*Try to answer the following questions without the use of book, notes or calculator. Time yourself and try to finish the questions in less than 50 minutes.*

**1.** (a) Use linearization to give an estimate for $\sqrt[3]{1017}$.

(b) Is the estimate given in part (a) too large or too small? Explain.

**2.** What is the area of the largest rectangle that you can make where the bottom edge is on the $x$-axis and the top two vertices lie on the parabola $y = 12 - x^2$?

**3.** A new toy is sweeping the nation, *The Silly Putty Ellipse.* It looks like any old ellipse but you can change the shape and it will always stay an ellipse with the same area (it comes straight out of the box as a circle with a radius of 6 inches)!

Let $a$ and $b$ be the length of the two axis of the ellipse. As you are playing with the ellipse you notice at one point when $a = 3$ inches that you are increasing the length of $a$ by a rate of $\frac{1}{8}$ of an inch per second. At that moment how fast is $b$ changing (include units)?

(Hint: the area of an ellipse with the two axis with length $a$ and $b$ is $\pi ab$.)

**4.** Consider the following function which is continuous and differentiable for all $x$ (you do not need to prove this!):

$$f(x) = \begin{cases} x^3 + 2x^2 - 4x + 2 & \text{if } x \leq 1; \\ 3x - 2 & \text{if } x > 1. \end{cases}$$

For the interval $-4 \leq x \leq 2$ find all values of $c$ that satisfies the Mean Value Theorem. (Hint: $f(-4) = -14$.)

**5.** The function $f(x) = \cos(x^3 - 2x)$ has a critical point at $x = 0$. Use the second derivative test to determine if it is a maximum or a minimum.