7 + 2\sqrt{10})/3$ [1]

Alternative method/answer:

Multiply by $(\sqrt{5} + \sqrt{2})/(\sqrt{5} + \sqrt{2})$: numerator = $7 + 2\sqrt{10}$, denominator = 3, final = $(7 + 2\sqrt{10})/3$

4. y varies directly as x and inversely as the square of z. Given that $y=12$ when $x=6$ and $z=2$, find y when $x=9$ and $z=3$. (3 marks)

Sets up variation equation: $y = kx/z^2$ [1]

Substitutes given values to find k: $12 = k(6)/4 \rightarrow k = 8$ [1]

Finds y when $x=9$, $z=3$: $y = 8(9)/9 = 8$ [1]

Alternative method/answer:

$k = (12 \times 4)/6 = 8$, then $y = 8 \times 9/9 = 8$

5. Solve for x: $\log_{10} x + \log_{10} (x+3) = 1$. (3 marks)

Combines logs: $\log_{10}[x(x+3)] = 1$ [1]

Writes exponential form: $x(x+3) = 10$ [1]

Solves quadratic $x^2 + 3x - 10 = 0 \rightarrow (x+5)(x-2) = 0$, rejects $x = -5$, gives $x = 2$ [1]

Alternative method/answer:

$\log_{10} x + \log_{10} (x+3) = \log_{10}[x(x+3)] = 1 \rightarrow x(x+3) = 10 \rightarrow x^2 + 3x - 10 = 0 \rightarrow x = 2 \text{ or } x = -5 \text{ (reject)} \rightarrow x = 2$

6. Solve the equation $2x^2 - 5x - 3 = 0$ by completing the square. (4 marks)

Divides by 2: $x^2 - (5/2)x - 3/2 = 0$ [1]

Adds $(5/4)^2$ to both sides: $x^2 - (5/2)x + 25/16 = 3/2 + 25/16$ [1]

Writes as $(x - 5/4)^2 = 49/16$ [1]

Solves: $x = 5/4 \pm 7/4 \rightarrow x = 3 \text{ or } x = -1/2$ [1]

Alternative method/answer:

Completing square: $(x-5/4)^2 = 49/16 \rightarrow x = 5/4 \pm 7/4 \rightarrow x=3$ or $x=-1/2$

7. If p varies jointly as q and the square root of r , and $p=20$ when $q=5$ and $r=16$, find the constant of variation k . (2 marks)

Writes joint variation: $p = k q \sqrt{r}$ [1]

Substitutes $p=20$, $q=5$, $r=16$: $20 = k \cdot 5 \cdot 4 \rightarrow k = 1$ [1]

Alternative method/answer:

$p = k q \sqrt{r} \rightarrow 20 = k \times 5 \times 4 \rightarrow k=1$

8. The third term of a geometric progression is 16 and the sixth term is 128. Find the first term and the common ratio. (3 marks)

Forms equations: $ar^2 = 16$, $ar^5 = 128$ [1]

Divides to find r : $r^3 = 128/16 = 8 \rightarrow r = 2$ [1]

Substitutes to find a : $a \cdot 4 = 16 \rightarrow a = 4$ [1]

Alternative method/answer:

$ar^2=16$, $ar^5=128 \rightarrow r^3=8 \rightarrow r=2 \rightarrow a=16/4=4$

9. Given that $\sin \theta = -(4)/(5)$ and θ lies in the third quadrant ($180^\circ < \theta < 270^\circ$), find the exact value of $\cos \theta$. (2 marks)

Uses identity $\sin^2 \theta + \cos^2 \theta = 1 \rightarrow \cos^2 \theta = 1 - (4/5)^2 = 9/25$ [1]

Decides sign: θ in third quadrant, $\cos$ negative $\rightarrow \cos \theta = -3/5$ [1]

Alternative method/answer:

$\cos^2 \theta = 1 - 16/25 = 9/25 \rightarrow \cos \theta = \pm 3/5$; third quadrant $\rightarrow \cos \theta = -3/5$

10. Find the equation of a circle whose centre is $(2, -1)$ and radius 3 units. Express your answer in the form $x^2 + y^2 + ax + by + c = 0$. (3 marks)

Applies circle equation: $(x-2)^2 + (y+1)^2 = 3^2$ [1]

Expands: $x^2 - 4x + 4 + y^2 + 2y + 1 = 9$ [1]

