

How to use this sheet. Nearly every question reuses vector algebra directly: a dot product of direction ratios tests for perpendicularity, proportional direction ratios test for parallelism, and a plane's normal is read straight off the coefficients of its equation.

Quick reference — $l^2 + m^2 + n^2 = 1$ for direction cosines · Distance point to plane $ax + by + cz = d$: $|ax_1 + by_1 + cz_1 - d| / (\text{magnitude of } a, b, c)$ · Zero dot product of normals = perpendicular planes

Section A · Level 1

Eight questions. None should take more than twenty seconds.

1. The direction cosines l, m, n of any line always satisfy:

(1) $l + m + n = 1$ (2) $l^2 + m^2 + n^2 = 1$ (3) $l \times m \times n = 1$ (4) $l = m = n$

2. If a line has direction ratios 1, 2, 2, its direction cosines are:

(1) 1, 2, 2 (2) $1/3, 2/3, 2/3$ (3) $1/5, 2/5, 2/5$ (4) $1/9, 2/9, 2/9$

3. Direction ratios of a line are proportional to its direction cosines, meaning:

(1) They are always identical (2) Multiplying the direction ratios by a suitable constant gives the direction cosines (3) Direction ratios must sum to 1 (4) Direction ratios have no length

4. Two lines with direction ratios (a_1, b_1, c_1) and (a_2, b_2, c_2) are perpendicular when:

(1) $a_1a_2 + b_1b_2 + c_1c_2 = 0$ (2) $a_1/a_2 = b_1/b_2 = c_1/c_2$ (3) $a_1 + a_2 = 0$ (4) $a_1a_2 = b_1b_2$

5. Two lines with direction ratios (a_1, b_1, c_1) and (a_2, b_2, c_2) are parallel when:

(1) $a_1a_2 + b_1b_2 + c_1c_2 = 0$ (2) $a_1/a_2 = b_1/b_2 = c_1/c_2$ (3) $a_1 = b_1 = c_1$ (4) The lines must intersect

6. The direction ratios of the line joining the points (1,2,3) and (4,6,3) are:

(1) (3,4,0) (2) (5,8,6) (3) (4,6,3) (4) (1,2,3)

7. The magnitude of the direction ratios (3,4,0) found for the previous line is:

(1) 3 (2) 4 (3) 5 (4) 7

8. Two lines have direction ratios (1,1,0) and (1,0,1). The cosine of the angle between them is:

(1) 0 (2) $1/2$ (3) 1 (4) $\sqrt{2}/2$

Section B · Level 2

Seven questions. The coefficients of x, y and z in a plane's equation are its normal's direction ratios.

9. The equation of a plane in the form $ax + by + cz = d$ has (a, b, c) as:

(1) A point on the plane (2) The direction ratios of the normal to the plane (3) The direction ratios of a line in the plane (4) The distance of the plane from the origin

10. The distance of the point (1,1,1) from the plane $x + 2y + 2z = 9$ is:

(1) 1 (2) $4/3$ (3) 3 (4) 9

11. The distance of the origin from the plane $2x + 3y + 6z = 14$ is:

(1) 1 (2) 2 (3) $14/7$ (4) Both 2 and $14/7$ are the same value

12. Two planes with normal direction ratios (2, -2, 1) and (1, 2, 2) are:

(1) Parallel (2) Perpendicular (3) Identical (4) Neither parallel nor perpendicular

13. Two planes with normal direction ratios (1,2,2) and (2,2,1) have the cosine of the angle between them equal to:

(1) $\frac{1}{9}$ (2) $\frac{8}{9}$ (3) $\frac{2}{3}$ (4) 1

14. A plane and a line are said to be perpendicular to each other when:

(1) The line's direction ratios are proportional to the plane's normal direction ratios (2) The line lies entirely within the plane (3) The line is parallel to the plane (4) The line passes through the origin

15. A line is parallel to a plane when the line's direction ratios and the plane's normal direction ratios satisfy:

(1) Their dot product is zero (2) They are proportional (3) Their cross product is zero (4) They are both zero

Section C · Level 3

Six questions. Skew lines exist only in three dimensions or more.

16. The shortest distance between two skew lines can be found using:

(1) Only their direction ratios (2) The scalar triple product of the connecting vector and the two direction vectors, divided by the magnitude of their cross product (3) The sum of their individual lengths (4) Simple subtraction of their equations

17. Two lines in space that are neither parallel nor intersecting are called:

(1) Coincident lines (2) Skew lines (3) Perpendicular lines (4) Collinear lines

18. If the shortest distance between two lines is zero, the two lines must be:

(1) Skew (2) Parallel (3) Intersecting (or coincident) (4) Perpendicular

19. The equation of a line passing through a point with position vector $\mathbf{a}$ and parallel to a vector $\mathbf{b}$ can be written in vector form as:

(1) $\mathbf{r} = \mathbf{a} \times \mathbf{b}$ (2) $\mathbf{r} = \mathbf{a} + \lambda \mathbf{b}$, for a scalar parameter λ (3) $\mathbf{r} = \mathbf{a} \cdot \mathbf{b}$ (4) $\mathbf{r} = \mathbf{b} - \mathbf{a}$

20. A plane passing through three non-collinear points can be found using the fact that the normal to the plane is:

(1) The sum of the position vectors of the three points (2) Perpendicular to any two vectors formed by pairs of the three points, found using their cross product (3) Equal to one of the three points (4) Always the vector (1,1,1)

21. A plane and a line intersect at a single point, provided that:

(1) The line is parallel to the plane (2) The line lies within the plane (3) The line is not parallel to the plane (4) The line has zero length

Answer key: 1. (2) 2. (2) 3. (2) 4. (1) 5. (2) 6. (1) 7. (3) 8. (2) 9. (2) 10. (2) 11. (4) 12. (2) 13. (2) 14. (1) 15. (1) 16. (2) 17. (2) 18. (3) 19. (2) 20. (2) 21. (3)

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