



Attempt all questions before checking the answer key. Only lines are considered. In symmetric equations, a zero direction component means that coordinate is constant.

A. Very short answers - 1 mark each

1. What are direction ratios of a line?
2. State the relation satisfied by direction cosines l, m, n .
3. Write a vector equation of a line through position vector a and parallel to $b \neq 0$.
4. What distinguishes skew lines from parallel lines?
5. Find direction ratios of the line joining $(1, 2, 3)$ and $(3, 1, 5)$.

B. Short answers / practice - 2 marks each

6. Find direction cosines for direction ratios $1, 2, 2$.
7. Write vector and Cartesian equations of the line through $(1, -2, 3)$ parallel to $2i + j - 2k$.
8. Find the acute angle between lines with directions $(1, 1, 0)$ and $(1, 0, 1)$.
9. Check whether $P(3, 3, 1)$ lies on $r = (1, 2, 3) + t(2, 1, -2)$.
10. Find the equation of the line through $A(2, 1, -1)$ and $B(4, 3, 2)$.
11. Find direction ratios through $(0,0,0), (2,3,4)$.
12. Find angle between x-axis and y-axis.
13. Does $r = (1,0,0) + t(0,1,0)$ pass through origin?
14. Find distance between lines $(t,0,0)$ and $(s,3,0)$.
15. Find direction cosines of a line parallel to z-axis.
16. Write line through origin parallel to $(1, -2, 1)$.
17. Are directions $(1,2,3)$ and $(2,4,6)$ parallel?
18. Find λ for perpendicular directions $(1,1,\lambda), (1,-2,1)$.
19. Find intersection of $r = (0,0,1) + t(1,1,-1)$ with xy-plane.
20. Explain why skew lines cannot be contained in one plane.

C. Short answers - 3 marks each

21. Determine whether $r = (1, 0, 0) + t(1, 1, 0)$ and $r = (0, 1, 0) + s(1, -1, 0)$ intersect. Find the point if they do.

22. Find the shortest distance between $r = t(1, 0, 0)$ and $r = (0, 2, 3) + s(0, 1, 0)$.

23. Find the distance between parallel lines $r = t(1, 2, 2)$ and $r = (1, 0, 0) + s(1, 2, 2)$.

24. Find λ so that lines with direction ratios $(1, 2, 3)$ and $(2, -1, \lambda)$ are perpendicular.

25. Find the foot of the perpendicular from $P(1, 2, 3)$ to $r = t(1, 1, 1)$ and its distance from the line.

D. Long answers - 5 marks each

26. Derive the shortest-distance formula for two non-parallel skew lines in vector form. Explain why it gives zero for intersecting lines and why the parallel case needs a different formula.
27. For $L_1: r = (1, 0, 1) + t(1, 2, 1)$ and $L_2: r = (0, 1, 0) + s(2, 1, -1)$, show they are skew and find their shortest distance and acute angle.
28. Find the point on $r = (1, 1, 0) + t(1, 2, 2)$ closest to $P(3, 0, 4)$. Obtain the distance and verify perpendicularity.
29. Find vector and Cartesian equations of the line through $(1, 2, 3)$ perpendicular to both directions $i + j$ and $j + k$. Find where it meets the xy-plane.
30. Show that lines $r = (1, 2, 0) + t(1, 0, 1)$ and $r = (3, 2, 2) + s(0, 1, 1)$ intersect. Find the intersection and angle, then write the line through the intersection parallel to the sum of their direction vectors.

ANSWER KEY - Numerical / short answers

- 2) $l^2 + m^2 + n^2 = 1$. 3) $r = a + tb$. 5) $2, -1, 2$. 6) $1/3, 2/3, 2/3$ (or all opposite signs). 7) $r = (1, -2, 3) + t(2, 1, -2)$; $(x-1)/2 = y+2 = (z-3)/(-2)$. 8) 60° . 9) Yes, $t=1$. 10) $r = (2, 1, -1) + t(2, 2, 3)$. 11) $2, 3, 4$. 12) 90° . 13) No. 14) 3. 15) $0, 0, \pm 1$. 16) $r = t(1, -2, 1)$. 17) Yes. 18) 1. 19) $(1, 1, 0)$. 21) Yes; $(1, 0, 0), t=0, s=1$. 22) 3. 23) $2\sqrt{2}/3$. 24) 0. 25) Foot $(2, 2, 2)$; distance $\sqrt{2}$. 27) Shortest distance $\sqrt{3}$; acute angle 60° . 28) $t=8/9$; point $(17/9, 25/9, 16/9)$; distance $5\sqrt{5}/3$. 29) $r = (1, 2, 3) + t(1, -1, 1)$; $x-1 = -(y-2) = z-3$; meets xy at $(-2, 5, 0)$. 30) $(3, 2, 2)$; angle 60° ; required line $r = (3, 2, 2) + u(1, 1, 2)$.