Abstract Thinking: Transformations and Views

Standard difficulty · 20 questions · 40 marks · Time: 36 minutes

Name: _____ Date: _____ Score: ____ / 40

Show your working for Sections B and C. Answers are on the last page — try every question first!

Section A — Choose the correct answer — 8 × 1 = 8 marks

1. A turn of 270° clockwise is the same as a turn of:
   (a) 180° **(b)** 270° anticlockwise
   (c) 90° clockwise **(d)** 90° anticlockwise

2. A child faces East and turns 270° clockwise, then 270° clockwise, then 270° clockwise, then 90° anticlockwise. Which way is the child facing now?
   (a) South **(b)** West **(c)** North **(d)** East

3. An arrow points up. You turn it 90° clockwise, then turn it 180°, then flip it left to right (mirror image), then turn it 180°. Which way does it point now?
   (a) up **(b)** left **(c)** right **(d)** down

4. What is the smaller angle between the hour hand and the minute hand of a clock at 12:25?
   (a) 107.5° **(b)** 150° **(c)** 167.5° **(d)** 137.5°

5. The corners of a regular octagon are numbered 1 to 8 clockwise, with corner 1 at the top. It is turned clockwise about its centre through 180°. Which corner is now at the top?
   (a) 5 **(b)** 7 **(c)** 4 **(d)** 6

6. A cube is painted on all its faces and then cut into 27 equal small cubes (3 along each edge). How many small cubes have exactly one painted face?
   (a) 6 **(b)** 1 **(c)** 8 **(d)** 12

7. How many rectangles (squares included) are there in a grid of 2 rows and 5 columns of small squares?
   (a) 47 **(b)** 35 **(c)** 10 **(d)** 45

8. A square sheet of paper is folded in half 4 times. Then 5 holes are punched through all the layers. How many holes are there when it is unfolded?
   (a) 80 **(b)** 160 **(c)** 20 **(d)** 40

Section B — Short answer — 8 × 2 = 16 marks

9. What is a compound transformation? Give an example.

10. An arrow points up. You turn it 90° anticlockwise, then flip it top to bottom (water image), then flip it top to bottom (water image), then flip it left to right (mirror image). Which way does it point now?

11. A child faces West and turns 90° anticlockwise, then 180° clockwise, then 270° clockwise, then 270° clockwise. Which way is the child facing now?

12. What is the smaller angle between the hour hand and the minute hand of a clock at 11:20?

13. How many rectangles (squares included) are there in a grid of 5 rows and 8 columns of small squares?

14. A cube is painted on all its faces and then cut into 64 equal small cubes (4 along each edge). How many small cubes have exactly one painted face?

15. 4 dice are stacked on a table. On each die, opposite faces add up to 7. The top face shows 1. How many dots in all are on the faces you cannot see from any side (the faces that touch each other or the table)?

16. Hold a mirror upright beside the word HOUSE (written in capital letters). How many of its letters look exactly the same in the mirror?

Section C — Word problems — 4 × 4 = 16 marks

17. A cube is painted and cut into 216 small cubes (6 along each edge). Find the number with (a) 3 (b) 2 (c) 1 (d) 0 painted faces, and check that they add up to 216.

18. (a) An arrow points right. You flip it top to bottom (water image), then turn it 180°, then turn it 180°, then flip it left to right (mirror image). Which way does it point now?
(b) A child faces West and turns 270° anticlockwise, then 135° clockwise, then 180° anticlockwise, then 180° clockwise. Which way is the child facing now?

19. (a) A cube is painted on all its faces and then cut into 216 equal small cubes (6 along each edge). How many small cubes have exactly two painted faces?
(b) A square sheet of paper is folded in half 4 times. Then 6 holes are punched through all the layers. How many holes are there when it is unfolded?

20. (a) How many rectangles (squares included) are there in a grid of 5 rows and 5 columns of small squares?
(b) The corners of a regular dodecagon are numbered 1 to 12 clockwise, with corner 1 at the top. It is turned clockwise about its centre through 180°. Which corner is now at the top?

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Answer key

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Q	Answer	Working
1	**(d) 90° anticlockwise**	—
2	**(d) East**	net turn = 0° clockwise from East
3	**(b) left**	follow each change in order and track the arrow's direction
4	**(d) 137.5°**	hour hand at 0 × 30° + 25 × 0.5° = 12.5°; minute hand at 25 × 6° = 150°; difference 137.5°
5	**(a) 5**	each 45° moves every corner one place clockwise; 180° = 4 places, so the corner 4 places anticlockwise of corner 1 comes to the top
6	**(a) 6**	the face-centre cubes: 6 faces × 1 × 1
7	**(d) 45**	choose 2 of the 3 horizontal lines (3 ways) and 2 of the 6 vertical lines (15 ways)
8	**(a) 80**	each fold doubles the layers: 16 layers × 5
9	**Two or more changes done one after another, e.g. turn 90° clockwise, then flip left to right.**	—
10	**right**	follow each change in order and track the arrow's direction
11	**South**	net turn = 270° clockwise from West
12	**140°**	hour hand at 11 × 30° + 20 × 0.5° = 340°; minute hand at 20 × 6° = 120°; difference 220°, so 360° − that
13	**540**	choose 2 of the 6 horizontal lines (15 ways) and 2 of the 9 vertical lines (36 ways)
14	**24**	the face-centre cubes: 6 faces × 2 × 2
15	**27**	4 pairs of top and bottom faces add up to 7 × 4 = 28; take away the 1 on top
16	**3**	letters with an upright line of symmetry: H, O, U
17	**(a) 8 (b) 12 × 4 = 48 (c) 6 × 16 = 96 (d) 4 × 4 × 4 = 64. 8 + 48 + 96 + 64 = 216.**	—
18	**(a) left; (b) South-East**	(a) follow each change in order and track the arrow's direction; (b) net turn = 225° clockwise from West
19	**(a) 48; (b) 96**	(a) the edge cubes: 12 edges × 4; (b) each fold doubles the layers: 16 layers × 6
20	**(a) 225; (b) 7**	(a) choose 2 of the 6 horizontal lines (15 ways) and 2 of the 6 vertical lines (15 ways); (b) each 30° moves every corner one place clockwise; 180° = 6 places, so the corner 6 places anticlockwise of corner 1 comes to the top

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