1. evidence of substituting into binomial expansion (M1)

e.g. $a^5 + \binom{5}{1}a^4b + \binom{5}{2}a^3b^2 + \ldots$

identifying correct term for x^4 (M1)

evidence of calculating the factors, in any order A1A1A1

e.g. $\binom{5}{2}$, $27x^6, \frac{4}{x^2}$; $10(3x^2)^3\left(\frac{-2}{x}\right)^2$

Note: *Award A1 for each correct factor.*

term = $1080x^4$ A1 N2

Note: *Award M1M1A1A1A1A0 for 1080 with working shown.*

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2. (a) 7 terms A1 N1

(b) A valid approach (M1)

Correct term **chosen** $\binom{6}{3}(x^3)^3(-3x)^3$ A1

Calculating $\binom{6}{3} = 20, (-3)^3 = -27$ (A1)(A1)

Term is $-540x^{12}$ A1 N3

[6]

3. The constant term will be the term independent of the variable *x*. (R1)

$\left(x - \frac{2}{x^2}\right)^9 = x^9 + 9x^8\left(\frac{-2}{x^2}\right) + \ldots + \binom{9}{3}x^6\left(\frac{-2}{x^2}\right)^3 + \ldots + \left(\frac{-2}{x^2}\right)^9$ (M1)

$\binom{9}{3}x^6\left(\frac{-2}{x^2}\right)^3 = 84x^6\left(\frac{-8}{x^6}\right)$ (A1)

$= -672$ (A1)

[4]

4. (a) correct equation in the form ***r*** = ***a*** + *t**b*** A2 N2 2

$$\boldsymbol{r} = \begin{pmatrix}1\\-1\\2\end{pmatrix} + t\begin{pmatrix}1\\3\\-2\end{pmatrix}$$

(b) (i) attempt to substitute $t = 2$ into the equation (M1)

e.g. $\begin{pmatrix} 2 \\ 6 \\ -4 \end{pmatrix}, \begin{pmatrix} 1 \\ -1 \\ 2 \end{pmatrix} + 2\begin{pmatrix} 1 \\ 3 \\ -2 \end{pmatrix}$

$\overrightarrow{OP} = \begin{pmatrix} 3 \\ 5 \\ -2 \end{pmatrix} 3$ A1 N2

(ii) correct substitution into formula for magnitude A1

e.g. $\sqrt{3^2 + 5^2 + (-2)^2}, \sqrt{3^2 + 5^2 + 2^2}$

$\left|\overrightarrow{OP}\right| = \sqrt{38}$ A1 N1 4

[6]

5. (a) $\overrightarrow{OB} = \begin{pmatrix} 10 \\ 5 \end{pmatrix}$ (A1) (C1)

$\overrightarrow{AC} = \begin{pmatrix} -3 \\ 6 \end{pmatrix}$ (A1) (C1)

(b) $\overrightarrow{OB} \cdot \overrightarrow{AC} = (10 \times (-3)) + (5 \times 6) = 0$ (M1)

Angle = 90° (A1) (C2)

[4]

6. Angle between lines = angle between direction vectors. (M1)

Direction vectors are $\begin{pmatrix} 4 \\ 3 \end{pmatrix}$ **and** $\begin{pmatrix} 1 \\ -1 \end{pmatrix}$. (A1)

$\begin{pmatrix} 4 \\ 3 \end{pmatrix} \cdot \begin{pmatrix} 1 \\ -1 \end{pmatrix} = \left|\begin{pmatrix} 4 \\ 3 \end{pmatrix}\right| \left|\begin{pmatrix} 1 \\ -1 \end{pmatrix}\right| \cos\theta$ (M1)

$4(1) + 3(-1) = \left(\sqrt{4^2 + 3^2}\right)\left(\sqrt{1^2 + (-1)^2}\right) \cos\theta$ (A1)

$\cos\theta = \dfrac{1}{5\sqrt{2}} = 0.1414$ (A1)

$\theta = 81.9°$ (3 sf), (1.43 radians) (A1) (C6)

Note: *If candidates find the angle between the vectors* $\begin{pmatrix} 4 \\ -1 \end{pmatrix}$ *and* $\begin{pmatrix} 2 \\ 4 \end{pmatrix}$*, award marks as below:*

