

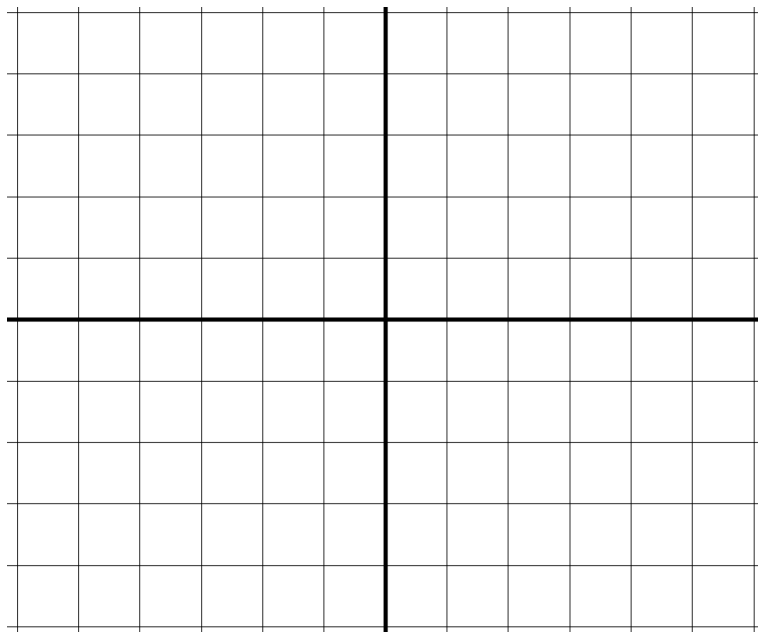
1. For $P(x) = 2x^4 + 12x^3 + 18x^2$ answer the following. (12 pts)

(a) Indicate on a graph or use arrow notation to indicate the end behavior of $P(x)$.

(b) Find the y -intercept of $P(x)$.

(c) Find all zeros of $P(x)$ **and** identify the multiplicity of each zero.

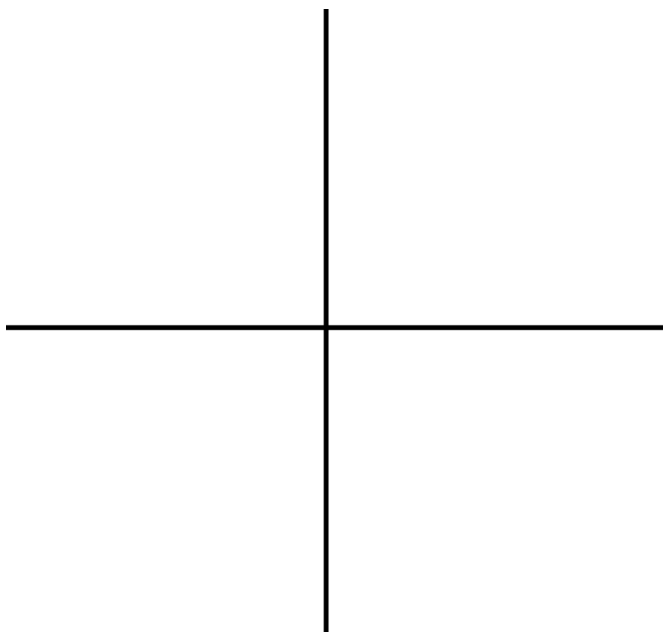
(d) Sketch the shape of the graph of $P(x)$ using parts (a) - (c).



2. Find the quotient and remainder using long division: $\frac{-3x^4 + 6x^3 + 4x^2 - 2}{x^3 - 4x^2 - x}$. (5 pts)

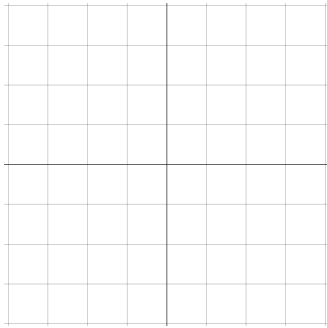
3. Sketch the shape of the graph of a rational function, $g(x)$, that satisfies **all** of the information. **Label** all intercepts on the graph. (5 pts)

- i. The graph has y -intercept $\left(0, -\frac{1}{2}\right)$.
- ii. The graph has vertical asymptotes $x = -2$ and $x = 3$.
- iii. The graph has a slant asymptote of $y = x + 2$
- iv. The graph crosses at $(-3, 0)$ and bounces (touches but does not cross) at $(1, 0)$.
- v. The graph has no other x -intercepts.

