

EDUZEDCO
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	25	Total	Grand Total

SECTION I

1. The period T of a simple pendulum is given by $T = 2\pi\sqrt{\frac{l}{g}}$. Express g in terms of T and l .

2. Given that the reciprocal of 1.732 is 0.5774, find the reciprocal of 0.001732, giving your answer in standard form.

Write 0.001732 in standard form.

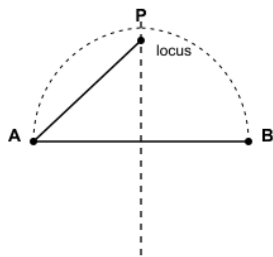
Use the given reciprocal to find the reciprocal.

3. Express $\frac{\sqrt{3}+1}{\sqrt{3}-1}$ in the form $a + b\sqrt{3}$, where a and b are integers.

4. The length and width of a rectangle are measured as 50 m and 30 m respectively, each correct to the nearest metre. Calculate the maximum possible area of the rectangle.

5. Solve the equation $2^x = 3^{x-1}$, giving your answer correct to 3 significant figures.

6. A point $P(x, y)$ moves such that its distance from $A(2, 3)$ is equal to its distance from $B(6, 1)$. Determine the equation of the locus of P .



7. A farmer invests Ksh 20,000 in a bank that offers a compound interest rate of 10% per annum compounded annually. Calculate the amount after 3 years.

8. Expand $(1 + 3x)^6$ up to the term in x^3 . Hence use your expansion to evaluate $(1.03)^6$ correct to 4 decimal places.

9. In a geometric progression, the second term is 6 and the fifth term is 48.

Find the common ratio and the first term.

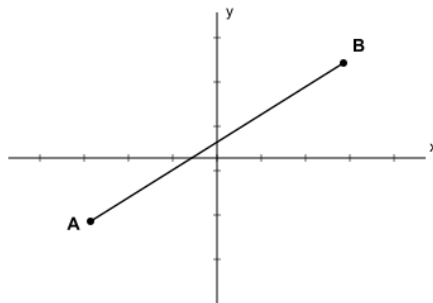
Hence, find the sum of the first 8 terms.

10. y varies directly as x and inversely as z^2 . When $x = 4$ and $z = 2$, $y = 12$. Find y when $x = 6$ and $z = 3$.

11. Given that $\sin \theta = \frac{3}{5}$ and θ is an acute angle, find $\cos \theta$ and $\tan \theta$.

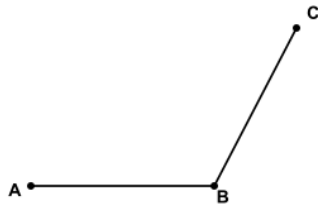
12. A bag contains 5 red marbles, 3 blue marbles, and 2 green marbles. Two marbles are drawn at random without replacement. Calculate the probability that both marbles are red.

13. Find the gradient of the curve $y = x^3 - 2x^2 + 5x - 1$ at the point where $x = 2$.



14. Solve the equation $2\cos^2 \theta + \cos \theta - 1 = 0$ for $0^\circ \leq \theta \leq 360^\circ$.

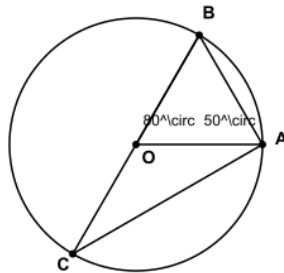
15. Given vectors $\mathbf{a} = 2\mathbf{i} + 3\mathbf{j} - \mathbf{k}$ and $\mathbf{b} = 4\mathbf{i} - \mathbf{j} + 2\mathbf{k}$, find:



Find $\mathbf{a} \cdot \mathbf{b}$

Find $|\mathbf{a} \times \mathbf{b}|$

- 16.** In the diagram below, O is the centre of the circle. $\angle AOB = 80^\circ$ and $\angle OAB = 50^\circ$. Find $\angle ACB$, where C is a point on the circumference such that AC is a chord.



SECTION II

Answer any five questions from this section.

