MATHEMATICS A · Mark scheme and worked solutions

Mathematics A Exam-Style Paper 1

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Question 1

[2 marks]

ANSWER

(a) 5

(b) 5

MARKING POINTS

B1 (a) · 1 mark · Correctly states there are 5 lines of symmetry.

B1 (b) · 1 mark · Correctly states the order of rotational symmetry is 5.

WORKED SOLUTION

A regular pentagon has 5 lines of symmetry and order of rotational symmetry 5.

Question 2

[1 mark]

ANSWER

element

Also accept: member

Common mistakes: object

MARKING POINTS

B1 · 1 mark · Correctly states 'element' or 'member' as the term for an object in a set.

WORKED SOLUTION

The correct term is 'element' (or 'member').

Question 3

[2 marks]

ANSWER

2 (±0)

Also accept: 2.0

Common mistakes: -2; 0.5

MARKING POINTS

M1 · 1 mark · Uses formula $m = \frac{y_2 - y_1}{x_2 - x_1}$.

A1 · 1 mark · Arrives at the answer 2.

WORKED SOLUTION

Gradient $m = \frac{10-2}{5-1} = \frac{8}{4} = 2$.

Question 4

[2 marks]

ANSWER

4x(2x - 5)

Also accept: 4x(2x-5)

Common mistakes: Taking out only x or only 2 as a factor

MARKING POINTS

M1 · 1 mark · Attempts to factorise by taking out a common factor (either 2 or x).

A1 · 1 mark · Correctly factorises completely as 4x(2x - 5).

WORKED SOLUTION

Write each term as a product: $8x^2$ = 4x \times 2x, and 20x = 4x \times 5.

Factor 4x from both terms:

$$8x^2 - 20x = 4x(2x) - 4x(5) = 4x(2x - 5)$$

Question 5

[2 marks]

ANSWER

30.0° (±0.2)

Also accept: 30°; 29.98°

Common mistakes: 60° (upside-down sides)

MARKING POINTS

M1 · 1 mark · Uses $\sin\theta = 7/14$. Attempts arcsin.

A1 · 1 mark · Obtains $\theta = 30.0^\circ$ (accept 29.98°, 30° to 3 s.f.) (follow-through)

WORKED SOLUTION

$\sin\theta = 7/14 = 0.5$

$$\theta = \sin^{-1}(0.5) = 30.0^\circ$$

Question 6

[2 marks]

ANSWER

Lower bound: 39.5 cm
Upper bound: 40.5 cm

Also accept: Lower bound 39.5 cm, upper bound 40.5 cm; 39.5 ≤ length < 40.5

Common mistakes: 39 cm and 41 cm; 39 and 40; 40 and 41

MARKING POINTS

B1 · 1 mark · Correct lower bound: 39.5 cm

B2 · 1 mark · Correct upper bound: 40.5 cm

WORKED SOLUTION

The measurement is to the nearest cm. Lower bound is 40 - 0.5 = 39.5 cm. Upper bound is 40 + 0.5 = 40.5 cm.

Question 7

[4 marks]

ANSWER

(a) C = 1.6n

(b) $192 dollars

(c) 125 posters

Must show: Find k, write formula; substitute for n or C

Common mistakes: Dividing instead of multiplying; Incorrectly setting up the formula

MARKING POINTS

M1 (a) · 1 mark · States correct formula relating C and n: C = kn and finds k = $1.6.

M2 (b) · 1 mark · Uses formula C = 1.6n for n = 120. (follow-through)

A1 (b) · 1 mark · Arrives at C = $192. (follow-through)

A2 (c) · 1 mark · Solves 200 = 1.6n for n and gets 125 posters. (follow-through)

WORKED SOLUTION

a) C ∝ n, so C = kn. When C = 80, n = 50, so 80 = k × 50, thus k = 1.6. Formula: C = 1.6n.

b) For n = 120, C = 1.6 × 120 = $192.

c) For C = 200, 200 = 1.6n, so n = 200 / 1.6 = 125 posters.

Question 8

[3 marks]

ANSWER

(a) Subtract 2 from both sides

(b) y = 12

Common mistakes: Subtracting instead of adding; Multiplying too soon

MARKING POINTS

M1 (a) · 1 mark · Correct first step identified: subtract 2 from both sides.

