MATH 130
Exam 2 Study Guide

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Contents

Chapter 1

Exam 2 Information

1.1 Exam 2 content

Exam 2 covers Chapter 2 in the 2024 version of my MATH 130 lecture notes.

1.2 Tasks for Exam 2

NOTE: This guide is not meant to be an exact representation of exam material. I always reserve the right to ask some questions that use the course material in a creative way.

1. Answer questions involving course vocabulary.
2. Classify statements as true or false.
3. Translate between any of these presentations of a function:
   - the rule of the function;
   - an arrow diagram describing the function;
   - a description of the function in words.
4. Given any of the presentations of the function described in item # 1 above, complete a table of values for the function.
5. Given any of these presentations of a function (or functions):

- the rule of the function;
- an arrow diagram describing the function;
- a description of the function in words;
- a table of values for the function; or
- the graph of the function;

compute/estimate expressions involving those functions (things like $f(7)$, $(f^2 \circ g^{-1})(2)$, $7-(3f-h^2)(-4+3)$, etc.).

6. Compute rules for complicated functions (like $f+g$, $3fg$, $f^2 \circ g$, etc.) made up of functions whose rule is given.

7. Apply a function to both sides of an equation.

8. Perform substitutions into functional expressions.

9. Determine whether or not a function is one-to-one (in relatively easy cases).

10. Determine whether a function is even, odd or neither (in relatively easy cases).

11. Diagram and reverse-diagram functions.

12. Graph a piecewise-defined function, given graphs of the pieces that make up the function.

13. Given the graph of a function, compute/estimate the following:
    - domain and/or range;
    - function values;
    - increasing/decreasing behavior;
    - maximum/minimum values;
    - x- and/or y-intercepts;
    - net, average rate and instantaneous rate of change;
    - symmetry in the function (even/odd/neither);
    - whether or not the function is one-to-one;
    - solutions to equations/inequalities involving intersection points of graphs.

14. Determine whether the graph of a multifunction is the graph of a function.

15. Answer questions involving functions and/or graphs in an applied context.

In the context of doing these things, do not forget these concepts we discussed in Chapter 1, which are likely to be assessed again on this exam:

1. Order of operations

2. Trig functions of special angles

3. Exponent and radical rules

Chapter 2

Old MATH 130 Exam 2s

2.1 Spring 2024 Exam 2

1. (2.2) Complete the following table of values for the function $\beta(x) = 8\cos 2x$:

x	$-\frac{\pi}{6}$	0	$\frac{\pi}{12}$	$\frac{\pi}{4}$	$\frac{\pi}{2}$	π
$\beta(x)$						

2. (2.8, 2.9) In this problem, let

$$Q(x) = 2\sqrt{x} \qquad R(x) = 2x^4 \qquad S(x) = 36 + x^2$$

Compute and simplify the rule for each of these functions:

a) $R - S$

b) QR

c) $R \circ Q$

d) $Q \circ S$

3. (2.2, 2.7) Let itch $x = 2x^2 - x$. Compute and simplify each expression:

a) itch 5

b) itch $\diamondsuit$

c) itch $\left(-\frac{1}{2}\right)$

d) itch $\{4, 5\}$

e) itch$^3(-1)$

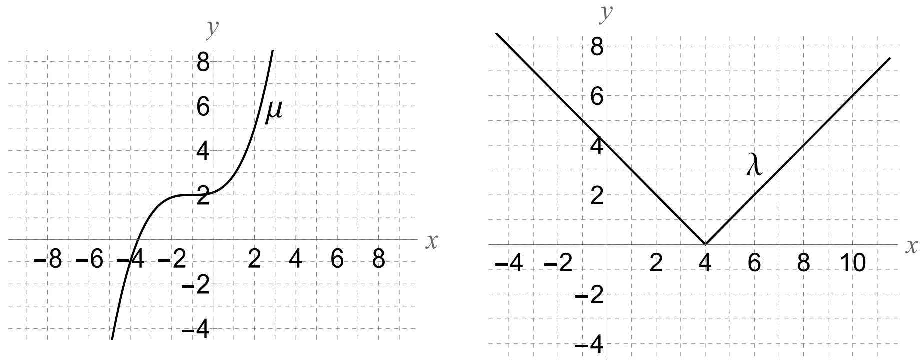
f) 2 itch $3 + 1$

g) itch $3x$

h) itch $(x + 3)-$ itch x

i) itch itch 2

4. Suppose μ and λ are the functions whose graphs are given below:



Now let A be the function

$$A(x) = \begin{cases} \mu(x) & x < 2 \\ -3 & x = 2 \\ \lambda(x) & x > 2 \end{cases}$$

a) (2.10) Sketch a graph of A.

b) (2.4) Compute $A(2)$.

c) (2.11) Estimate $A^{-1}(4)$.

d) (2.10) Is A a one-to-one function?