17. Mr. Ochieng earns a monthly basic salary of Ksh 85,000 and a house allowance of Ksh 25,000. He is entitled to a personal relief of Ksh 2,400 per month. The tax brackets are as follows: first Ksh 24,000 tax-free, next Ksh 12,000 taxed at 10%, next Ksh 18,000 at 15%, next Ksh 24,000 at 20%, next Ksh 30,000 at 25%, and all income above Ksh 108,000 at 30%. [10 marks]

(a) Taxable income = Basic salary + House allowance.

(b) Use progressive tax brackets to compute tax.

(c) Subtract personal relief from gross tax.

(d) Net salary = Taxable income - (tax after relief + other deductions).

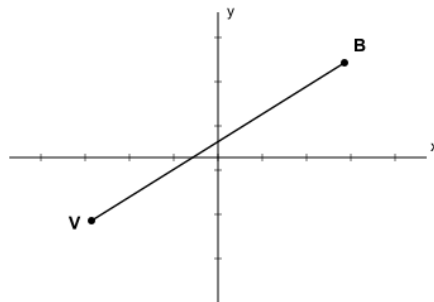
18. Two points P and Q lie on the equator. P has longitude 30°E and Q has longitude 45°W . Given that the radius of the Earth is 6370 km, [10 marks]

(a) Angular difference = $30^\circ + 45^\circ = 75^\circ$.

(b) Distance = $(\theta/360) \times 2\pi R$.

(c) Time difference = $(\theta/15)$ hours; Q is west of P, so subtract.

19. The curve $y = x^2 + 1$ is rotated about the x -axis from $x = 0$ to $x = 2$. Find the volume of the solid generated. (Use $\pi = 3.142$) [10 marks]



Set up the integral: $V = \pi \int_0^2 (x^2 + 1)^2 dx$

Expand and integrate.

Substitute limits and compute.

20. A box contains 5 red balls and 3 blue balls. Two balls are drawn at random without replacement. [10 marks]

(a) Tree diagram: first draw probabilities ($\frac{5}{8}$ red, $\frac{3}{8}$ blue); second draw conditional.

(b) $P(\text{both same}) = P(RR) + P(BB)$.

(c) $P(\text{at least one blue}) = 1 - P(\text{both red})$.

21. A farmer wants to enclose a rectangular field using a river as one side. He has 800 m of fencing material. Determine the maximum possible area that can be enclosed. [10 marks]

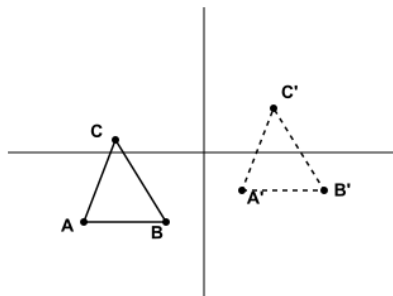
Let width = x , length = y . Then $2x + y = 800$ ($y = 800 - 2x$).

Area $A = x \cdot y = x(800 - 2x) = 800x - 2x^2$.

Differentiate: $dA/dx = 800 - 4x$. Set $=0 \Rightarrow x=200$.

Max area = $200 \times (800 - 400) = 200 \times 400 = 80000 \text{ m}^2$.

22. A triangle with vertices $A(1,2)$, $B(3,4)$, $C(5,0)$ is transformed by matrix $M = \begin{pmatrix} 1 & 2 \\ 1 & 0 \end{pmatrix}$ followed by matrix $N = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$. [10 marks]



(a) Combined matrix $P = N \times M$.

(b) Multiply P by each vertex vector.

(c) Area of image = $|\det(P)| \times \text{area of original triangle}$.

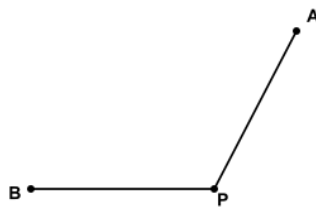
23. A particle moves along a straight line such that its displacement s metres from a fixed point O after t seconds is given by $s = t^3 - 6t^2 + 9t + 2, t \geq 0$. [10 marks]

(a) $v = ds/dt = 3t^2 - 12t + 9, a = dv/dt = 6t - 12$.

