12. (From Fall 2010, Exam 1) The Parallelogram Law states that, for any vectors $\mathbf{u}$ and $\mathbf{v}$,

$$|\mathbf{u} + \mathbf{v}|^2 + |\mathbf{u} - \mathbf{v}|^2 = 2|\mathbf{u}|^2 + 2|\mathbf{v}|^2.$$ 

(a) Give a geometrical interpretation of the Parallelogram Law.

(b) Prove the Parallelogram Law using vector algebra. [Hint: Use $|\mathbf{u} + \mathbf{v}|^2 = (\mathbf{u} + \mathbf{v}) \cdot (\mathbf{u} + \mathbf{v})$ together with the distributive law for the dot product.]

13. Set up but do not evaluate an integral to calculate the length of the parametrized curve

$$\mathbf{r}(t) = (t^2, e^{3t}, \cos(4t)), \quad 0 \leq t \leq \pi.$$ 

That is, find numbers $a$ and $b$ and a function $F$ so that the length of the curve is given by $\int_a^b F(t) \, dt$. 