Here are some double angle formulas for you. Enjoy.

$\sin(2\theta) = 2\sin\theta\cos\theta$ • $\cos(2\theta) = \cos^2\theta - \sin^2\theta$ • $\sin^2\theta = \frac{1}{2}\big(1 - \cos(2\theta)\big)$ • $\cos^2\theta = \frac{1}{2}\big(1 + \cos(2\theta)\big)$

1. (a) (4 pts) Write down the formula for the arc length of a parametric curve

$$\{x = f(t), y = g(t)\}$$

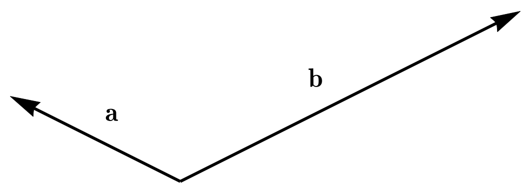
for t ranging from a to b.

(b) (6 pts) Explain conceptually the derivation of the formula from part (a).

2. (10 pts) Set up, but DO NOT EVALUATE an expression involving integrals that calculates the area inside the polar curve $r = \sin^2\theta$ and outside the polar curve $r = \sin(2\theta)$.

Justify your answer.

3. (15 pts) Copy the following diagram into your blue book **twice**.



(a) On the first copy of the diagram, **DRAW** and **LABEL** the vectors $\mathbf{a} + \mathbf{b}$ and $\mathbf{a} - \mathbf{b}$.

(b) On the second copy of the diagram, **DRAW** and **LABEL** the vector $\mathbf{proj_b a}$.
Explain in a sentence why you gave the answer you gave.

(c) Is the dot product of these two vectors, $\mathbf{a} \cdot \mathbf{b}$, positive, negative, or zero?
Using two or more sentences, explain your reasoning.

4. (10 pts) Here are two lines which intersect:

$$\ell_1 : \langle -4 + 5t, -3 + 2t, 2 + t\rangle \qquad \text{and} \qquad \ell_2 : \langle 3 + 4t, 1 + 4t, 4 + 2t\rangle$$

Find the equation of the plane that contains both lines. Explain your reasoning.