M2 (b) · 1 mark · Multiplies both sides of resulting equation by 4 or writes $y/4 = 3$.

A1 (b) · 1 mark · Finds final value: $y = 12$. (follow-through)

WORKED SOLUTION

Step 1: Subtract 2 from both sides:

$$\frac{y}{4} = 3$$

Step 2: Multiply both sides by 4:

$$y = 3 \times 4 = 12$$

Question 9

[4 marks]

ANSWER

(a) $\frac{5}{12} < \frac{2}{3} < \frac{3}{4}$

(b) (2, -3)

(c) 8

MARKING POINTS

M1 (a) · 1 mark · Convert all fractions to common denominator or decimal

A1 (a) · 1 mark · Correctly order fractions: 5/12 < 2/3 < 3/4

B1 (b) · 1 mark · Correct coordinates for reflection: (2, -3)

A2 (c) · 1 mark · Correct numerator 8 for denominator 12

WORKED SOLUTION

a) $\frac{5}{12} \approx 0.416$, $\frac{2}{3} \approx 0.667$, $\frac{3}{4} = 0.75$. So order is 5/12 < 2/3 < 3/4.

b) To reflect (2, 3) across x-axis, change sign of y-coordinate: (2, -3).

c) $\frac{2}{3} = \frac{2\times4}{3\times4} = \frac{8}{12}$. So numerator is 8.

Question 10

[2 marks]

ANSWER

4, 5, 6, 7, 8

Also accept: {4,5,6,7,8}; 4,5,6,7,8

Common mistakes: Listing 9 as an element.; Missing 4 or 8.

MARKING POINTS

B1 · 1 mark · Correctly identifies the set of whole numbers in the range (ignores format).

B1 · 1 mark · Lists all and only the correct elements (4, 5, 6, 7, 8) — order and brackets not required.

WORKED SOLUTION

The smallest whole number ≥ 4 is 4, and the largest whole number less than 9 is 8.

So the elements are: 4, 5, 6, 7, 8.

Question 11

[5 marks]

ANSWER

(a) 2.8×10^{-5}

(b) 9×10^{16}

(c) 2.52×10^{12}

Common mistakes: Forgetting powers of ten in multiplication; Incorrectly squaring 10^8

MARKING POINTS

M1 (a) · 1 mark · Correct conversion of 0.000028 to standard form as 2.8×10^{-5}.

M2 (b) · 1 mark · Squares 3 to give 9.

A1 (b) · 1 mark · Squares (10^8) to give 10^{16}, answer 9×10^{16} in standard form.

M3 (c) · 1 mark · Substitutes the numbers in E = mc^2 with their standard form values. (follow-through)

A2 (c) · 1 mark · Correct final answer E = 2.52×10^{12} in standard form. (follow-through)

WORKED SOLUTION

a) $0.000028 = 2.8 \times 10^{-5}$

b) $c = 3 \times 10^8$, so $c^2 = (3 \times 10^8)^2 = 9 \times 10^{16}$

c) $E = mc^2 = (2.8 \times 10^{-5}) \times (9 \times 10^{16}) = (2.8 \times 9) \times 10^{-5+16} = 25.2 \times 10^{11} = 2.52 \times 10^{12}$

Question 12

[4 marks]

ANSWER

(a) 0.73

(b) 2.8×10^1

(c) 1.26×10^0

Common mistakes: Incorrect decimal placement; Incorrect multiplication of indices

MARKING POINTS

A1 (a) · 1 mark · Writes B as 0.73

A2 (b) · 1 mark · Writes C as 2.8×10^1 to 1 decimal place

M1 (c) · 1 mark · Multiplies A × C correctly using laws of indices

A3 (c) · 1 mark · Gives the answer 1.26×10^0 (or 1.26)

WORKED SOLUTION

a) B = $7.3 \times 10^{-1} = 0.73$

b) C is already in standard form to 1 decimal place: 2.8×10^1

c) $(4.5 \times 10^{-2}) \times (2.8 \times 10^1) = (4.5 \times 2.8) \times 10^{-2+1} = 12.6 \times 10^{-1} = 1.26 \times 10^0$

Question 13

[4 marks]

ANSWER

(a) (0, -4)

(b) 2

(c) 2

(d) y = 2x + 3

MARKING POINTS

B1 (a) · 1 mark · Correctly states the y-intercept is (0, -4).

