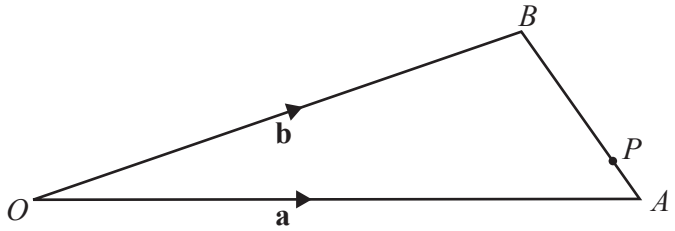
3 (a)



The diagram shows a triangle OAB. The point P lies on AB. The ratio $AP:PB$ is $1:3$.
Given that $\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OB} = \mathbf{b}$, find an expression for $\overrightarrow{OP}$ in terms of $\mathbf{a}$ and $\mathbf{b}$. Simplify your answer. [2]

(b) Vector $\mathbf{q}$ has magnitude $12\sqrt{5}$ and direction $\begin{pmatrix} 6 \\ -3 \end{pmatrix}$.

Vector $\mathbf{r}$ has magnitude $15\sqrt{2}$ and direction $\begin{pmatrix} -5 \\ 5 \end{pmatrix}$.

Find the unit vector in the direction of $\mathbf{q} + \mathbf{r}$. [6]

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4 **(a)** **(i)** Given that $y = 3\sin^2 x + \cos x$, show that $y + \cot x \frac{\mathrm{d}y}{\mathrm{d}x} = k(1 + \cos^2 x)$, where k is an integer. [4]

(ii) Using your value of k, solve the equation $k(1 + \cos^2 x) = 4$ for $-\pi \leqslant x \leqslant \pi$. [4]