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HIGHER

3.17H Transformations: Higher Tier Practice

EDEXCEL Edexcel 1MA1 · Calculator allowed · about 75 minutes

Total Marks

Name: _______________________________ Date: ____ / ____ / ______

Answer ALL questions. Show all your working.

1 Triangle A has vertices A(1, 2), B(4, 2) and C(1, 5). Describe fully the single transformation that maps triangle A to triangle A' with vertices A'(1, -2), B'(4, -2) and C'(1, -5).

(Total for Question 1 is 2 marks)

2 Enlarge triangle T with vertices (2, 1), (4, 1) and (2, 3) by a scale factor of -2 centre (1, 1). Find the coordinates of the image vertices.

(Total for Question 2 is 3 marks)

3 A transformation maps the point P(3, -1) first by a shear in the x-direction with shear factor 2 (so (x, y) -> (x + 2y, y)), then by a rotation of 90 degrees anticlockwise about the origin. Find the final coordinates of P after both transformations.

(Total for Question 3 is 4 marks)

4 Triangle DEF is translated by vector v to triangle D'E'F'. Point D does not move under the translation. If D has coordinates (2, 3), state the translation vector v and explain what this implies about D'E'F'.

(Total for Question 4 is 3 marks)

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5 The transformation T maps the vector a = (3, 2) to a' = (6, 4). It maps b = (1, -1) to b' = (2, -2). Write down the single transformation T and explain briefly how you know. State the image of c = (5, 0) under T.

(Total for Question 5 is 4 marks)

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6 Show that the composite transformation consisting of a rotation of 180 degrees about the origin followed by a reflection in the line y = -x maps any point (x, y) to (y, x). Explain each step.

(Total for Question 6 is 5 marks)

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7 A right-angled triangle with vertices P(0, 0), Q(6, 0) and R(6, 8) is transformed by a clockwise rotation of 90 degrees about the point (6, 0), then translated by vector (-4, 2). Find the coordinates of the image of R after the two transformations.

(Total for Question 7 is 4 marks)

8 The matrix M = [[0, -1], [1, 0]] acts on column vectors $(x, y)^T$. (a) Identify the single transformation represented by M. (b) Use M to find the image of the point S(2, -3).

(a) (a) Identify the single transformation represented by M. **(2)**

(b) (b) Use M to find the image of the point S(2, -3). **(3)**

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(Total for Question 8 is 5 marks)

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9 A regular pentagon has centre O and a vertex at V(0, r) on the positive y-axis. A rotation of 72 degrees anticlockwise about O maps the pentagon to itself, sending V to the next vertex W. Express the rotation as a 2x2 matrix R in terms of cos(72 degrees) and sin(72 degrees). Then show that applying R to V gives the coordinates of W in terms of r, cos(72 degrees) and sin(72 degrees).

(a) Write down the 2x2 matrix R representing a rotation by 72 degrees anticlockwise about the origin. **(2)**

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(b) Use R to find the coordinates of W, the image of V(0, r), in terms of r, cos72 and sin72. **(3)**

(Total for Question 9 is 5 marks)

Mark scheme · 3.17H Transformations: Higher Tier Practice

Question 1

- **B1** state reflection in the x-axis oe
- **B1** fully described mapping (x, y) -> (x, -y) or equivalent cao
- **Answer: Reflection in the x-axis. (x, y) -> (x, -y).**

Question 2

- **M1** subtract centre (1,1) then multiply by -2 for each coordinate (method shown) oe
- **A1** image of (2,1) is (-1,1) cao
- **A1** images of other vertices: (4,1) -> (-5,1) and (2,3) -> (-1,-3) cao
- **Answer: Images: (2,1) -> (-1,1); (4,1) -> (-5,1); (2,3) -> (-1,-3).**

Question 3

- **M1** apply shear: (3, -1) -> (3 + 2(-1), -1) = (1, -1) or equivalent method
- **M1** apply rotation 90 anticlockwise about origin: (x, y) -> (-y, x) applied to (1, -1)
- **A1** state intermediate result (-y, x) = -(-1), 1 = (1, 1) cao
- **B1** final coordinates clearly stated as (1, 1) cao
- **Answer: Final coordinates: (1, 1).**

Question 4

- **B1** state vector v = (0, 0) or 'no translation' oe
- **B1** state D' = D or give coordinates D' = (2, 3) cao
- **B1** conclude D'E'F' coincides with DEF (the whole triangle is unchanged) oe
- **Answer: Translation vector v = (0, 0). D' = D = (2, 3), so D'E'F' coincides with DEF (no change).**

Question 5

- **M1** identify common multiplication by 2 for given vectors or state scale factor 2
- **A1** state transformation is enlargement with scale factor 2 centre at origin (or equivalent) cao
- **M1** apply to c: (5,0) -> (10,0)
- **A1** state image (10, 0) cao
- **Answer: T is an enlargement with scale factor 2 centre at the origin. Image of c is (10, 0).**

Question 6

- **M1** state rotation 180 about origin maps (x, y) -> (-x, -y) or show this algebraically
- **M1** state reflection in y = -x maps (u, v) -> (-v, -u)
- **M1** apply to (-x, -y): substitute u = -x, v = -y to get (-v, -u)
- **M1** simplify (-v, -u) = (-(-y), -(-x)) = (y, x)
- **A1** conclude with clear explanation linking combined steps to obtain (y, x) (final statement) cao
- **Answer: Rotation 180: (x, y) -> (-x, -y). Reflection in y = -x: (u, v) -> (-v, -u). Apply: (-x, -y) -> (y, x). Hence the composite transformation maps (x, y) to (y, x).**

Question 7

- **M1** apply rotation 90 clockwise about (6,0): translate so centre at origin then rotate, method shown
- **M1** compute position after rotation: R(6,8) relative to centre (6,0) is (0,8) -> rotate 90 clockwise to (8,0) then translate back to (14,0) oe
- **M1** apply translation (-4,2) to (14,0) gives (10,2) oe
- **A1** final coordinates (10, 2) cao
- **Answer: Image of R is (10, 2).**

Question 8

- (a) **B1** state rotation of 90 degrees anticlockwise about the origin oe
- (a) **B1** reference to mapping rule or effect on axes (e.g. (1,0)->(0,1)) cao
- **(a) Answer: Rotation 90 degrees anticlockwise about the origin.**
- (b) **M1** multiply matrix by vector: show calculation [[0, -1],[1,0]] * $(2, -3)^T$
- (b) **M1** compute entries: first entry 0*2 + (-1)*(-3) = 3, second entry 1*2 + 0*(-3) = 2
- (b) **A1** state image (3, 2) cao
- **(b) Answer: (3, 2)**

Question 9

- (a) **M1** state general rotation matrix form [[cos θ, -sin θ],[sin θ, cos θ]] oe
- (a) **A1** substitute θ = 72 degrees: R = [[cos72, -sin72],[sin72, cos72]] cao
- **(a) Answer: R = [[cos72, -sin72], [sin72, cos72]]**
- (b) **M1** multiply matrix by vector: show [[cos72, -sin72],[sin72, cos72]] * $(0, r)^T$
- (b) **M1** compute entries: first = cos72*0 + (-sin72)*r = -r sin72; second = sin72*0 + cos72*r = r cos72
- (b) **A1** state W = (-r sin72, r cos72) cao
- **(b) Answer: W = (-r sin72, r cos72)**