1. Substitute, $t = -3$, $P = (-2, 7, 7)$.

2. $4x - y - 2z = 11$.

3. $x = 2 + t, y = -1 + 3t, z = -5t$.

4. $\mathbf{u} = (4, 0, -1) = \mathbf{v}$, $x = 2 + 4t, y = -5, z = -2 - t$.

5. $\mathbf{v} = (2, -2, 3) = \mathbf{u}$, $2x - 2y + 3z = -9$.

6. $5x - 4y + 3z = 0$, yes.

7. $\mathbf{v} = (4, -4, 2), x = 2 + 2t, y = 7 - 2t, z = 3 + t$. Yes, $t = 5$.

8. a) Yes, both planes contain $P$,
   b) Yes, $\mathbf{u}_1 \cdot \mathbf{u}_2 = 0$.

9. $x = 6 + t, y = 3 + 4t, z = -1 - 4t$, $(4 + t) + 4(9 + 4t) - 3(-4 - 3t) = 0$, $t = -2$, $P = (4, 5, 7)$.

10. Same question as previous, $P = (2, -1, 3)$.

11. Yes, $P = (0, 0, 7)$.

12. $M = (2, 1, 3)$, $\mathbf{n} = (1, 0, 2)$. Doesn’t intersect the $y$ axis.

13. a) $p = 3, q \neq 4$ (no solutions),
   b) $p \neq 3$ (exactly one solution),
   c) $p = 3, q = 4$ (infinitely many solutions).

14. $\mathbf{v} = (2, -5, -1)$, parallel to both planes, so also to the intersection.

15. They have a common point, namely $(1, 1, 1)$.

16. $p = 1, q = 2$.

17. $2x - y + 3z = 23$, no.

18. $x = 3 + 2t, y = 1 - 4t, z = 7t$, no.

19. $(2, 5, 7) = (\overrightarrow{AB} + \overrightarrow{AC})/2$

20. $x = 3 + 3t, y = 17 - t, z = 27 - 2t$, $(18, 12, 17)$. 

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**Exercise-set 5. Solutions**