(b) Set $v=0 \Rightarrow 3t^2 - 12t + 9 = 0 \Rightarrow t=1$ or $t=3$.

(c) Need to check direction changes: at $t=1$ and $t=3$. Compute $s(0), s(1), s(3), s(4)$.

24. Points A, B, and C have position vectors $\vec{a} = 2\vec{i} + 3\vec{j} - \vec{k}, \vec{b} = 4\vec{i} - \vec{j} + 2\vec{k}$, and $\vec{c} = 5\vec{i} + 2\vec{j} - 3\vec{k}$ respectively. [10 marks]

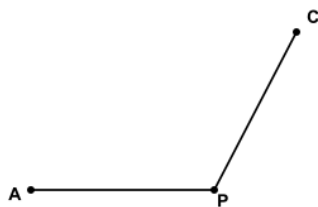


(a) External division: $\vec{p} = \frac{3\vec{b} - 2\vec{a}}{3 - 2}$.

(b) $\vec{BP} = \vec{p} - \vec{b}$.

(c) Show $\vec{AP} = k\vec{AC}$ for some scalar k .

25. Points A, B, and C have position vectors $\vec{a} = \vec{i} + \vec{j} + \vec{k}$, $\vec{b} = 4\vec{i} + 7\vec{j} + 13\vec{k}$, and $\vec{c} = 3\vec{i} + 5\vec{j} + 9\vec{k}$ respectively. [10 marks]



(a) Internal division: $\vec{p} = \frac{2\vec{a} + 1\vec{b}}{3}$.

(b) $\vec{AP} = \vec{p} - \vec{a}$.

(c) Show $\vec{AP} = k\vec{AC}$ for some scalar k .

121/2 MATHEMATICS MARKING SCHEME

Form 4 Paper 2

SECTION I (50 marks)

1. The period T of a simple pendulum is given by $T = 2\pi \sqrt{l/g}$. Express g in terms of T and l . (3 marks)

■ Squaring both sides: $T^2 = 4\pi^2 l/g$ (M1) (1)

■ Multiplying by g : $gT^2 = 4\pi^2 l$ (M1) (1)

■ Dividing by T^2 : $g = (4\pi^2 l)/(T^2)$ (A1) (1)

Alt:

— Accept: $g = (4\pi^2 l)/(T^2)$ only.

2. Given that the reciprocal of 1.732 is 0.5774, find the reciprocal of 0.001732, giving your answer in standard form. (4 marks)

■ Writing $0.001732 = 1.732 \times 10^{-3}$ (B1) (1)

■ Reciprocal = $\frac{1}{1.732 \times 10^{-3}} = (1)/(1.732) \times 10^3$ (M1) (1)

■ Using given reciprocal $(1)/(1.732) = 0.5774$ (A1) (1)

■ Final answer = $0.5774 \times 10^3 = 577.4 = 5.774 \times 10^2$ (A1) (1)

Alt:

— Accept 5.774×10^2 or 577.4.

— If written as 577.4 without standard form, award M1 for multiplying correctly, A1 for conversion if done.

3. Express $(\sqrt{3} + 1)/(\sqrt{3} - 1)$ in the form $a + b\sqrt{3}$, where a and b are integers. (3 marks)

■ Multiplying numerator and denominator by $\sqrt{3}+1$: $((\sqrt{3}+1)^2)/(3-1)$ (M1) (1)

■ Expanding numerator: $3+2\sqrt{3}+1 = 4+2\sqrt{3}$ (A1) (1)

■ Simplifying: $(4+2\sqrt{3})/(2) = 2+\sqrt{3}$ (A1) (1)

Alt:

— Accept alternative rationalising using conjugate.