B2 (b) · 1 mark · Writes gradient = 2.

B3 (c) · 1 mark · Solves $2x - 4 = 0$ for $x = 2$.

B4 (d) · 1 mark · Correct parallel equation: $y = 2x + 3$.

WORKED SOLUTION

a) The y-intercept is at $x = 0$: $y = 2 \times 0 - 4 = -4 \Rightarrow (0, -4)$.

b) The gradient of $y = 2x - 4$ is 2.

c) To find x-intercept: $2x - 4 = 0$, $2x = 4$, $x = 2$.

d) Parallel means same gradient, so $y = 2x + c$ passes through (0,3): $3 = 2 \times 0 + c \implies c = 3$, $y = 2x + 3$.

Question 14

[4 marks]

ANSWER

(a) $x^2 + 2x - 15$

(b) (x + 5)(x - 3)

Common mistakes: Incorrect expansion; Factors with sign errors

MARKING POINTS

M1 (a) · 1 mark · Expands (x+5)(x−3) correctly to form quadratic

A1 (a) · 1 mark · All signs and terms correct in expansion

M2 (b) · 1 mark · Attempts to factorise given quadratic

A2 (b) · 1 mark · Both brackets correct: (x+5)(x−3), order unimportant

WORKED SOLUTION

a) Expand:

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

b) Factorising $x^2 + 2x - 15$: Need two numbers that multiply to -15 and add to 2. These are 5 and -3.

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

Question 15

[6 marks]

ANSWER

(a) $17.87 $

(b) A = l × w

(c) 40 m^2

Common mistakes: Confusing simple and compound interest; Using l + w instead of l × w

MARKING POINTS

M1 (a) · 1 mark · Identifies compound interest method using multiplying factor 1.06^n.

A1 (a) · 2 marks · Correct calculation of final amount, rounded to 2 decimal places. (follow-through)

B1 (b) · 1 mark · Correct area formula A = l × w or A = lw.

M2 (c) · 1 mark · Substitutes values into area formula.

A2 (c) · 1 mark · Accurate calculation to obtain 40 m^2. (follow-through)

WORKED SOLUTION

(a) Original price = $15

$$Price = 15 \times (1.06)^3$$

$$15 \times 1.191016 = 17.86524...$$

Rounded: $17.87

(b) Area formula: A = l × w

(c) Substituting l = 8 m and w = 5 m:

$$A = 8 \times 5 = 40 \text{ m}^2$$

Question 16

[6 marks]

ANSWER

(a) 90

(b) £1.70 pounds

(c) £153 pounds

(d) 106

MARKING POINTS

M1 (a) · 1 mark · Divides total by price (£180/£2).

A1 (b) · 1 mark · Finds new price using multiplying factor (1-0.15=0.85).

A2 (b) · 1 mark · New price is £1.70. (follow-through)

M2 (c) · 1 mark · Multiplies new unit price by original number.

A3 (c) · 1 mark · Finds money raised: 90×£1.70=£153. (follow-through)

B1 (d) · 1 mark · Computes new number needed as: 180 / 1.7 ≈ 105.88 → 106 (follow-through)

WORKED SOLUTION

a) Number of cupcakes = £180 / £2 = 90.

b) New price = £2 × 0.85 = £1.70.

c) Money received at new price = 90 × £1.70 = £153.

d) 180 / 1.70 = 105.88 ≈ 106 cupcakes.

Question 17

[2 marks]

ANSWER

Because if two lines are perpendicular, their gradients m1 and m2 satisfy m1 × m2 = –1

Also accept: The gradients multiply to –1 for perpendicular lines

Common mistakes: Confusing with parallel lines

MARKING POINTS

B1 · 2 marks · Explains the negative reciprocal property and/or states m1 × m2 = -1 for perpendicular lines

WORKED SOLUTION

For two lines to be perpendicular, one must have the negative reciprocal gradient of the other (m2 = –1/m1). Multiplying the gradients gives m1 × m2 = m1 × (–1/m1) = –1.