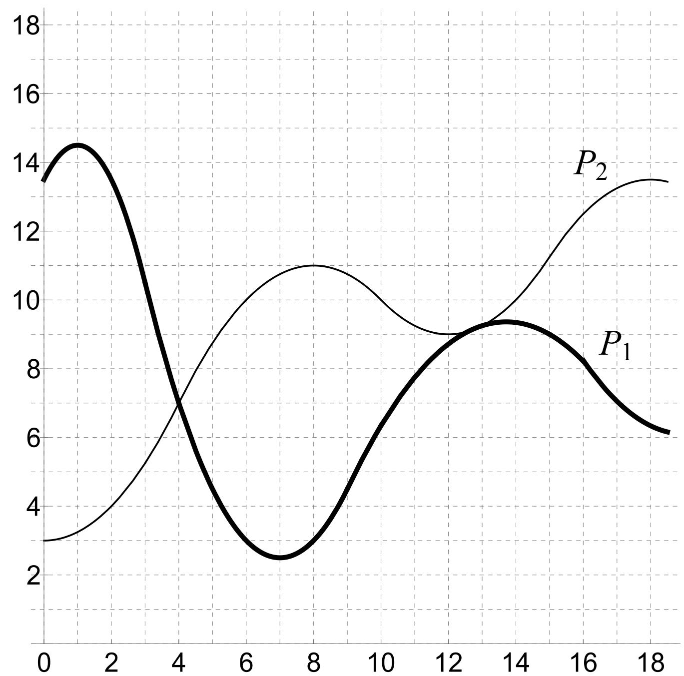
5. (2.8, 2.9) Diagram each function:

a) $k_1(x) = \cos 4x + \dfrac{5}{x+1}$

b) $k_2(x) = \tan^3 2x^2$

c) $k_3(x) = |13 - x|$

6. Suppose that $P_1(t)$ and $P_2(t)$ are the pressures (measured in kiloPascals, which is abbreviated kPa) inside two gas tanks at time t (measured in minutes after 1:00 PM), where P_1 and P_2 are graphed below (P_1 is the thick curve; P_2 is the thin curve):



a) (2.11) What is the pressure in tank 1 at 1:10 PM?

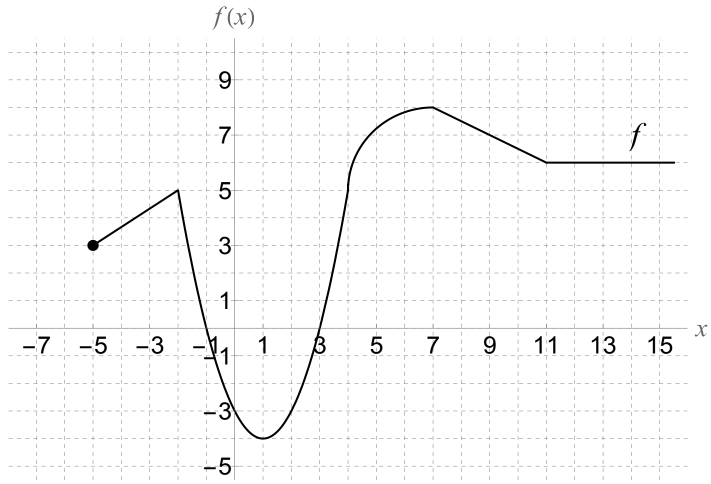
b) (2.11) What is the first time after 1:00 PM where the pressure in tank 1 is equal to 3 kPa?

c) (2.12) At what time(s), if any, are the pressures in the two tanks equal?

d) (2.13) What is the net change in the pressure in tank 2 from 1:02 PM to 1:10 PM?

e) (2.13) What is the average rate of change in tank 1 from 1:06 PM to 1:15 PM?

