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www.askiitians.com
Email: info@askiitians.com
Tel: 1800-2000-838

Class: 11
Subject: Mathematics
Topic: Linear Equations in one variable
No. of Questions: 20
Duration: 60 Min
Maximum Marks: 60

1. A plane p is perpendicular to the two planes $2x - 2y + z = 0$ and $x - y + 2z = 4$ and passes through the point $(1, -2, 1)$. The distance of p from the point $(1, 2, 2)$ is

a) 0
b) 1
c) $\sqrt{2}$
d) $2\sqrt{2}$

Ans. D

Solution:

Let the equation of the plane be

$$a(x-1) + b(y+2) + c(z-1) = 0.$$

Since it is perpendicular to the given planes

$$2a - 2b + c = 0, \qquad a - b + 2c = 0.$$

$\Rightarrow$ $c = 0,\ a = b.$

$\Rightarrow$ Equation of the plane is $x + y + 1 = 0$

Its distance from the point (1, 2, 2) is

$$\left|\frac{1+2+1}{\sqrt{1+1}}\right| = 2\sqrt{2}$$

2. Equation of a plane which passes through the line $x + py + q = 0 = rz + s$ and makes equal intercepts on y and z axes is $x + py + q + \lambda(rz + s) = 0$ where λ is equal to

a) q/s
b) p/r
c) r/s
d) p/q

Ans. B

Solutions:

$$\frac{-\lambda s - q}{p} = \frac{-\lambda s - q}{\lambda r} \quad \Rightarrow \quad p = \lambda r \Rightarrow \lambda = p/r.$$

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3. Let P (3, 2, 6) be a point in space and Q be a point on the line r = (i – j + 2k) + μ (– 3i + j + 5k) Then the value of μ for which the vector PQ is parallel to the plane x –4y +3z – 1 is
   a) ¼
   b) –1/4
   c) 1/8
   d) –1/8

   Ans. A

   Solution:

   As Q lies on the given line

   Let $\mathbf{OQ} = (\mathbf{i} - \mathbf{j} + 2\mathbf{k}) + \mu(-3\mathbf{i} + \mathbf{j} + 5\mathbf{k})$

   Also $\mathbf{OP} = 3\mathbf{i} + 2\mathbf{j} + 6\mathbf{k}$

   As $\mathbf{PQ}$ is parallel to the plane $x - 4y + 3z = 1$

   $\mathbf{PQ} \cdot (\mathbf{i} - 4\mathbf{j} + 3\mathbf{k}) = 0$

   $\Rightarrow \quad (\mathbf{OQ} - \mathbf{OP}) \cdot (\mathbf{i} - 4\mathbf{j} + 3\mathbf{k}) = 0$

   $\Rightarrow \quad (1 + 4 + 6) + \mu(-3 - 4 + 15) - (3 - 8 + 18) = 0$

   $\Rightarrow \quad 11 + 8\mu - 13 = 0 \Rightarrow \mu = 1/4$

4. A line with positive direction cosine passes through the point P (2, –1, 2) and makes equal angles with the coordinate axes. The line meets the plane 2x + y + z = 9 at point Q. The length of the line segment PQ equals.

   a) 1
   b) $\sqrt{2}$
   c) $\sqrt{3}$
   d) 2

   Ans. C

   Solution:

   The equation of the line is

   $$\frac{x-2}{1} = \frac{y+1}{1} = \frac{z-2}{1} = k$$

   Let the coordinates of the point Q on this line be

   $Q(k+2, k-1, k+2)$. Since Q lies on the plane

   $2(k+2) + (k-1) + (k+2) = 9$

   $\Rightarrow \quad k = 1$ and $PQ = \sqrt{(3-2)^2 + (0+1)^2 + (3-2)^2} = \sqrt{3}$

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5. The foot of the perpendicular from (a, b, c) on the line x = y = z is the point (r, r, r) where

   a) r = a + b + c
   b) r = 3 (a + b + c)
   c) 3r = a + b + c
   d) none of these

   Ans. C

   Solution:

   Direction ratios of the perpendicular are $r - a$, $r - b$, $r - c$ and those of the lines are 1, 1, 1. So $1.(r - a) + 1.(r - b) + 1.(r - c) = 0$