Question 18

[3 marks]

ANSWER

18 grams; m = 1/3 × (patient mass) g

Common mistakes: inverting relationship; incorrect proportionality constant

MARKING POINTS

M1 · 1 mark · Recognises direct proportion; sets up m = k × (mass) and finds value of k

A1 · 1 mark · Writes correct formula, m = 24/72 × (mass) or m = 1/3 × (mass)

A2 · 1 mark · Correct medicine value for 54 kg patient (18 grams)

WORKED SOLUTION

Let m grams be required for mass M kg. As m ∝ M, m = kM.

When M = 72, m = 24, so 24 = k × 72 → k = 24 / 72 = 1/3.

Formula: m = 1/3 × (mass in kg).

For M = 54, m = 1/3 × 54 = 18 grams.

Question 19

[3 marks]

ANSWER

(a) 0.625

(b) 0.35

(c) $\frac{9}{50}$

MARKING POINTS

A1 (a) · 1 mark · Correct decimal answer to part a: 0.625

A1 (b) · 1 mark · Correct decimal answer to part b: 0.35

A1 (c) · 1 mark · Correct fraction for 0.18 in simplest form: $\frac{9}{50}$

WORKED SOLUTION

(a) $\frac{5}{8} = 5 \div 8 = 0.625$

(b) $\frac{7}{20} = 7 \div 20 = 0.35$

(c) $0.18 = \frac{18}{100} = \frac{9}{50}$ in its simplest form.

Question 20

[9 marks]

ANSWER

(a) 2.4 m²

(b(i)) 28

(b(ii)) $f^{-1}(y) = \sqrt{y-3}$

(c) $x = \sqrt{27-3} = \sqrt{24} = 4.90$ (2 d.p.)

Common mistakes: Incorrect cm² to m² conversion; Algebra error in inverting function

MARKING POINTS

M1 (a) · 1 mark · Sets up or applies correct conversion (divides by 10,000)

A1 (a) · 1 mark · Gives 2.4 m² (follow-through)

M2 (b(ii)) · 1 mark · Sets up equation $y = x^2 + 3$ and rearranges to find inverse

A2 (b(ii)) · 1 mark · Expresses inverse as $f^{-1}(y) = \sqrt{y-3}$, or equivalent (follow-through)

B1 (b(ii)) · 1 mark · States correct domain for inverse ($y \geq 3$ or $x > 0$)

M3 (c) · 1 mark · Uses inverse on 27: $\sqrt{24}$

A3 (c) · 1 mark · Evaluates $\sqrt{24} = 4.90$ (2 d.p.) (follow-through)

B2 (c) · 2 marks · Concludes correctly

WORKED SOLUTION

a) 1 m² = 10,000 cm²; 24000 ÷ 10000 = 2.4 m²

b) i) f(5) = 5² + 3 = 25 + 3 = 28

ii) y = x² + 3 ⇒ x² = y − 3 ⇒ x = sqrt(y − 3); So f^{1}(y) = sqrt(y − 3), valid for y ≥ 3.

c) f(x) = 27 ⇒ x² + 3 = 27 ⇒ x² = 24 ⇒ x = sqrt(24) ≈ 4.90 (2 d.p.)

Question 21

[3 marks]

ANSWER

$24,000 $ (±1)

Also accept: 24000; $24 000

Common mistakes: Applying 40% to the full salary.; Forgetting to use two bands.

MARKING POINTS

M1 · 1 mark · Correctly identify parts of the salary in each tax band.

M2 · 1 mark · Calculate tax for each band: $50,000 at 20%, $35,000 at 40%. (follow-through)

A1 · 1 mark · Add tax amounts correctly for final answer $24,000. (follow-through)

WORKED SOLUTION

First $50,000 at 20%: $50,000 × 0.20 = $10,000

Next $35,000 at 40%: $35,000 × 0.40 = $14,000

Total income tax = $10,000 + $14,000 = $24,000

Question 22

[4 marks]

ANSWER

(a) -2

(b) y = -2x - 3

Common mistakes: Sign errors in gradient; Using wrong coordinates to find y-intercept

MARKING POINTS

M1 (a) · 1 mark · Correct substitution into gradient formula ($\frac{y_2-y_1}{x_2-x_1}$).