Simplifies to general form: $x^2 + y^2 - 4x + 2y - 4 = 0$ [1]

Alternative method/answer:

$x^2 + y^2 - 4x + 2y - 4 = 0$

11. Given matrix $A = \begin{pmatrix} 3 & 4 \\ 2 & k \end{pmatrix}$ and $\det(A) = 1$, find the value of k . (2 marks)

Uses determinant formula: $\det(A) = ad - bc = 3(k) - 4(2) = 3k - 8$ [1]

Sets equal to 1: $3k - 8 = 1 \rightarrow k = 3$ [1]

Alternative method/answer:

$3k - 8 = 1 \rightarrow k = 3$

12. The diagram below shows a rectangular prism ABCDEFGH with $AB = 6$ cm, $BC = 8$ cm, and $AE = 10$ cm. Calculate the angle between line AG and the plane ABCD. (3 marks)

Finds diagonal AC of base: $AC = \sqrt{6^2 + 8^2} = 10$ cm [1]

Identifies right triangle ACG with $CG = AE = 10$ cm, angle at C is 90° [1]

Uses tan: $\tan(\angle GAC) = CG/AC = 10/10 = 1 \rightarrow \angle GAC = 45^\circ$ [1]

Alternative method/answer:

Angle between AG and base = $\angle GAC$; $AC = 10$, $CG = 10 \rightarrow \tan(\angle) = 1 \rightarrow 45^\circ$

13. Two points P and Q are 6 cm apart. On the diagram below, construct the locus of points that are equidistant from P and Q and also equidistant from lines PX and QY where PX and QY are perpendicular to PQ at P and Q respectively. Describe the locus. (3 marks)

Identifies locus equidistant from P and Q as perpendicular bisector of PQ [1]

Identifies locus equidistant from parallel lines PX and QY as a line parallel to them midway [1]

Finds intersection: midpoint of PQ (3,1) $\rightarrow$ locus is a single point (3,1) [1]

Alternative method/answer:

Point equidistant from P and Q is on perpendicular bisector; equidistant from lines is on line midway;
intersection is midpoint of PQ: (3,1)

- 14.** Find the area bounded by the curve $y = x^2 + 2$, the x-axis, and the lines $x = 1$ and $x = 3$. (3 marks)

Sets up definite integral: $\int_1^3 (x^2+2) dx$ [1]

Integrates correctly: $[x^3/3 + 2x]$ from 1 to 3 [1]

Evaluates: $(27/3+6) - (1/3+2) = 15 - 7/3 = 38/3$ square units [1]

Alternative method/answer:

$\int_1^3 (x^2+2)dx = [x^3/3+2x]_1^3 = (9+6)-(1/3+2) = 38/3$

- 15.** Two points X and Y on the equator have longitudes 30°E and 60°E respectively. Taking the radius of the Earth as 6370 km, calculate the distance between X and Y along the equator in kilometres. (Use $\pi = (22)/(7)$) (2 marks)

Finds difference in longitude: 30° [1]

Applies arc length formula: $(30/360) \times 2\pi \times 6370 = (1/12) \times (44/7) \times 6370 = 3336\frac{2}{3}$ km [1]

Alternative method/answer:

Distance = $(\theta/360) \times 2\pi R = (30/360) \times (44/7) \times 6370 = 3336.67$ km

- 16.** A transformation T is represented by the matrix $\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$. A point P(3, -2) is transformed under T to P'. (a) Determine the coordinates of P'. (b) . (4 marks)

(a) Multiplies matrix by vector: $T(3,-2) = (-2,3)$ [2]

(a) Correct coordinates P'(-2,3) [1]

(b) Identifies transformation as reflection in line $y=x$ [1]

Alternative method/answer:

$T(3,-2) = (0 \cdot 3 + 1 \cdot (-2), 1 \cdot 3 + 0 \cdot (-2)) = (-2,3)$; transformation: reflection in $y=x$

SECTION II (50 marks)

- 17.** The table below shows the distribution of masses (in kg) of 80 students. (a) (3 marks) (b) (4 marks) (c) (3 marks) Give your answers correct to 2 decimal places. (10 marks)

(a) Finds midpoints: 42,47,52,57,62,67,72 [1]

(a) $\Sigma fx = 4 \times 42 + 10 \times 47 + 18 \times 52 + 22 \times 57 + 14 \times 62 + 8 \times 67 + 4 \times 72 = 4520$ [1]