7. Use the graph of f provided below to answer these questions:



a) (2.11) What is the domain of f?

b) (2.11) What is the minimum value of f?

c) (2.11) What is the maximum value of f, for negative x?

d) (2.11) What is/are the y-intercept(s) of f?

e) (2.12) How many solutions does the equation $f(x) = 4$ have?

f) (2.13) Estimate the instantaneous rate of change of f when $x = 5$.

8. (2.11) Use the graph of function f given in Question 7, together with the information about functions g, h and k provided below, to compute/estimate each quantity.

x	-4	-3	-1	0	1	2	3	4
$g(x)$	1	$\frac{3}{4}$	0	$\frac{1}{2}$	$-\frac{3}{5}$	3	3	2
$h(x)$	3	-2	$-\frac{1}{2}$	3	0	-1	$\frac{1}{2}$	$\frac{1}{4}$

$$k(x) = |x - 5|$$

a) $f(-2)$

b) $5g(1) + 2$

c) $f \circ g(-1)$

d) $h^{-1}(3)$

e) $f(3g(2))$

f) $hk^2(3)$

g) $(h \circ f + 3k)(2)$

h) $\left(\frac{g}{f}\right)(4)$

i) $f \circ f \circ g \circ k(8)$

Solutions

1. Plug in each value of x and evaluate the function:

$$\beta\left(-\frac{\pi}{6}\right) = 8\cos -\frac{2\pi}{6} = 8\cos -\frac{\pi}{3} = 8\left(\frac{1}{2}\right) = 4;$$
$$\beta(0) = 8\cos 2(0) = 8\cos 0 = 8(1) = 8;$$
$$\beta\left(\frac{\pi}{12}\right) = 8\cos\frac{2\pi}{12} = 8\cos\frac{\pi}{6} = 8\left(\frac{\sqrt{3}}{2}\right) = 4\sqrt{3};$$
$$\beta\left(\frac{\pi}{4}\right) = 8\cos\frac{2\pi}{4} = 8\cos\frac{\pi}{2} = 8(0) = 0;$$
$$\beta\left(\frac{\pi}{2}\right) = 8\cos\frac{2\pi}{2} = 8\cos\pi = 8(-1) = -8;$$
$$\beta(\pi) = 8\cos 2\pi = 8(1) = 8.$$

This makes the table

x	$-\frac{\pi}{6}$	0	$\frac{\pi}{12}$	$\frac{\pi}{4}$	$\frac{\pi}{2}$	π
$\beta(x)$	4	8	$4\sqrt{3}$	0	-8	8

.

2. a) $(R-S)(x) = R(x) - S(x) = 2x^4 - (36 + x^2) = \boxed{2x^4 - x^2 - 36}$.

   b) $(QR)(x) = Q(x)R(x) = 2\sqrt{x}(2x^4) = 2x^{1/2}2x^4 = \boxed{4x^{9/2}}$.

   c) $R \circ Q(x) = R(Q(x)) = R(2\sqrt{x}) = 2(2\sqrt{x})^4 = 2(2^4(x^{1/2})^4) = 2(16x^2) = \boxed{32x^2}$.

   d) $Q \circ S(x) = Q(S(x)) = Q(36 + x^2) = \boxed{2\sqrt{36 + x^2}}$. This does not simplify further.

3. a) itch $5 = 2(5^2) - 5 = 2(25) - 5 = \boxed{45}$.

   b) itch $\diamondsuit = \boxed{2\diamondsuit^2 - \diamondsuit}$.

   c) itch $\left(-\frac{1}{2}\right) = 2\left(-\frac{1}{2}\right)^2 - \left(-\frac{1}{2}\right) = 2\left(\frac{1}{4}\right) + \frac{1}{2} = \frac{1}{2} + \frac{1}{2} = \boxed{1}$.

   d) itch $\{4, 5\} = \{2(4^2) - 4, 2(5^2) - 5\} = \boxed{\{28, 45\}}$.

   e) itch$^3(-1) = (\text{itch} - 1)^3 = (2(-1)^2 - (-1))^3 = (2 + 1)^3 = 3^3 = \boxed{27}$.

