You **may NOT** use a calculator in this section

1. a. Evaluate $\dfrac{d}{dx}\displaystyle\int_{\pi}^{x} \frac{\cos^{27}(t)}{\arctan(t-7)}\,dt$

b. Evaluate $\dfrac{d}{dx}\displaystyle\int_{x^3}^{\pi} \frac{\cos^{27}(t)}{\arctan(t-7)}\,dt$

2. Evaluate $\int (x^4 - 1 + \frac{1}{\sqrt[7]{x}} + 3e^{-x})dx$

3. Evaluate and give an exact answer $\int_0^{\pi/6} (\sec^2(\theta) + \sin(\theta))d\theta$

4. Evaluate $\displaystyle\int (x^2 - 1)e^{x^3-3x+2}dx$

5. Evaluate and give an exact answer $\displaystyle\int_1^{e^2} \frac{(\ln(x))^2}{x}dx$

6. Evaluate and give an exact answer $\lim_{x \to 0} \dfrac{1 - 5^x}{\tan(3x)}$

7. Find the linearization of $f(x) = \ln(x^2 + 3x + 1)$ at $x = 0$. Use it to find an approximation for $f(0.002)$.

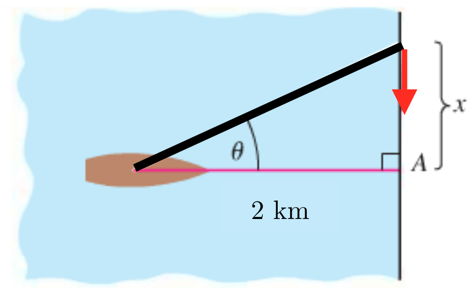
8. Which function grows faster as $x \to \infty$, $\ln(x)$ or $\sqrt[10]{x}$? Justify your answer using a limit argument.

You **MAY** use a calculator in this section.

9. A boat 2 km offshore is sweeping the beach with a searchlight.

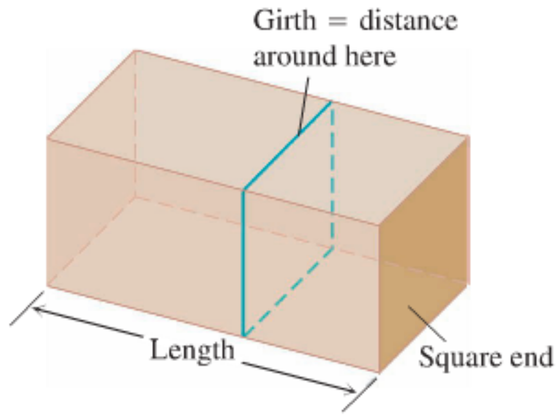
   The light turns at a rate $\frac{d\theta}{dt}$ = –2.4 rad/s.

   How fast is the light moving along the shore when it reaches point A? Make sure to include correct units with your answer.



10. The Post Office will accept a box only if the sum of its length and girth (distance around the box) does not exceed 228 in. What *dimensions* will give a box with a square end the largest possible volume?

Use Calculus to both find the maximal dimensions, and to justify they give the maximum (rather than a minimum).



$$\boxed{\text{Girth } + \text{Length } = 228}$$

If you can't set up the problem, assume the setup leads to the function for the volume

$$V(x) = -x^3 - 15x^2 + 3600x$$

(where x is the height of the box). Even though **this is not the correct formula**, you will still get **partial credit** for finding the height of the optimal box.

