**7.** The ellipse $E$ has equation

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1 \qquad a > b > 0$$

The point $P(a\cos\theta, b\sin\theta)$ lies on $E$ where $0 < \theta < \frac{\pi}{2}$

(a) Use calculus to show that an equation of the normal to $E$ at $P$ is

$$by = ax\tan\theta + \left(b^2 - a^2\right)\sin\theta$$

**(4)**

The normal to $E$ at $P$ meets $E$ again on the $y$-axis at the point $B$.

Given that $O$ is the origin and that the area of triangle $OBP$ is $\frac{3b^2}{4}$

(b) show that $\sin\theta = \frac{1}{2}$

**(5)**

(c) determine, in terms of $a$ only, the exact coordinates of the point $P$.

**(3)**

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**(Total for Question 7 is 12 marks)**

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