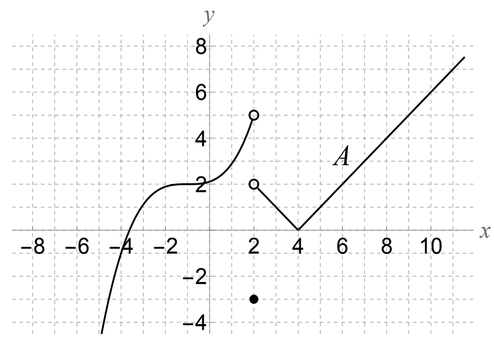
   f) 2 itch $3 + 1 = 2[2(3^2) - 3] + 1 = 2[15] + 1 = \boxed{31}$.

   g) itch $3x = 2(3x)^2 - (3x) = 2(9x^2) - 3x = \boxed{18x^2 - 3x}$.

h) itch $(x+3)-$ itch $x = [2(x+3)^2 - (x+3)] - [2x^2 - x] = [2(x^2+6x+9) - x - 3] - 2x^2 + x = 2x^2 + 12x + 18 - x - 3 - 2x^2 + x = \boxed{12x+15}$.

i) itch itch $2 =$ itch$(2(2^2) - 2) =$itch $6 = 2(6^2) - 6 = 2(36) - 6 = \boxed{66}$.

4. a) Use the part of μ to the left of $x = 2$ and the part of λ to the right of $x = 2$, together with the point $(2, -3)$ to get this graph:

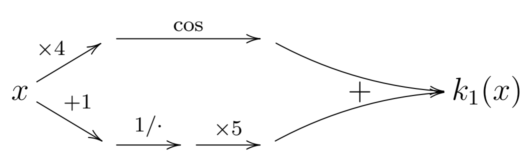


b) $A(2) = \boxed{-3}$.

c) $A^{-1}(4) = \boxed{\{1.5, 8\}}$.

d) A is $\boxed{\text{not}}$ one-to-one since at least one horizontal line (for instance, $y = 1$) hits A in more than one point.

5. a)



b) $x \xrightarrow{\wedge 2} \xrightarrow{\times 2} \xrightarrow{\tan} \xrightarrow{\wedge 3} k_2(x)$

c) $x \xrightarrow{\times -1} \xrightarrow{+13} \xrightarrow{|\cdot|} k_3(x)$

6. a) $P_1(10) \approx \boxed{6.5 \text{ kPa}}$.

b) $P_1(t) = 3$ for the first time when $t = 6$, i.e. $\boxed{\text{1:06 PM}}$.

c) $P_1(t) = P_2(t)$ when the graphs intersect at $t = 4$ and $t = 13$, i.e. the times $\boxed{\text{1:04 PM and 1:13 PM}}$.

d) This is $P_2(10) - P_2(2) = 10 - 4 = \boxed{6 \text{ kPa}}$.

e) This is $\dfrac{P_1(15) - P_1(6)}{15 - 6} = \dfrac{9-3}{9} = \dfrac{6}{9} = \boxed{\dfrac{2}{3} \text{ kPa/min}}$.

7. a) $\boxed{[-5, \infty)}$ (the set of x-values covered by the graph).

b) $\boxed{-4}$ (lowest y-value on graph).

c) $\boxed{5}$ (highest y-value on graph to the left of $x = 0$).

d) $\boxed{(0, -3)}$ (place where graph crosses y-axis).

e) $\boxed{3}$ (number of intersection points of graph with horizontal line at height 4).

f) $\approx \boxed{1}$ (slope of line tangent to f when $x = 5$).

8. a) $f(-2) = \boxed{5}$.

b) $5g(1) + 2 = 5\left(-\dfrac{3}{5}\right) + 2 = -3 + 2 = \boxed{-1}$.

c) $f \circ g(-1) = f(g(-1)) = f(0) = \boxed{-3}$.

d) $h^{-1}(3) = \boxed{\{-4, 0\}}$.

e) $f(3g(2)) = f(3 \cdot 3) = f(9) = \boxed{7}$.

f) $hk^2(3) = h(3)[k(3)]^2 = \dfrac{1}{2}\left(|3 - 5|\right)^2 = \dfrac{1}{2}(2^2) = \dfrac{1}{2}(4) = \boxed{2}$.

g) $(h \circ f + 3k)(2) = h(f(2)) + 3k(2) = h(-3) + 3|2 - 5| = -2 + 3|-3| = -2 + 3(3) = \boxed{7}$.

h) $\left(\dfrac{g}{f}\right)(4) = \dfrac{g(4)}{f(4)} = \boxed{\dfrac{2}{5}}$.

i) $f \circ f \circ g \circ k(8) = f(f(g(k(8)))) = f(f(g(|8-5|))) = f(f(g(3))) = f(f(3)) = f(0) = \boxed{-3}$.