A1 (a) · 1 mark · Correct calculation of gradient as -2.

M2 (b) · 1 mark · Uses correct gradient with one point to substitute into $y = mx + c$ or equivalent method. (follow-through)

A2 (b) · 1 mark · Gives final equation as $y = -2x - 3$. (follow-through)

WORKED SOLUTION

a) Gradient = $\frac{-9-7}{3-(-5)} = \frac{-16}{8} = -2$

b) Use point (3, –9):

$$y = mx + c$$

$$-9 = -2 \times 3 + c$$

$$-9 = -6 + c$$

$$c = -3$$

Equation: $y = -2x - 3$

Question 23

[5 marks]

ANSWER

(a) 3.18×10^1

(b) 1.20×10^7 hours

Common mistakes: Incorrectly dividing or multiplying the powers of ten; Ignoring multiplication rules for $a \times 10^n$

MARKING POINTS

M1 (a) · 1 mark · Attempts to divide the two distances in standard form: $(7.82 \times 10^{13}) \div (2.46 \times 10^{12})$

A1 (a) · 2 marks · Correct answer in standard form: 3.18×10^1 (accept 31.8), with working.

M2 (b) · 1 mark · Attempts to divide the distance to Star X by the speed, using correct standard form rules.

A2 (b) · 1 mark · Correct answer (1.20×10^7) in standard form with working.

WORKED SOLUTION

a) To find how many times farther Star Y is from Earth compared to Star X:

$$\frac{7.82 \times 10^{13}}{2.46 \times 10^{12}} = \frac{7.82}{2.46} \times 10^{13-12} = 3.18 \times 10^1 = 31.8$$

Star Y is 3.18×10^1 (or 31.8) times farther from Earth than Star X.

b) To estimate the travel time to Star X:

$$\frac{2.46 \times 10^{12}}{2.05 \times 10^5} = \frac{2.46}{2.05} \times 10^{12-5} = 1.2 \times 10^7 \text{ hours}$$

Question 24

[4 marks]

ANSWER

The greatest number of teams is 9, with 22 boys and 15 girls in each team.

Also accept: The highest common factor is 9. Each team has 22 boys and 15 girls.

Common mistakes: Incorrect HCF calculation; swapping boys and girls.

MARKING POINTS

M1 · 1 mark · Express 198 and 135 as products of their prime factors.

M2 · 1 mark · Find the HCF of 198 and 135.

A1 · 1 mark · Obtain correct HCF = 9 and state as the number of teams.

A2 · 1 mark · State correct number of boys (22) and girls (15) per team. (follow-through)

WORKED SOLUTION

Prime factors: $198 = 2 \times 3^2 \times 11$; $135 = 3^3 \times 5$.

HCF is $3^2 = 9$.

So, there will be 9 teams.

Number of boys per team: 198 / 9 = 22. Number of girls per team: 135 / 9 = 15.

Final answer: 9 teams, with 22 boys and 15 girls in each team.

Question 25

[3 marks]

ANSWER

(a) $2,040 USD

(b) $1,836 USD

(c) 23.5%

Common mistakes: Adding losses (15% + 10% = 25%) instead of using compound method; not applying percentage to the reduced value in year 2

MARKING POINTS

M1 (a) · 1 mark · Finds 85% of $2,400 correctly: $2,040.