4. The length and width of a rectangle are measured as 50 m and 30 m respectively, each correct to the nearest metre. Calculate the maximum possible area of the rectangle. (3 marks)

■ Maximum length = 50.5 m (B1) (1)

■ Maximum width = 30.5 m (B1) (1)

■ Maximum area = $50.5 \times 30.5 = 1540.25 \text{ m}^2$ (A1) (1)

Alt:

— Accept 1540.25 m^2 ; if answer given as 1540 (incorrect rounding) award A0.

5. Solve the equation $2^x = 3^{x-1}$, giving your answer correct to 3 significant figures. (3 marks)

■ Taking logs: $\log 2^x = \log 3^{x-1}$ (M1) (1)

■ Expanding: $x \log 2 = (x-1) \log 3$ (M1) (1)

■ Collecting x terms: $x(\log 2 - \log 3) = -\log 3$, so $x = (\log 3)/(\log 3 - \log 2)$ (M1) (1)

■ Evaluating: $x = (0.4771)/(0.1761) = 2.709$ approx 2.71 (A1) (1)

Alt:

— Accept $x = 2.71$ (3 s.f.). Award M1 for correct numerical substitution.

6. A point P(x,y) moves such that its distance from A(2,3) is equal to its distance from B(6,1). Determine the equation of the locus of P. (4 marks)

■ Setting up distance condition: $\sqrt{(x-2)^2 + (y-3)^2} = \sqrt{(x-6)^2 + (y-1)^2}$ (M1) (1)

■ Squaring both sides and expanding: $(x-2)^2 + (y-3)^2 = (x-6)^2 + (y-1)^2$ (M1) (1)

■ Simplifying to $8x - 4y = 24$ (A1) (1)

■ Final equation: $y = 2x - 6$ (A1) (1)

Alt:

— Accept $2x - y = 6$ or equivalent.

7. A farmer invests Ksh 20,000 in a bank that offers a compound interest rate of 10% per annum compounded annually. Calculate the amount after 3 years. (2 marks)

■ Using $A = P(1+r)^n$: $A = 20000(1.1)^3$ (M1) (1)

■ Calculating: $20000 \times 1.331 = 26620$ (A1) (1)

Alt:

— Accept 26620 or Ksh 26,620.

8. Expand $(1+3x)^6$ up to the term in x^3 . Hence use your expansion to evaluate $(1.03)^6$ correct to 4 decimal places. (3 marks)

■ Expanding up to x^3 : $1 + 18x + 135x^2 + 540x^3$ (M1 for at least 3 correct terms) (1)

■ Substituting $x=0.01$ into expansion (M1) (1)

■ Evaluating to 1.1940 (A1) (1)

Alt:

— Accept 1.1940; if 1.19404 given but not rounded, award A1 only if stated correct to 4 d.p.

9. In a geometric progression, the second term is 6 and the fifth term is 48. (3 marks)

■ Setting up $ar=6$, $ar^4=48$ and dividing to get $r^3=8$, so $r=2$ (M1) (1)

■ Finding a: $a \times 2 = 6 \rightarrow a=3$ (A1) (1)

■ Sum $S_8 = (3(2^8-1))/(2-1) = 3(255)=765$ (A1) (1)

Alt:

— Accept $a=3, r=2, S_8=765$.

10. y varies directly as x and inversely as z^2 . When $x = 4$ and $z = 2$, $y = 12$. Find y when $x = 6$ and $z = 3$. (4 marks)

■ Writing $y = (kx)/(z^2)$ (M1) (1)

■ Substituting $x=4, z=2, y=12$ to get $k=12$ (A1) (1)

■ Using $y = (12x)/(z^2)$ (M1) (1)

■ Substituting $x=6, z=3$ to get $y=8$ (A1) (1)

Alt:

— Accept $y=8$.

11. Given that $\sin \theta = (3)/(5)$ and θ is an acute angle, find $\cos \theta$ and $\tan \theta$. (2 marks)

■ Using $\cos^2 \theta = 1 - \sin^2 \theta = 1 - (9)/(25) = (16)/(25)$, so $\cos \theta = (4)/(5)$ (M1) (1)

■ $\tan \theta = (\sin \theta)/(\cos \theta) = (3/5)/(4/5) = (3)/(4)$ (A1) (1)

Alt:

— Accept correct values.