   $\Rightarrow \quad 3r = a + b + c.$

6. Equation of a line passing through the point whose position vector is 2i – 3j + 4k and in the direction of the vector 3i + 4j – 5k is

   a) 4x + 3y = 17, 5y – 4z = 1
   b) 4x – 3y = 17, 5y + 4z = 1
   c) 4x + 5y = 12, 3y + 4z = 1
   d) 5y + 4z = 1, 4x + 3z = 1

   Ans. B

   Solution:

   Equation of the line is $\mathbf{r} = 2\mathbf{i} - 3\mathbf{j} + 4\mathbf{k} - \lambda(3\mathbf{i} + 4\mathbf{j} - 5\mathbf{k})$ so the line passes through (2, – 3, 4) and the direction ratios are 3, 4, – 5 and so its equation is $\frac{x-2}{3} = \frac{y+3}{4} = \frac{z-4}{-5}$

   $\Rightarrow \quad 4x - 3y = 17,\ 5y + 4z = 1$

7. Equation of the plane containing the straight line $\frac{x}{2} = \frac{y}{3} = \frac{z}{4}$ and perpendicular to the plane containing the straight lines $\frac{x}{2} = \frac{y}{3} = \frac{z}{4}$ and $\frac{x}{4} = \frac{y}{2} = \frac{z}{3}$.

a) x + 2y – 2z = 0
b) 3x + 2y – 2z = 0
c) x – 2y + z = 0
d) 5x + 2y – 4z = 0

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Ans. C

Solution:

Let a, b, c be the direction ratios of the normal to the plane containing the lines $\frac{x}{3}=\frac{y}{4}=\frac{z}{2}$ and $\frac{x}{4}=\frac{y}{2}=\frac{z}{3}$

then $3a+4b+2c=0$

$4a+2b+3c=0$

$\Rightarrow \quad \frac{a}{8}=\frac{b}{-1}=\frac{c}{-10}$

Let α, β, γ be the direction ratios of the normal to the required plane.

then $8\alpha-\beta-10\gamma=0$

$2\alpha+3\beta+4\gamma=0$

$\Rightarrow \quad \frac{\alpha}{26}=\frac{\beta}{-52}=\frac{\gamma}{26}$

$\Rightarrow \quad \frac{\alpha}{1}=\frac{\beta}{-2}=\frac{\gamma}{1}$

As the required plane contains the line $\frac{x}{2}=\frac{y}{3}=\frac{z}{4}$, the point (0, 0, 0) lying on it also lies on the plane and hence equation of the required plane is $x-2y+z=0$

8. YZ-plane divides the line joining the points (3, 5, – 7) and (– 2, 1, 8) in the ratio

a) 1: 2
b) 2: 3
c) 3: 2
d) 2: 1

Ans. C

Solution:

Let the ratio be $m : n$, then x-coordinate of the point of division is zero

$$\Rightarrow \quad \frac{-2m+3n}{m+n}=0 \Rightarrow \frac{m}{n}=\frac{3}{2}.$$

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9. The angle between the lines $\frac{x-2}{3} = \frac{y+1}{-2}$, z = 2 and $\frac{x-1}{1} = \frac{2y+3}{3} = \frac{z+5}{2}$ is

a) $\pi/3$
b) $\pi/6$
c) $\pi/4$
d) $\pi/2$

Ans. D

Solution:

Direction ratios of the lines are 3, –2, 0 and 1, 3/2, 2; $3 \times 1 - 2 \times \frac{3}{2} + 0 \times 2 = 0$

10. If the distance of the point P (1, –2, 1) from the plane x + 2y – 2z = α, where, $\alpha >$ 0, is 5, then the foot of the perpendicular from P to the plane is

a) $\left(\frac{8}{3}, \frac{4}{3}, \frac{-7}{3}\right)$
b) $\left(\frac{4}{3}, \frac{-4}{3}, \frac{1}{3}\right)$
c) $\left(\frac{1}{3}, \frac{2}{3}, \frac{10}{3}\right)$
d) $\left(\frac{2}{3}, \frac{-1}{3}, \frac{5}{2}\right)$