2.2 Relevant exam questions from Spring 2018

1. Throughout this problem, assume $f(x) = 2x^2 - x$ and $g(x) = \frac{x+3}{2}$. Compute and simplify each of the following expressions:

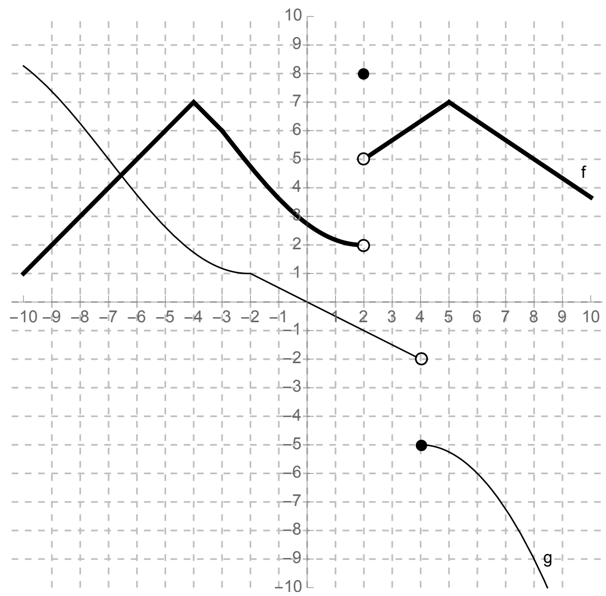
   a) $(f \circ g)(x)$

   b) $4f(2x)$

   c) $(f - g)(3)$

   d) $g^{-1}(x)$

2. Throughout this problem, suppose f and g are functions whose graphs are given below (f is the thick curve, g is the thin curve):



Suppose also that h is a one-to-one function with the following table of values:

x	-3	-2	-1	0	1	2	3	4
$h(x)$	5	-3	0	4	-2	1	7	2

Use this information to answer the following questions:

   a) What is $f(-3)$?

   b) What is $f(2)$?

   c) What is $g^{-1}(-1)$?

   d) For what value(s) of x, if any, does $g(x) = -3$?

   e) For what value(s) of x, if any, does $f(x) = g(x)$?

   f) What is the average change in h from $x = 1$ to $x = 4$?

   g) What is the instantaneous rate of change in g at $x = 6$?

h) Find $(f \circ g)(6)$.
i) Find $(fh)(3-6)$.
j) Find $(h^{-1} \circ g \circ h)(1)$.

Solutions

1. a) $(f \circ g)(x) = f(g(x)) = f\left(\frac{x+3}{2}\right) = 2\left(\frac{x+3}{2}\right)^2 - \left(\frac{x+3}{2}\right) = 2\left(\frac{x^2+6x+9}{4}\right) - \frac{x+3}{2} = \frac{x^2+6x+9}{2} - \frac{x+3}{2} = \boxed{\frac{x^2+5x+6}{2}}$.

   b) $4f(2x) = 4\left[2(2x)^2 - (2x)\right] = 4\left[2(4x^2) - 2x\right] = 4[8x^2 - 2x] = \boxed{32x^2 - 8x}$.

   c) $(f-g)(3) = f(3) - g(3) = [2(3^2) - 3] - \frac{3+3}{2} = 15 - 3 = \boxed{12}$.

   d) Let $y = g(x)$ so $y = \frac{x+3}{2}$. Solve for x to get $x = 2y - 3$, so $g^{-1}(x) = \boxed{2x-3}$.

2. a) $f(-3) = \boxed{6}$.

   b) $f(2) = \boxed{8}$.

   c) $g^{-1}(-1) = \boxed{2}$.

   d) $g(x) = -3$ for no x, so x $\boxed{\text{DNE}}$.

   e) $f(x) = g(x)$ when $\boxed{x \approx -6.5}$.

   f) $\frac{h(4) - h(1)}{4-1} = \frac{2-(-2)}{3} = \boxed{\frac{4}{3}}$.

   g) The slope of the tangent line is about $\boxed{\frac{-2}{3}}$.

   h) $(f \circ g)(6) = f(g(6)) = f(-6) = \boxed{5}$.

   i) $(fh)(3-6) = (fh)(-3) = f(-3)h(-3) = 6(5) = \boxed{30}$.

   j) $(h^{-1} \circ g \circ h)(1) = h^{-1}(g(h(1)) = h^{-1}(g(-2)) = h^{-1}(1) = \boxed{2}$.