12. A bag contains 5 red marbles, 3 blue marbles, and 2 green marbles. Two marbles are drawn at random without replacement. Calculate the probability that both marbles are red. (4 marks)

■ Total marbles = 10 (B1) (1)

■ $P(\text{first red}) = (5)/(10) = (1)/(2)$ (M1) (1)

■ $P(\text{second red} \mid \text{first red}) = (4)/(9)$ (M1) (1)

■ $P(\text{both red}) = (1)/(2) \times (4)/(9) = (2)/(9)$ (A1) (1)

Alt:

— Accept $(2)/(9)$.

13. Find the gradient of the curve $y = x^3 - 2x^2 + 5x - 1$ at the point where $x = 2$. (2 marks)

■ Differentiating: $(dy)/(dx) = 3x^2 - 4x + 5$ (M1) (1)

■ Substituting $x=2$: $3(4) - 4(2) + 5 = 12 - 8 + 5 = 9$ (A1) (1)

Alt:

— Accept 9.

14. Solve the equation $2\cos^2 \theta + \cos \theta - 1 = 0$ for $0^\circ \leq \theta \leq 360^\circ$. (4 marks)

■ Let $t = \cos \theta$, equation $2t^2 + t - 1 = 0$ (M1) (1)

■ Solving: $(2t-1)(t+1) = 0$ so $t = (1)/(2)$ or $t = -1$ (M1) (1)

■ For $\cos \theta = (1)/(2)$: $\theta = 60^\circ, 300^\circ$ (A1) (1)

■ For $\cos \theta = -1$: $\theta = 180^\circ$ (A1) (1)

Alt:

— Accept $60^\circ, 180^\circ, 300^\circ$; accept radian equivalents if stated.

15. Given vectors $\mathbf{a} = 2\mathbf{i} + 3\mathbf{j} - \mathbf{k}$ and $\mathbf{b} = 4\mathbf{i} - \mathbf{j} + 2\mathbf{k}$, find: (4 marks)

■ (a) Dot product: $(2)(4) + (3)(-1) + (-1)(2) = 8 - 3 - 2 = 3$ (M1, A1) (2)

■ (b) Cross product: $\begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ 2 & 3 & -1 \\ 4 & -1 & 2 \end{vmatrix} = 5\mathbf{i} - 8\mathbf{j} - 14\mathbf{k}$ (M1) (1)

■ Magnitude: $\sqrt{5^2 + (-8)^2 + (-14)^2} = \sqrt{285}$ (A1) (1)

Alt:

— Accept $\sqrt{285}$ or $\sqrt{285}$ as exact.

16. In the diagram below, O is the centre of the circle. angle AOB = 80° and angle OAB = 50° . Find angle ACB, where C is a point on the circumference such that AC is a chord. (4 marks)

■ Recognising angle AOB = 80° (given, B1) (1)

■ Using angle at centre twice angle at circumference: angle ACB = $(1)/(2)$ angle AOB (M1) (1)

■ Calculating angle ACB = $(1)/(2) \times 80^\circ = 40^\circ$ (A1) (1)

■ Correct conclusion (B1 for stating the theorem appropriately) (1)

Alt:

— Accept 40° ; alternative method using cyclic quadrilateral or inscribed angle.

SECTION II (50 marks)

17. Mr. Ochieng earns a monthly basic salary of Ksh 85,000 and a house allowance of Ksh 25,000. He is entitled to a personal relief of Ksh 2,400 per month. The tax brackets are as follows: first Ksh 24,000 tax-free, next Ksh 12,000 taxed at 10%, next Ksh 18,000 at 15%, next Ksh 24,000 at 20%, next Ksh 30,000 at 25%, and all income above Ksh 108,000 at 30%. (10 marks)

■ Taxable income = $85,000 + 25,000 = 110,000$ (B1) (1)

■ First 24,000: tax free (B1) (1)

■ Next 12,000: 10% $\rightarrow 1,200$ (M1) (1)