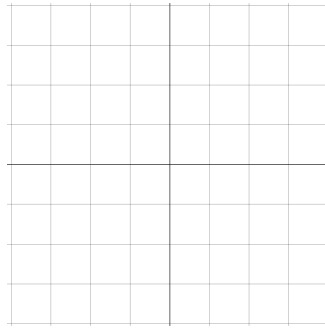


4. Sketch the following graphs: **Be sure to label** any asymptotes and intercepts for each graph.

(a) $h(x) = 2^x - 1$ (3 pts)



(b) $f(x) = \log(x)$ (3 pts)



(c) Fill in the blanks for $h(x)$ from part (a): $h(x) \rightarrow ______$ as $x \rightarrow -\infty$ and $h(x) \rightarrow ______$ as $x \rightarrow \infty$. (2 pts)

5. Simplify: $5(3^x)^4 - 3^x(3^{3x} - 3^{-x})$ (4 pts)

6. (a) Simplify (rewrite without logs): $-\log_4(64) + \log(10^{\sqrt{2}}) + \log_6\left(\frac{1}{\sqrt{6}}\right) - e^{\ln(3)}$. (5 pts)

(b) Rewrite as a single logarithm without negative exponents: (5 pts)

$$3 \ln(y^2) - 4 \ln(y) - \frac{2}{3} \ln(y)$$

7. Solve the following equations for x . If there are no solutions write “no solutions” (be sure to justify answer for full credit). Recall you are not allowed a calculator, do not attempt to give a decimal answer. (16 pts)

(a) $3^{5x-1} = 9$

(b) $7 = 2^{3+2x}$

(c) $\log(2x) = \log(3x^2 - 9) - \log(3)$

(d) $5 = 2 \log_2 \left(x - \frac{1}{2} \right)$

8. The raccoon population in a certain Colorado town was 100 in 2022. The population is expected to double every 5 years. Use this information to answer the following.

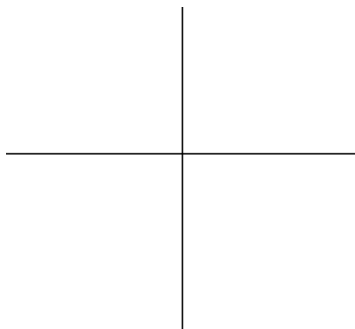
(a) Find an exponential model $n(t) = n_0 2^{t/a}$ for the number of raccoons after t years. (3 pts)

(b) What is the expected population size in 2032? Give the exact answer. Recall you are not allowed a calculator, do not attempt to give a decimal answer. (3 pts)

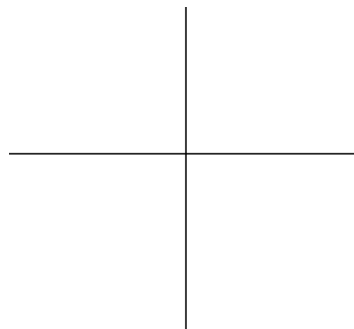
(c) How many years until the population triples? Give the exact answer. Recall you are not allowed a calculator, do not attempt to give a decimal answer. (4 pts)

9. Graph the terminal point determined by each real number on the unit circle.

(a) $t = \frac{7\pi}{4}$ (2 pts)



(b) $t = -\frac{2\pi}{3}$ (2 pts)



10. For the real number t , suppose we know $\sin(t) > 0$ and $\cos(t) < 0$. What quadrant does the terminal point determined by t lie in? (3 pts)

11. If we know $\sin(t) = -\frac{2}{5}$ what is $\csc(t)$? (3 pts)

12. If we know the terminal point on the unit circle, $\left(\frac{\sqrt{3}}{8}, y\right)$, is determined by t and we know $\tan(t) > 0$, find y . (5 pts)

13. Find the exact value of each of the following. If a value does not exist write DNE. (15 pts)

(a) $\sin(\pi)$

(b) $\cos\left(\frac{4\pi}{3}\right)$

(c) $\tan\left(-\frac{5\pi}{6}\right)$

(d) $\sec(0)$

(e) $\cos\left(\frac{7\pi}{4}\right)$