(a) Mean = $4520/80 = 56.5$ kg [1]

(b) Computes $\Sigma f(x-\text{mean})^2$ correctly (allow 5440) [2]

(b) Variance = $5440/80 = 68.0$, standard deviation = $\sqrt{68} \approx 8.25$ kg [2]

(c) Constructs cumulative frequency table: 4,14,32,54,68,76,80 [1]

(c) Draws ogive and reads median at 40th value $\rightarrow \approx 57.5$ kg (accept 57.3-57.7) [2]

Alternative method/answer:

Mean = $\Sigma fx / \Sigma f = 4520/80 = 56.5$; variance = $\Sigma f(x-\text{mean})^2 / n = 5440/80 = 68$, SD = 8.25; median from ogive ≈ 57.5 kg

- 18.** A businesswoman deposits Ksh 200,000 in a bank account that pays compound interest at a rate of 12% per annum, compounded monthly. She also starts a second account by depositing Ksh 100,000 at the beginning of each year for 5 years in a different bank that offers a simple interest rate of 10% per annum. (a) (3 marks) (b) (4 marks) (c) (3 marks) Give your answers to the nearest shilling. (10 marks)

(a) Rate per month = $12\%/12 = 1\%$, number of periods = 36 [1]

- (a) Amount = $200000(1+0.01)^{36} = 200000 \times 1.43077 \approx 286154$ [2]
 (a) Correct amount to nearest shilling: Ksh 286,154 [1]
 (b) Recognises each deposit earns simple interest for different periods [1]
 (b) Computes total: $100000 \times 5 + 0.1 \times 100000 \times (5+4+3+2+1) = 500000 + 10000 \times 15 = 650000$ [2]
 (b) Correct amount: Ksh 650,000 [1]
 (c) Difference = $650000 - 286154 = 363846$ [2]

Alternative method/answer:

First account: $A = 200000(1.01)^{36} = 286154$; Second account: sum of $100000(1+0.1(6-k))$ for $k=1..5 = 650000$; difference = 363846

19. (a) (3 marks) (b) (3 marks) (c) (4 marks) (10 marks)

- (a) Writes binomial expansion: $(1+2x)^6 = 1 + 6(2x) + 15(2x)^2 + 20(2x)^3 + \dots$ [2]
 (a) Correct expansion up to x^3 : $1 + 12x + 60x^2 + 160x^3$ [1]
 (b) Substitutes $x=0.01$ into expansion: $1 + 0.12 + 0.006 + 0.00016 = 1.12616$ [2]
 (b) Rounds to 4 significant figures: 1.126 [1]
 (c) Expands $(1-2x)^5$ correctly up to x^4 : $1 - 10x + 40x^2 - 80x^3 + 80x^4$ [2]
 (c) Multiplies by $(1+3x)$ and extracts coefficient of x^4 : $(1)(80) + (3)(-80) = 80 - 240 = -160$ [2]

Alternative method/answer:

- (a) $1+12x+60x^2+160x^3$; (b) Substitute $x=0.01 \rightarrow 1.12616 \approx 1.126$; (c) Coefficient = -160

20. In the diagram below, O is the centre of the circle. P, Q, R and S are points on the circumference. angle PQR = 70° , angle PRS = 30° , and angle QPR = 40° . (10 marks)

(a) (3 marks) (b) (3 marks) (c) (4 marks)

- (a) Uses cyclic quadrilateral: $\angle PQR + \angle PSR = 180^\circ \rightarrow \angle PSR = 110^\circ$ [1]
 (a) Uses triangle PQR: $\angle PRQ = 180 - 70 - 40 = 70^\circ$ [1]
 (a) $\angle QRS = \angle PRQ + \angle PRS = 70 + 30 = 100^\circ$ [1]
 (b) Uses angles subtended by same arc: $\angle PQS = \angle PRS = 30^\circ$ [2]
 (b) Correct angle: 30° [1]
 (c) States $\angle PQR + \angle PSR = 180^\circ$ (opposite angles of cyclic quad) [2]
 (c) Therefore $\angle PSR = 180 - 70 = 110^\circ$ [2]

Alternative method/answer:

- (a) $\angle QRS = 180 - \angle QPS$, but better: $\angle QRS = \angle PRQ + \angle PRS = 70 + 30 = 100$; (b) $\angle PQS = \angle PRS = 30$; (c) $\angle PSR = 180 - \angle PQR = 110$