■ Next 18,000: 15% $\rightarrow 2,700$ (M1) (1)

■ Next 24,000: 20% $\rightarrow 4,800$ (M1) (1)

■ Next 30,000: 25% $\rightarrow 7,500$ (M1) (1)

■ Remaining 2,000: 30% $\rightarrow 600$ (M1) (1)

■ Gross tax = $1,200 + 2,700 + 4,800 + 7,500 + 600 = 16,800$ (A1) (1)

■ Net tax = $16,800 - 2,400 = 14,400$ (A1) (1)

■ Net salary = $110,000 - 14,400 = 95,600$ (allow if other deductions mentioned? Here no other deductions, so net salary = $110,000 - 14,400 = 95,600$) (A1) (1)

Alt:

— If candidate includes NHIF/NSSF deductions not stated, mark accordingly but note question did not include them.

18. Two points P and Q lie on the equator. P has longitude 30°E and Q has longitude 45°W . Given that the radius of the Earth is 6370 km, (10 marks)

- Angular difference = $30^\circ + 45^\circ = 75^\circ$ (B1) (1)
- Distance = $(75/360) \times 2\pi R$ (M1) (1)
- Substituting $R=6370$ and $\pi=3.142$ or calculator value (M1) (1)
- Distance = $(75/360) \times 2 \times 3.142 \times 6370 = (75/360) \times 40040 = 8341.67$ km (approx 8342 km) (A1) (1)
- Time difference = $75/15 = 5$ hours (B1) (1)
- Since Q is west of P, local time at Q = 2:00 pm - 5 hours = 9:00 am (M1, A1) (2)
- Correct unit and final answer (A1 for distance, A1 for time) (2)

Alt:

— Accept 8342 km; accept 9:00 am or 9:00 a.m.

19. The curve $y = x^2 + 1$ is rotated about the x-axis from $x = 0$ to $x = 2$. Find the volume of the solid generated. (Use $\pi = 3.142$) (10 marks)

- Volume $V = \pi \int_0^2 (x^2+1)^2 dx$ (M1) (1)
- Expanding: $(x^2+1)^2 = x^4 + 2x^2 + 1$ (M1) (1)
- Integrating: $\int_0^2 (x^4+2x^2+1)dx = [(x^5)/(5)+(2x^3)/(3)+x]_0^2$ (M1) (1)
- Substituting limits: $(32)/(5)+(16)/(3)+2 = 6.4+5.3333+2 = 13.7333$ (A1) (1)
- Multiplying by pi: $13.7333 \times 3.142 = 43.15$ (M1, A1) (2)
- Final answer with correct units: 43.15 cubic units (A1 for unit, A1 for accuracy) (2)

Alt:

— Accept 43.15 or 43.2 if rounding.

20. A box contains 5 red balls and 3 blue balls. Two balls are drawn at random without replacement. (10 marks)

- $P(RR) = (5)/(8) \times (4)/(7) = (20)/(56) = (5)/(14)$ (M1, A1) (2)
- $P(BB) = (3)/(8) \times (2)/(7) = (6)/(56) = (3)/(28)$ (M1, A1) (2)
- $P(\text{both same}) = (5)/(14) + (3)/(28) = (10)/(28) + (3)/(28) = (13)/(28)$ (M1, A1) (2)
- $P(\text{at least one blue}) = 1 - (5)/(14) = (9)/(14)$ (M1, A1) (2)
- Tree diagram drawn correctly with probabilities labelled (B1 for first branches, B1 for second branches) (2)

Alt:

— Accept fractions or decimals equivalent to 3 s.f.

21. A farmer wants to enclose a rectangular field using a river as one side. He has 800 m of fencing material. Determine the maximum possible area that can be enclosed. (10 marks)

- Let width = x , length = y ; fencing: $2x+y=800$ so $y=800-2x$ (B1 for variables, M1 for equation) (2)
- Area $A = x(800-2x) = 800x-2x^2$ (M1) (1)
- Differentiate: $(dA)/(dx)=800-4x$ (M1) (1)
- Set derivative to zero: $800-4x=0 \Rightarrow x=200$ (A1) (1)
- Corresponding $y=800-400=400$ (A1) (1)
- Maximum area = $200 \times 400 = 80,000 \text{ m}^2$ (A1) (1)
- Confirmation of maximum (e.g., second derivative negative) (M1) (1)
- Correct units (B1) (1)

Alt:

— Accept $80,000 \text{ m}^2$; alternative method using completing square.