Angle required is between $\begin{pmatrix} 4 \\ -1 \end{pmatrix}$ and $\begin{pmatrix} 2 \\ 4 \end{pmatrix}$ (M0)(A0)

$\begin{pmatrix} 4 \\ -1 \end{pmatrix} \cdot \begin{pmatrix} 2 \\ 4 \end{pmatrix} = \left|\begin{pmatrix} 4 \\ -1 \end{pmatrix}\right| \left|\begin{pmatrix} 2 \\ 4 \end{pmatrix}\right| \cos\theta$ (M1)

$4(2) + (-1)\,4 = \left(\sqrt{4^2 + (-1)^2}\right)\left(\sqrt{2^2 + 4^2}\right) \cos\theta$ (A1)

$\frac{4}{\sqrt{17}\sqrt{20}} = \cos\theta = 0.2169$ (A1)

$\theta = 77.5°$ (3sf), (1.35 radians) (A1) (C4)

[6]

7. (a) evidence of appropriate approach (M1)

e.g. $\overrightarrow{BC} = \overrightarrow{BA} + \overrightarrow{AC}$, $\begin{pmatrix} -2 \\ -3 \\ 2 \end{pmatrix} - \begin{pmatrix} 6 \\ -2 \\ 3 \end{pmatrix}$

$\overrightarrow{BC} = \begin{pmatrix} -8 \\ -1 \\ -1 \end{pmatrix}$ A1 N2

(b) attempt to find the length of $\overrightarrow{AB}$ (M1)

$\left|\overrightarrow{AB}\right| = \sqrt{6^2 + (-2)^2 + 3^2}$ $(= \sqrt{36+4+9} = \sqrt{49} = 7)$ (A1)

unit vector is $\frac{1}{7}\begin{pmatrix} 6 \\ -2 \\ 3 \end{pmatrix}$ $\left(= \begin{pmatrix} \frac{6}{7} \\ -\frac{2}{7} \\ \frac{3}{7} \end{pmatrix}\right)$ A1 N2

(c) recognizing that the dot product or cos θ being 0 implies perpendicular (M1)

correct substitution in a scalar product formula A1

e.g. (6) × (–2) + (–2) × (–3) + (3) × (2), $\cos\theta = \dfrac{-12+6+6}{7\times\sqrt{17}}$

correct calculation A1

e.g. $\overrightarrow{AB}\bullet\overrightarrow{AC} = 0$, $\cos\theta = 0$

therefore, they are perpendicular AG N0

[8]

8. evidence of appropriate approach (M1)

e.g. $\begin{pmatrix}2\\3\\-1\end{pmatrix}+s\begin{pmatrix}5\\-3\\2\end{pmatrix}=\begin{pmatrix}9\\2\\2\end{pmatrix}+t\begin{pmatrix}-3\\5\\-1\end{pmatrix}$

two correct equations A1A1

e.g. $2 + 5s = 9 - 3t$, $3 - 3s = 2 + 5t$, $-1 + 2s = 2 - t$

attempting to solve the equations (M1)

one correct parameter $s = 2$, $t = -1$ A1

P is (12, –3, 3) $\left(\text{accept}\begin{pmatrix}12\\-3\\3\end{pmatrix}\right)$ A1 N3

[6]

9. (a) $\begin{pmatrix}2x\\x-3\end{pmatrix}\bullet\begin{pmatrix}x+1\\5\end{pmatrix} = 0$ (M1)(M1)

$\Rightarrow 2x(x + 1) + (x - 3)(5) = 0$ (A1)

$\Rightarrow 2x^2 + 7x - 15 = 0$ (C3)

(b) **METHOD 1**

$2x^2 + 7x - 15 = (2x - 3)(x + 5) = 0$

$\Rightarrow x = \frac{3}{2}$ or $x = -5$ (A1) (C1)

METHOD 2

$$x = \frac{-7 \pm \sqrt{7^2 - 4(2)(-15)}}{2(2)}$$

$\Rightarrow x = \frac{3}{2}$ or $x = -5$ (A1) (C1)

[4]