1. The midpoint Q has coordinates $\left(\frac{-2+2}{2}, \frac{1+2}{2}, \frac{5+2}{2}\right) = \left(0, \frac{3}{2}, \frac{7}{2}\right)$. The direction of the line $\mathbf{v} = \overrightarrow{PQ} = \left\langle 1, \frac{7}{2}, -\frac{1}{2}\right\rangle$. The desired parametric equations are $x = -1 + t,\ y = -2 + \frac{7}{2}t,\ z = 4 - \frac{1}{2}t$

2.
   1. The directions $\mathbf{v}_1,\ \mathbf{v}_2$ of $L_1,\ L_2$ are $\mathbf{v}_1 = \langle 7, 1, -3\rangle$ and $\mathbf{v}_2 = \langle -1, 0, 2\rangle$. $\mathbf{v}_1 \times \mathbf{v}_2 = \begin{vmatrix} 7 & 1 & -3 \\ -1 & 0 & 2 \end{vmatrix} = \langle 2, -11, 1\rangle \neq \mathbf{0}$. This means that $\mathbf{v}_1,\ \mathbf{v}_2$ are not parallel vectors. Hence $L_1,\ L_2$ are not parallel.
   2. No, because the distance between the two lines is not zero as calculated in part c. below.
   3. The plane Π through L_1 that is parallel to L_2 normal direction $\mathbf{v}_1 \times \mathbf{v}_2 = \langle 2, -11, 1\rangle$ and passes through the point $(1, 3, 5)$ on L_1. Hence it has equation $2(x-1) - 11(y-3) + (z-5) = 0$. The distance D between $L_1,\ L_2$ is equal to the distance between any point on L_2 and Π. If we take the point $(4, 6, 7)$ on L_2 then

   $$D = \frac{|2(4-1) - 11(6-3) + (7-5)|}{\sqrt{2^2 + 11^2 + 1^2}} = \frac{25}{42}\sqrt{14}$$

   ---

3. The normals $\mathbf{n}_1, \mathbf{n}_2$ to the planes are $\mathbf{n}_1 = \langle 1, -1, 1\rangle,\ \mathbf{n}_2 = \langle 2, 1, 3\rangle$. The formula for the angle θ between the two planes is $\cos\theta = \dfrac{|\mathbf{n}_1 \cdot \mathbf{n}_2|}{\|\mathbf{n}_1\|\,\|\mathbf{n}_2\|} = \dfrac{4}{\sqrt{3}\sqrt{14}} = \frac{2}{21}\sqrt{42}$. Hence $\theta = \cos^{-1}\frac{2}{21}\sqrt{42} = 0.905\,6 = 51.89°$.

---

4. The distance formula gives $D = \dfrac{|8(3) + (-2)(-5) + (2) - 5|}{\sqrt{8^2 + (-2)^2 + (1)^2}} = \frac{31}{69}\sqrt{69}$.

---

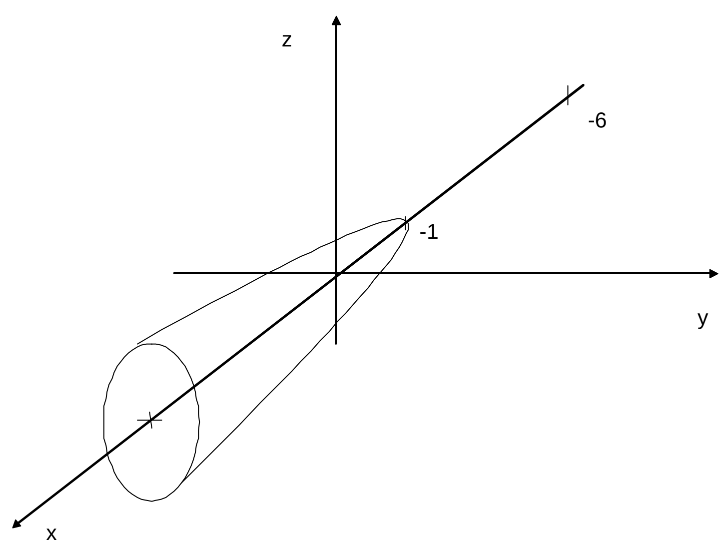
5. We need to find values of t which give points on the line at distance $\sqrt{14}$ from the plane. Substituting the general point on the line in the distance formula and equating to $\sqrt{14}$ gives

$$\sqrt{14} = \frac{|3(2+3t) - (1-t) + 2(8+2t) - 4|}{\sqrt{3^2 + (-1)^2 + (2)^2}} = \frac{|17 + 14t|}{\sqrt{14}}.$$

Therefore, $17+14t = \pm 14$. Solve to get $t = -\frac{31}{14}, -\frac{3}{14}$. Substitute these values in the equations of the line to obtain the two points $\left(-\frac{65}{14}, \frac{45}{14}, \frac{25}{7}\right), \left(\frac{19}{14}, \frac{17}{14}, \frac{53}{7}\right)$.

---

6. The normals to the planes are $\mathbf{n}_1 = \langle 1, 1, -1 \rangle$, $\mathbf{n}_2 = \langle 2, 3, -5 \rangle$. The direction $\mathbf{v}$ of the line of intersection is $\mathbf{v} = \mathbf{n}_1 \times \mathbf{n}_2 = \begin{vmatrix} 1 & 1 & -1 \\ 2 & 3 & -5 \end{vmatrix} = \langle -2, 3, 1 \rangle$. Therefore, the equations of the line are $x = 2 - 2t,\ y = 3 + 3t,\ z = 1 + t$.

7.
   1. The surface is a *circular paraboloid* with vertex at $(-1, 0, 0)$ and opening in the positive x-direction.
   2. 

   3. The point $(-6, 0, 0)$ is a point at a distance 5 from the surface.

8.
   1. A sphere centered at the origin of radius 2
   2. A sphere centered at the origin of radius 2
   3. The upper half of a cone of vertex angle $\frac{\pi}{4}$
   4. Changing to cylindrical coordinates, we get $r = 2,\ z \geq 0$. Therefore, we have the upper half of a cylinder with axis along the z-axis of radius 2.