22. A triangle with vertices A(1,2), B(3,4), C(5,0) is transformed by matrix $M = \begin{pmatrix} 1 & 2 \\ 1 & 0 \end{pmatrix}$ followed by matrix $N = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$. (10 marks)

- Combined matrix $P = N \times M = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix} \begin{pmatrix} 1 & 2 \\ 1 & 0 \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ -1 & -2 \end{pmatrix}$ (M1, A1) (2)
- Transforming A: $P \begin{pmatrix} 1 \\ 2 \end{pmatrix} = \begin{pmatrix} 1 \\ -5 \end{pmatrix} \rightarrow A'(1, -5)$ (M1, A1) (2)
- Transforming B: $P \begin{pmatrix} 3 \\ 4 \end{pmatrix} = \begin{pmatrix} 3 \\ -11 \end{pmatrix} \rightarrow B'(3, -11)$ (A1) (1)
- Transforming C: $P \begin{pmatrix} 5 \\ 0 \end{pmatrix} = \begin{pmatrix} 5 \\ -5 \end{pmatrix} \rightarrow C'(5, -5)$ (A1) (1)
- Area of original triangle: $(1)/(2) |x_1(y_2-y_3)+x_2(y_3-y_1)+x_3(y_1-y_2)| = (1)/(2) |1(4-0)+3(0-2)+5(2-4)| = (1)/(2) |4-6-10| = 6$ (M1, A1) (2)
- Area of image = $|\det(P)| \times \text{area original} = |-2| \times 6 = 12$ (M1, A1) (2)

Alt:

— Accept area if computed directly from image vertices.

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

- Velocity $v = (ds)/(dt) = 3t^2 - 12t + 9$ (M1, A1) (2)
- Acceleration $a = (dv)/(dt) = 6t - 12$ (M1, A1) (2)
- Setting $v=0$: $3t^2 - 12t + 9 = 0 \Rightarrow t^2 - 4t + 3 = 0 \Rightarrow (t-1)(t-3) = 0$, $t=1$ or 3 (M1, A1) (2)
- Finding positions: $s(0)=2$, $s(1)=6$, $s(3)=2$, $s(4)=6$ (M1 for evaluating at least two) (1)
- Distance travelled: $|6-2| + |2-6| + |6-2| = 4+4+4 = 12 \text{ m}$ (M1, A1) (2)

Alt:

— Accept 12 m; if candidate integrates absolute velocity, mark accordingly.

24. Points A, B, and C have position vectors $\text{veca} = 2\text{veci} + 3\text{vecj} - \text{veck}$, $\text{vecb} = 4\text{veci} - \text{vecj} + 2\text{veck}$, and $\text{vecc} = 5\text{veci} + 2\text{vecj} - 3\text{veck}$ respectively. (10 marks)

■ Internal division: $\text{vecp} = \frac{2\text{veca} + 1\text{vecb}}{3} = (2(1,1,1) + (4,7,13))/3 = (2,3,5)$ (M1, A1) (2)

■ $\text{vecAP} = \text{vecp} - \text{veca} = (2-1, 3-1, 5-1) = (1,2,4)$ (M1, A1) (2)

■ $\text{vecAC} = \text{vecc} - \text{veca} = (3-1, 5-1, 9-1) = (2,4,8)$ (B1) (1)

■ $\text{vecAC} = 2 \times \text{vecAP}$ (M1) (1)

■ Thus vecAP and vecAC are parallel and share point A, hence A, P, C are collinear (A1) (1)

■ Correct conclusion (B1 for stating collinearity condition) (1)

Alt:

— Accept any valid proof of collinearity.