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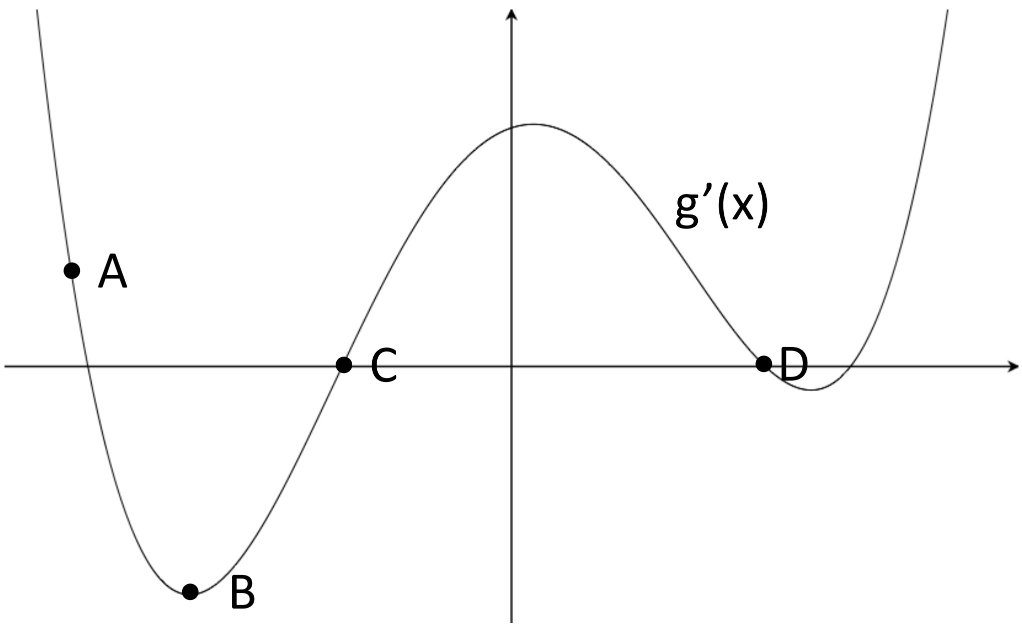
11. A metal beam is 25 feet long, and the temperature at a point x feet along the beam is given by the function

$$T(x) = \frac{1500}{1 + x^2}$$

What is the average temperature of the beam?

12. **Use Calculus** to find the area bounded by the curves $y = x^2 - 4x$ and $y = 30 - x^2$.

13. The graph below is the graph of the **derivative** of a function g(x). It is **not** the graph of g(x).

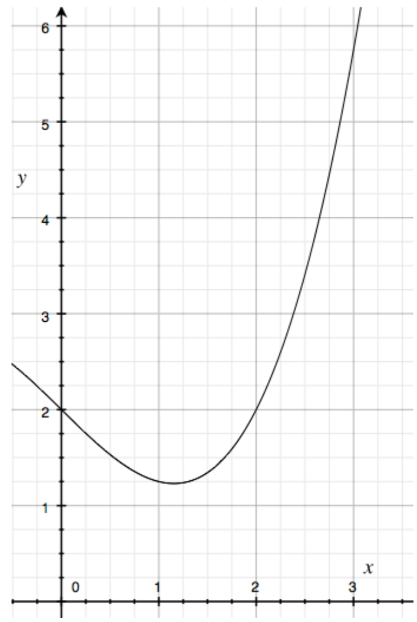


For each of the points above, circle all the statements that **apply** at each of the points A, B, C, and D.

	Concerning g''(x)			**Concerning g(x)**		
Point A	g'' > 0	g'' = 0	g'' < 0	local min	local max	inflection pt
Point B	g'' > 0	g'' = 0	g'' < 0	local min	local max	inflection pt
Point C	g'' > 0	g'' = 0	g'' < 0	local min	local max	inflection pt
Point D	g'' > 0	g'' = 0	g'' < 0	local min	local max	inflection pt

14. The function shown is $f(x) = \dfrac{x^3}{4} - x + 2$.

a. Approximate the area under the curve between x=1 and x=3 by finding the Riemann sum that uses 4 equal rectangles. Use the **left endpoint**.



b. f(x) actually represents the velocity in m/s of a particle moving inside a wind tunnel. Which of the following is true of the Riemann sum you obtained in part a? (Check all that are true.)

- ☐ The Riemann sum gives an approximation of the **speed** of the particle.
- ☐ The Riemann sum give an approximation of the **acceleration** of the particle.
- ☐ The Riemann sum give an approximation of the **distance** travelled by the particle.

15. Find the solution of the differential equation $\frac{dy}{dx} = \frac{x-5}{y^2}$ for which y=1 when x=2. (Your solution should look like y=f(x)).