21. Consider the function $y = 3\sin(2x) - 1$ for $0^\circ \leq x \leq 360^\circ$. (a) (3 marks) (10 marks)

(b) Clearly label the axes and key points. (4 marks) (c) (3 marks)

- (a) Amplitude = 3, period = 180° , phase shift = 0 [3]
 (b) Correctly labelled axes and key points (max at $(45^\circ, 2)$, min at $(135^\circ, -4)$, midline $y = -1$) [4]
 (b) Sketch shows one complete wave from 0° to 360° (two periods) [1]
 (c) Range: $-4 \leq y \leq 2$ [2]

Alternative method/answer:

Amplitude=3, period= 180° , shift=none; graph: shape correct; range: $y \in [-4, 2]$

22. Vectors $\vec{v}_a$, $\vec{v}_b$ and $\vec{v}_c$ are such that $\vec{v}_a = \begin{pmatrix} 2 \\ -1 \end{pmatrix}$, $\vec{v}_b = \begin{pmatrix} 4 \\ 0 \end{pmatrix}$ and $\vec{v}_c = \begin{pmatrix} 1 \\ 5 \end{pmatrix}$. (10 marks)

(a) (3 marks) (b) (4 marks) (c) (3 marks)

- (a) Computes vector sum: $\vec{a} + \vec{b} - \vec{c} = (2+4-1, -1+0-5, 3-2+1) = (5, -6, 2)$ [1]
 (a) Magnitude = $\sqrt{5^2 + 6^2 + 2^2} = \sqrt{65} \approx 8.0623$ [2]
 (a) Correct value: $\sqrt{65}$ [1]
 (b) Applies external section formula: $P = (2\vec{B} - 1\vec{A}) / (2 - 1) = 2(4, -1, 6) - (1, 2, 3) = (7, -4, 9)$ [3]
 (b) Correct coordinates: $(7, -4, 9)$ [1]
 (c) Computes dot product: $\vec{a} \cdot \vec{b} = 2 \times 4 + (-1) \times 2 + 3 \times (-2) = 8 - 2 - 6 = 0$ [1]

(c) Concludes perpendicular since dot product = 0 [1]

Alternative method/answer:

(a) $a+b-c=(5,-6,2)$, $|v|=\sqrt{65}$; (b) $P=(7,-4,9)$; (c) $a \cdot b=0 \rightarrow$ perpendicular

23. A particle moves in a straight line such that its displacement s metres from a fixed point O after t seconds is given by $s = t^3 - 6t^2 + 9t + 5$, for $t \geq 0$. (a) (3 marks) (b) (3 marks) (c) (2 marks) (d) (2 marks) (10 marks)

(a) Differentiates to get $v = 3t^2 - 12t + 9$ [1]

(a) Substitutes $t=2$: $v = 12 - 24 + 9 = -3$ m/s [1]

(b) Sets $v=0$: $3t^2 - 12t + 9 = 0 \rightarrow t^2 - 4t + 3 = 0 \rightarrow t=1$ or $t=3$ [2]

(b) Both values: $t=1$ s and $t=3$ s [1]

(c) Differentiates to get $a = 6t - 12$ [1]

(c) Substitutes $t=1$: $a = 6 - 12 = -6$ m/s² [1]

(d) Computes displacements: $s(0)=5$, $s(1)=9$, $s(3)=5$, $s(4)=9$ [1]

(d) Total distance = $|9-5| + |5-9| + |9-5| = 4+4+4 = 12$ m [2]

Alternative method/answer:

(a) $v=3t^2-12t+9$, at $t=2$ $v=-3$; (b) $v=0$ at $t=1,3$; (c) $a=6t-12$, at $t=1$ $a=-6$; (d) distance = 12 m

24. A circle passes through the points A(1, 2), B(3, 4) and C(5, 0). (a) (5 marks) (b) (3 marks) (c) (2 marks) (10 marks)

(a) Substitutes points into general equation: $x^2+y^2+ax+by+c=0$ [1]

(a) Forms system: A: $1+4+a+2b+c=0 \rightarrow a+2b+c=-5$; B: $9+16+3a+4b+c=0 \rightarrow 3a+4b+c=-25$; C: $25+0+5a+0b+c=0 \rightarrow 5a+c=-25$ [2]

(a) Solves to get $a=0$, $b=-10$, $c=-25$ [1]

(a) Equation: $x^2+y^2-10y-25=0$