Chapter 3

Additional Practice Exam 2s

3.1 Practice Exam A

A1. Complete this table of values for the function $q(x) = 4x^{-2} + 1$, simplifying answers where appropriate.

x	-4	-1	0	1	2	5
$q(x)$						

A2. Write a rule for the function H that works like this: if the input is less than 0, then the output is twice the input squared; if the input is 0, then the output is 4; if the input is greater than 0, then the output is the cube root of one more than the input.

A3. Let h be the function $h(x) = 2x^2$ and let g be the multifunction $g(x) = x \pm 3$. Compute and simplify each quantity:

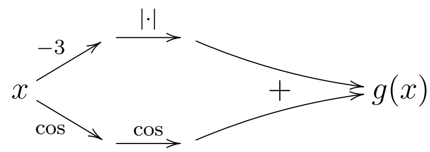
a) $g(2)$ b) $h(\{-3, 1, 4\})$ c) $(g \circ h)(1)$ d) $(h \circ g)(1)$

A4. Suppose throughout this problem that $F(x) = \dfrac{1}{4}\sqrt{x}$ and $G(x) = 8x^2$. Compute and simplify the rule for each indicated function:

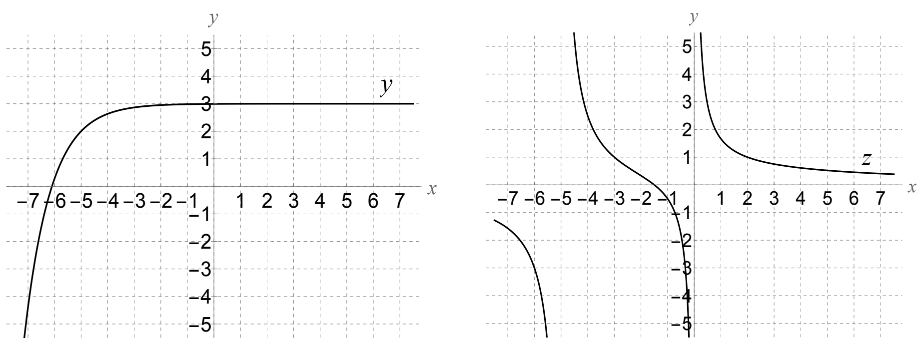
a) $\dfrac{F}{G}$ b) $8F + G$ c) $G \circ F$ d) F^{-1}

A5. Reverse-diagram each arrow picture, simplifying the rule for the function obtained:

a) $x \xrightarrow{\times -2} \xrightarrow{+3} \xrightarrow{\wedge 5} \xrightarrow{\cos} \xrightarrow{\wedge 8} f(x)$

b) 

A6. Suppose y and z are functions whose graphs are given below:



Sketch the graph of the function

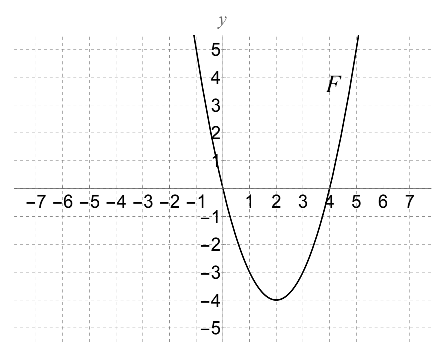
$$f(x) = \begin{cases} y(x) & x < 2 \\ z(x) & x \geq 2 \end{cases}.$$

A7. Classify each function as even, odd, both (even and odd), or neither:

