# Abstract Thinking: Turns, Views and Symmetry

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. Keeping only the important details of a problem and ignoring the rest is:
   **(a)** debugging **(b)** looping **(c)** decomposition **(d)** abstraction

2. A child faces East and turns 45° clockwise, then 45° clockwise, then 45° clockwise. Which way is the child facing now?
   **(a)** South-East **(b)** North-West **(c)** South-West **(d)** North-East

3. What is the smaller angle between the hour hand and the minute hand of a clock at 2:20?
   **(a)** 80° **(b)** 20° **(c)** 60° **(d)** 50°

4. A clock shows 11:40. What time does its image in a mirror seem to show?
   **(a)** 1:40 **(b)** 1:20 **(c)** 12:20 **(d)** 11:20

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 135°. Which corner is now at the top?
   **(a)** 5 **(b)** 6 **(c)** 4 **(d)** 7

6. A square sheet of paper is folded in half 3 times. Then 3 holes are punched through all the layers. How many holes are there when it is unfolded?
   **(a)** 12 **(b)** 9 **(c)** 18 **(d)** 24

7. A cube is painted on all its faces and then cut into 125 equal small cubes (5 along each edge). How many small cubes have no painted faces?
   **(a)** 27 **(b)** 54 **(c)** 36 **(d)** 8

8. Hold a mirror upright beside the word MATH (written in capital letters). How many of its letters look exactly the same in the mirror?
   **(a)** 4 **(b)** 0 **(c)** 5 **(d)** 3

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

9. What is abstraction? Give an example.

10. A child faces West and turns 90° clockwise, then 45° clockwise, then 90° clockwise. Which way is the child facing now?

**11.** What is the smaller angle between the hour hand and the minute hand of a clock at 9:40?

**12.** 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 210°. Which corner is now at the top?

**13.** A square sheet of paper is folded in half 3 times. Then 3 holes are punched through all the layers. How many holes are there when it is unfolded?

**14.** 5 dice are stacked on a table. On each die, opposite faces add up to 7. The top face shows 5. How many dots in all are on the faces you cannot see from any side (the faces that touch each other or the table)?

**15.** How many squares of all sizes are there in a grid of 3 rows and 3 columns of small squares?

**16.** A cube is painted on all its faces and then cut into 343 equal small cubes (7 along each edge). How many small cubes have exactly two painted faces?

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

**17.** A child faces North. She turns 90° clockwise, then 180°, then 45° anticlockwise. (a) What single clockwise turn from North gives the same result? (b) Which way does she face? (c) Explain your method.

**18.** (a) A child faces East and turns 90° anticlockwise, then 45° clockwise, then 180° anticlockwise. Which way is the child facing now?
(b) What is the smaller angle between the hour hand and the minute hand of a clock at 8:10?

**19.** (a) How many squares of all sizes are there in a grid of 2 rows and 5 columns of small squares?
(b) 5 dice are stacked on a table. On each die, opposite faces add up to 7. The top face shows 6. How many dots in all are on the faces you cannot see from any side (the faces that touch each other or the table)?

**20.** (a) A square sheet of paper is folded in half 3 times. Then 3 holes are punched through all the layers. How many holes are there when it is unfolded?
(b) Hold a mirror upright beside the word WITTY (written in capital letters). How many of its letters look exactly the same in the mirror?

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# Answer key

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| Q | Answer | Working |
|---|---|---|
| 1 | **(d) abstraction** | — |
| 2 | **(c) South-West** | net turn = 135° clockwise from East |
| 3 | **(d) 50°** | hour hand at 2 × 30° + 20 × 0.5° = 70°; minute hand at 20 × 6° = 120°; difference 50° |
| 4 | **(c) 12:20** | mirror time = 11:60 − 11:40 |
| 5 | **(b) 6** | each 45° moves every corner one place clockwise; 135° = 3 places, so the corner 3 places anticlockwise of corner 1 comes to the top |
| 6 | **(d) 24** | each fold doubles the layers: 8 layers × 3 |
| 7 | **(a) 27** | the inside cubes: 3 × 3 × 3 |
| 8 | **(a) 4** | letters with an upright line of symmetry: M, A, T, H |
| 9 | **Keeping only the details needed and leaving out the rest, e.g. a metro map shows stations and lines, not every building.** | — |
| 10 | **South-East** | net turn = 225° clockwise from West |
| 11 | **50°** | hour hand at 9 × 30° + 40 × 0.5° = 290°; minute hand at 40 × 6° = 240°; difference 50° |
| 12 | **6** | each 30° moves every corner one place clockwise; 210° = 7 places, so the corner 7 places anticlockwise of corner 1 comes to the top |
| 13 | **24** | each fold doubles the layers: 8 layers × 3 |
| 14 | **30** | 5 pairs of top and bottom faces add up to 7 × 5 = 35; take away the 5 on top |
| 15 | **14** | 9 + 4 + 1 (sizes 1 × 1 up to 3 × 3) |
| 16 | **60** | the edge cubes: 12 edges × 5 |
| 17 | **(a) 90 + 180 − 45 = 225° clockwise. (b) South-West. (c) Add the clockwise turns and take away the anticlockwise ones; then count 45° steps from North: North-East, East, South-East, South, South-West.** | — |
| 18 | **(a) South-West; (b) 175°** | (a) net turn = 135° clockwise from East; (b) hour hand at 8 × 30° + 10 × 0.5° = 245°; minute hand at 10 × 6° = 60°; difference 185°, so 360° − that |
| 19 | **(a) 14; (b) 29** | (a) 10 + 4 (sizes 1 × 1 up to 2 × 2); (b) 5 pairs of top and bottom faces add up to 7 × 5 = 35; take away the 6 on top |
| 20 | **(a) 24; (b) 5** | (a) each fold doubles the layers: 8 layers × 3; (b) letters with an upright line of symmetry: W, I, T, T, Y |