M2 (b) · 1 mark · Finds 90% of value after 1st year (i.e., $2,040 × 0.90): $1,836. (follow-through)

A1 (c) · 1 mark · Calculates loss: $2,400 to $1,836, finds and states correct total percentage loss (to 1 decimal place): 23.5%. (follow-through)

WORKED SOLUTION

a) After 1st year: 85% of $2,400 = $2,400 × 0.85 = $2,040

b) After 2nd year: 90% of $2,040 = $2,040 × 0.90 = $1,836

c) Loss = $2,400 − $1,836 = $564

Percentage loss = ($564 ÷ $2,400) × 100 = 23.5% (1 decimal place)

Question 26

[5 marks]

ANSWER

(a) k = 2

(b) Other vertices: (–2, 2), (–8, 8) · must show (-2, 2), (-8, 8)

Common mistakes: Incorrect computation of scale factor; Applying scale factor to only one coordinate

MARKING POINTS

M1 (a) · 1 mark · Sets up correct equation for scale factor using coordinates

A1 (a) · 1 mark · Correctly finds scale factor k = 2

M2 (b) · 1 mark · Applies scale factor to coordinates correctly for at least one point (follow-through)

A2 (b) · 1 mark · Both other vertices correctly found (follow-through)

B1 (b) · 1 mark · All three vertices for shape B written clearly and matched to original points (follow-through)

WORKED SOLUTION

To determine k, compare a vertex from A and B:

(–4, 1) enlarged by k gives (–8, 2):

$$(-4k, 1k) = (-8, 2)$$

So k = –8 / –4 = 2 (also check 2 / 1 = 2).

Apply scale factor to other points:

Vertices after enlargement

Original	Enlarged
(–4, 1)	(–8, 2)
(–1, 1)	(–2, 2)
(–4, 4)	(–8, 8)

Question 27

[4 marks]

ANSWER

Upper bound speed = maximum distance ÷ minimum time = 100.5 ÷ 12.35 = 8.137 m/s (rounded to 3 significant figures: 8.14 m/s) m/s (±0.01)

Also accept: Full marks for correct bounds and answer to correct accuracy.

Common mistakes: Using wrong bounds (min numerator/max denominator instead of max numerator/min denominator).

MARKING POINTS

M1 · 1 mark · Finds both the lower and upper bounds for both distance and time correctly.

M2 · 1 mark · Recognises to use maximum distance, minimum time for upper bound of speed.

M3 · 1 mark · Correct substitution into the speed formula using bounds.

A1 · 1 mark · Final answer given to 3 significant figures and correct calculation performed. (follow-through)

WORKED SOLUTION

Lower bound for distance = 100 – 0.5 = 99.5 m; upper bound = 100 + 0.5 = 100.5 m.

Lower bound for time = 12.4 – 0.05 = 12.35 s; upper bound = 12.4 + 0.05 = 12.45 s.

To find the upper bound for speed: use maximum distance and minimum time.

$$\text{Upper bound speed} = \frac{100.5}{12.35} = 8.137... \text{ m/s}$$

To 3 significant figures: 8.14 m/s.

Question 28

[2 marks]

ANSWER

{ c, d }

Also accept: { d, c }

Common mistakes: Including elements not in both sets; Listing elements outside U

MARKING POINTS

B2 · 2 marks · Both elements c and d listed, no extras.

WORKED SOLUTION

The elements in both X and Y are c and d, so $X \cap Y = \{c, d\}$.

Question 29

[4 marks]

ANSWER

(a) Ratio of radii = 1:2 (use square root of surface area ratio)

(b) Ratio of volumes = 1:8

Common mistakes: using area ratio directly as volume ratio

MARKING POINTS

M1 (a) · 1 mark · States or implies that for similar solids, (radius ratio)² = (area ratio).

A1 (a) · 1 mark · Finds correct ratio: √(48/192) = 1/2, so ratio 1:2.

M2 (b) · 1 mark · States that volumes ratio is $(r_1/r_2)^3$ or uses $(\text{area ratio})^{3/2}$. (follow-through)

A2 (b) · 1 mark · Gets correct ratio of volumes: $(1/2)^3 = 1/8$. (follow-through)

WORKED SOLUTION

a) For similar solids, the ratio of surface areas = (ratio of radii)².

$$\frac{48}{192} = \left(\frac{r_1}{r_2}\right)^2$$

$$\frac{48}{192} = \frac{1}{4}$$

$$(r_1/r_2) = 1/2$$

So the ratio of radii is 1:2.

b) The ratio of volumes is (radius ratio)³ = (1/2)³ = 1/8.