Ans. A

Solution:

Let Q be the foot of the perpendicular from P

then equation of PQ is $\frac{x-1}{1} = \frac{y+2}{2} = \frac{z-1}{-2} = r$ (say)

Let the coordinates of Q be $(r+1, 2r-2, -2r+1)$ Since it lies on the plane, $r + 1 + 2(2r-2) - 2(-2r+1) = \alpha$

$\Rightarrow \quad 9r - 5 = \alpha \quad \Rightarrow \quad r = (1/9)(5 + \alpha)$

Now $PQ = 5$

$\Rightarrow \quad r^2 + 4r^2 + 4r^2 = 25 \Rightarrow r = \pm 5/3$

So $\quad \frac{\alpha+5}{9} = r = \frac{\pm 5}{3} \Rightarrow \alpha = 10 \qquad (\because \alpha > 0)$

and $r = 5/3$

Hence the coordinates of Q are $\left(\frac{8}{3}, \frac{4}{3}, \frac{-7}{3}\right)$

11. If the plane $\frac{x}{a} + \frac{y}{b} + \frac{y}{c} = 3$ meets the coordinate axes in A, B, C, and the centroid of the triangle ABC is at P(2, 4, 8), then a, b, c are in

a) A.P
b) G.P
c) H.P
d) None of these

Ans. B

Solution:

Coordinate of A are $(3a, 0, 0)$ $B(0, 3b, 0)$ and $C(0, 0, 3c)$ so the centroid of the triangle ABC is $(a, b, c) = (2, 4, 8)$

12. The points (1, – 2, 3), (2, 3, – 4) (0, – 7, 10) are the vertices of

a) a right angled triangle
b) isosceles triangle
c) equilateral triangle
d) none of these

Ans. B

Solution:

Lengths of the sides are
$\sqrt{(2-1)^2+(3+2)^2+(-4-3)^2}=\sqrt{75}$, $\sqrt{75}$ and
$\sqrt{300}$. So the triangle is isosceles.

13. The lines r = i – j + λ(2i + k) and r = 2i – j + μ(i + j – k)

a) intersect each others
b) do not intersect
c) intersect at r = 3i – j + k
d) are parallel

Ans. B

Solution:

Since $\begin{vmatrix} 2-1 & -1+1 & 0 \\ 2 & 0 & 1 \\ 1 & 1 & -1 \end{vmatrix} = -1 \neq 0$, the lines do not intersect.

14. Mirror image of the point P (2, 1, 6) in the plane passing through the points. (2, 1, 0), (5, 0, 1) and (4, 1, 1) is the point

a) (–2, – 1, –6)
b) (6, 5, –2)
c) (1, 1, 4)
d) (2, 5, 4)

Ans. B

Solution:

Equation of the plane through the given points

is
$$\begin{vmatrix} x-2 & y-1 & z-0 \\ 5-2 & 0-1 & 1-0 \\ 4-2 & 1-1 & 1-0 \end{vmatrix} = 0$$

$$\Rightarrow \begin{vmatrix} x-2 & y-1 & z-0 \\ 3 & -1 & 1 \\ 2 & 0 & 1 \end{vmatrix} = 0$$

$\Rightarrow \quad x + y - 2z = 3$

Equation of the line through P perpendicular to this plane is
$$\frac{x-2}{1} = \frac{y-1}{1} = \frac{z-6}{-2} = r \text{ say}$$

Let $Q\,(r+2, r+1, -2r+6)$ be the image of P in this plane, then the mid-point $R\left(\frac{r}{2}+2, +\frac{r}{2}+1, -r+6\right)$ of PQ lies on the plane.

