The diagram below shows a circle, centre O, with a radius 12 cm. The chord AB subtends at an angle of 75° at the centre. The tangents to the circle at A and at B meet at P.

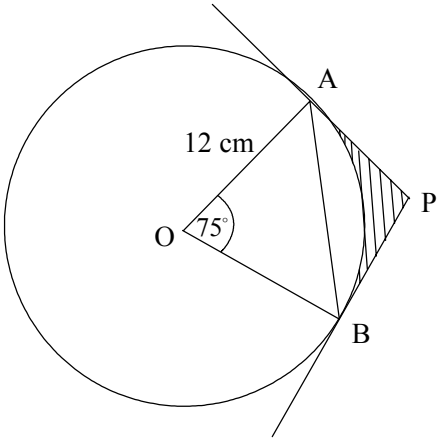

diagram not to scale

(a) Using the cosine rule, show that the length of AB is $12\sqrt{2(1-\cos 75^\circ)}$.

(b) Find the length of BP.

(c) Hence find

(i) the area of triangle OBP;

(ii) the area of triangle ABP.

(d) Find the area of **sector** OAB.

(e) Find the area of the shaded region.