Question 30

[4 marks]

ANSWER

Must show: Calculation and verification of magnitude, Calculation and verification of direction (angle)

Common mistakes: Switching x and y when calculating the angle; Forgetting to use inverse tangent for direction

MARKING POINTS

M1 · 1 mark · Uses $\sqrt{x^2 + y^2}$ to find the magnitude for $\begin{pmatrix} 5 \\ 12 \end{pmatrix}$.

A1 · 1 mark · Shows the magnitude is indeed 13. (follow-through)

M2 · 1 mark · Calculates the angle to the positive x-axis using $\tan^{-1}(y/x)$. (follow-through)

A2 · 1 mark · Shows that the angle is 67.4°, correctly matching the given value. (follow-through)

WORKED SOLUTION

Firstly, calculate the magnitude of $\begin{pmatrix} 5 \\ 12 \end{pmatrix}$:

$$|\vec{s}| = \sqrt{5^2 + 12^2} = \sqrt{25 + 144} = \sqrt{169} = 13$$

So the magnitude is correct.

Next, calculate the angle θ with the positive x-axis:

$$\tan\theta = \frac{y}{x} = \frac{12}{5}$$

$$\theta = \tan^{-1}\left(\frac{12}{5}\right) \approx 67.4^\circ$$

Therefore, $\begin{pmatrix} 5 \\ 12 \end{pmatrix}$ is a vector of magnitude 13 which makes an angle of 67.4° with the positive x-axis.

Question 31

[4 marks]

ANSWER

(See marking scheme and solution.)

Must show: Identifying right triangle with height and half-diagonal, Using trigonometric ratios to find angle

Also accept: Correct structured step-by-step explanation with/without diagram drawn, correct reasoning

Common mistakes: Omitting how to find base diagonal; Missing use of trigonometric ratios; Stating only Pythagoras, not angle

MARKING POINTS

M1 · 1 mark · Identifies and draws the correct vertical right-angled triangle (from vertex, centre of base, to corner of base).

M2 · 1 mark · Finds the distance from the centre to a corner of the base using Pythagoras' theorem.

M3 · 1 mark · States the trigonometric ratio needed (e.g., $\tan\theta = \frac{14}{7.07}$) to find the angle between the slant edge and the base.

A1 · 1 mark · Shows how to use the inverse tangent (or equivalent) to obtain the angle.

WORKED SOLUTION

Step 1: Draw a right-angled triangle formed by the pyramid's height (14 cm), the slant edge from the vertex to a base corner (unknown), and the line from the centre of the base to the corner.

Step 2: The base is 10 cm square. The distance from the centre to any corner is $\sqrt{5^2+5^2} = 7.07$ cm.

$$\text{Centre to corner} = \sqrt{(\frac{10}{2})^2 + (\frac{10}{2})^2} = \sqrt{25+25} = \sqrt{50} = 7.07 \text{ cm}$$

Step 3: Recognise that the slant edge, the height, and the centre-to-corner distance form a right-angled triangle, with the slant edge as the hypotenuse.

Step 4: The angle between the slant edge and the base (θ) is found using:

$$\tan\theta = \frac{14}{7.07}$$

Step 5: Use the inverse tangent:

$$\theta = \arctan\left(\frac{14}{7.07}\right)$$

This gives the required angle.

Question 32

[2 marks]

ANSWER

\frac{2(x + 2)}{x + 2} = 2\ (x\neq-2,\ x\neq2)

Also accept: 2 (x \neq -2,\ x \neq 2)

Common mistakes: Failing to restrict domain

MARKING POINTS

M1 · 1 mark · Correctly factorises numerator and denominator (numerator as 2(x-2), denominator as (x+2)(x-2)).

A1 · 1 mark · Correct final simplified answer, cancelling common factors, and noting restrictions on x (x≠2, x≠-2).

WORKED SOLUTION

First, factorise numerator and denominator:

$$2x^2 - 8 = 2(x^2 - 4) = 2(x+2)(x-2)$$

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

So,

$$\frac{2x^2-8}{x^2-4} = \frac{2(x+2)(x-2)}{(x+2)(x-2)}$$

The (x + 2)(x - 2) terms cancel, leaving 2, provided x ≠ 2 and x ≠ –2.

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