So $\quad \frac{r}{2}+2+\frac{r}{2}+1-2(-r+6) = 3$

$\Rightarrow \quad 3r = 12 \quad \Rightarrow r = 4$

and the coordinates of Q are $(6, 5, -2)$

15. The variable plane $(2\lambda + 1)\,x + (3 - \lambda)\,y + z = 4$ always passes through the line

a) $\frac{x}{2} = \frac{y}{1} = \frac{z+4}{1}$

b) $\frac{x}{1} = \frac{y}{2} = \frac{z}{-3}$

c) $\frac{x}{1} = \frac{y}{2} = \frac{z-4}{-7}$

d) none of these

Ans. C

Solution:

Plane passes through the line
$$x + 3y + z - 4 = 2x - y = 0$$

or $\quad \frac{x}{1} = \frac{y}{2} = \frac{z-4}{-7}$

16. A line with direction ratios 2, 7, – 5 is drawn to intersect the lines $\frac{x-5}{3}=\frac{y-7}{-1}=\frac{z+2}{1}$ and $\frac{x+3}{-3}=\frac{y-3}{2}=\frac{z-6}{4}$ at P and Q respectively. Length of PQ is

a) $\sqrt{78}$
b) $\sqrt{77}$
c) $\sqrt{54}$
d) $\sqrt{74}$

Ans. A

Solution:

Right Answer Explanation:
Let $P(3r_1+5, -r_1+7, r_1-2)$ and $Q(-3r_2-3, 2r_2+3, 4r_2+6)$, direction ratios of PQ are 2, 7, – 5

So $\frac{3r_1+3r_2+8}{2}=\frac{-r_1-2r_2+4}{7}=\frac{r_1-4r_2-8}{-5}$ $r_1 = r_2 = -1$

P (2, 8, -3), Q (0, 1, 2) $\Rightarrow PQ = \sqrt{78}$

17. Parametric form of the equation of the line 3x – 6y – 2z – 15 = 0 and 2x + y – 2z – 5 = 0 is

a) $\frac{x-5}{14}=\frac{y}{2}=\frac{z}{12}$
b) $\frac{x-1}{14}=\frac{y-5}{2}=\frac{z-1}{15}$
c) $\frac{x-3}{14}=\frac{y+1}{2}=\frac{z}{15}$
d) none of these

Ans. C

Solution:

If l, m, n are the direction ratios of the line then $3l - 6m - 2n = 0$ and $2l + m - 2n = 0$

$\Rightarrow \quad \frac{l}{14} = \frac{m}{2} = \frac{n}{15}$

Equation of the line is

$\frac{x-\alpha}{14} = \frac{y-\beta}{2} = \frac{z-\gamma}{15}$

where (α, β, γ) lies on the line. only $(\alpha, \beta, \gamma) = (3, -1, 0)$ satisfies the condition.

18. The plane passing through the points (– 2, – 2, 2) and containing the line joining the points (1, 1, 1) and (1, – 1, 2) makes intersections on the coordinates axes, the sum of whose length is

a) 3
b) 4
c) 6
d) 12

Ans. D

Solution:

Equation of the plane be $a(x + 2) + b(y + 2) + c(z - 2) = 0$. As it passes through (1, 1, 1) and

(1, –1, 2), $\frac{a}{1} = \frac{b}{-3} = \frac{c}{-6}$. Equation of the plane is

$\frac{x}{-8} + \frac{y}{8/3} + \frac{z}{8/6} = 1$ and the required sum = 12.

19. If the foot of the perpendicular from the origin to a plane is (a, b, c), then the equation of the plane is

a) ax + by + cz = 1
b) $\frac{x}{a} + \frac{y}{b} + \frac{z}{c} = 1$
c) $ax + by + cz = a^2 + b^2 + c^2$
d) ax + by + cz = 0

Ans. C

Solution:

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Let $P(a, b, c)$, d.r. of the normal to the plane are a, b, c and as it passes through (a, b, c) its equation is $a(x - a) + b(y - b) + c(z - c) = 0$

20. If r. n = q is the equation of a plane normal to the vector n, the length of the perpendicular from the origin on the plane is

a) $\frac{q}{n}$
b) q|n|
c) q/|n|
d) q/|q|

Ans. C

Solution:

Equation of the plane is $\mathbf{r}.\frac{\mathbf{n}}{|\mathbf{n}|} = \frac{q}{|\mathbf{n}|}$, $\frac{\mathbf{n}}{|\mathbf{n}|}$ is a unit vector, So the required length $= q/|\mathbf{n}|$.