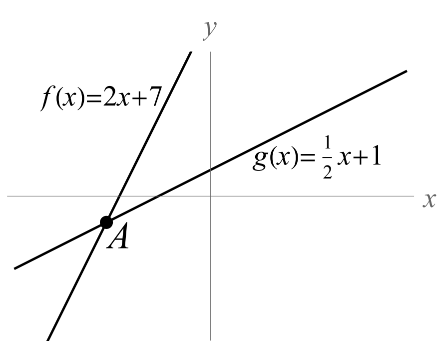
(a) $H(x) = 3x^2$

(b) $n(x) = \sin x$

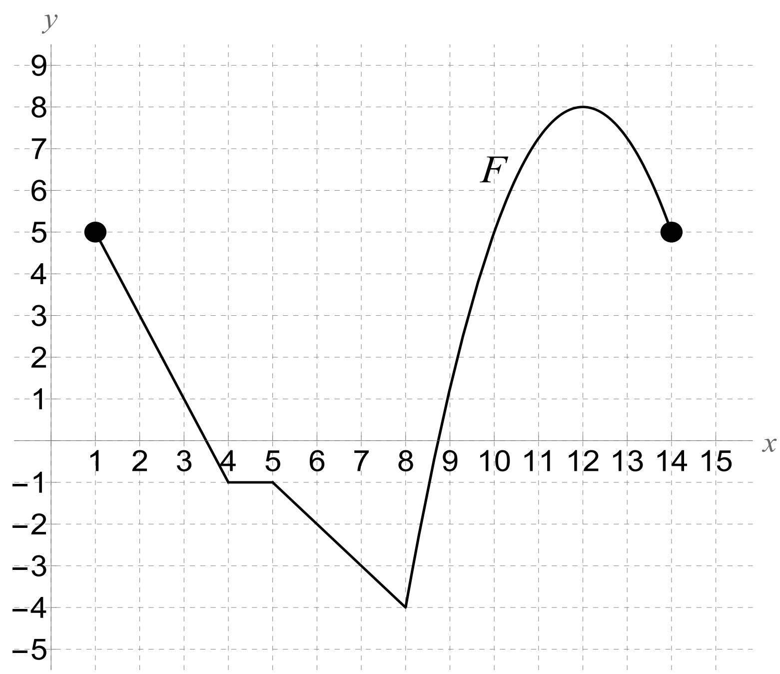
(c) The function F whose graph is shown at right.



A8. Compute the coordinates of the point marked A in this picture:



A9. Suppose that F is the function graphed here:



Let $G : \mathbb{R} \to \mathbb{R}$ be the function that squares its input, subtracts twice the input and then adds 3 to yield the output.

Last, let H_1 and H_2 be functions given by this table of values:

x	0	2	4	6	8	10
$H_1(x)$	3	0	-2	5	8	10
$H_2(x)$	0	4	8	7	12	7

Use all this information to compute/estimate the following quantities:

a) $F(7)$

b) $F(3+5)+2$

c) $(H_1+F)(2)$

d) $H_1 \circ H_1(0)$

e) $F \circ (F+G)(3)$

f) $H_2^{-1}(0)$

g) $H_1^2 \circ G(3)$

h) $\dfrac{3F(6)}{F(12)}+3$

i) $G(H_1(6)+2)$

j) $H_2(10) - 2G(1)$

k) $FG \circ H_1(6)$

l) $F(10) + H_2 \circ G(1)$

3.2 Practice Exam B

B1. Complete this table of values for the function $r(x) = 8\cos 2x$, simplifying answers where appropriate.

x	$-\frac{\pi}{2}$	$-\frac{\pi}{4}$	0	$\frac{\pi}{6}$	$\frac{\pi}{4}$	$\frac{\pi}{2}$	π
$r(x)$							

B2. What function would have to be applied to both sides of the equation $2x = 14$, in order to isolate x on the left-hand side?

B3. Determine whether or not each function is one-to-one:

a) $Q(x) = \tan x$

b) $H(x) = x^4$

B4. a) If you know $x = -5$, how does robber $x + 4$ simplify?

b) If you know robber $x = -5$, how does robber $x + 4$ simplify?

c) If you know robber $x = -5$, how does robber$^2 x + 4$ simplify?

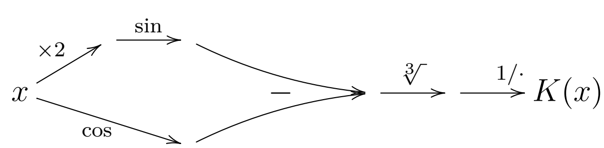
B5. Diagram each function:

a) $\Sigma(x) = \sec 3x$

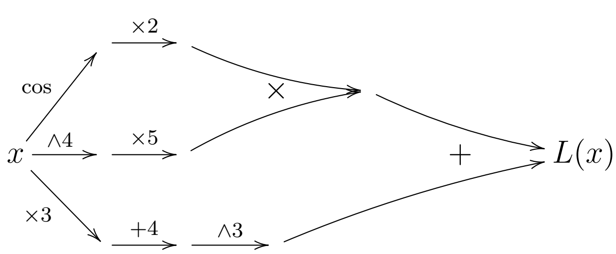
b) $\Phi(x) = \sqrt[3]{3 + \sqrt[3]{x}}$

B6. Reverse-diagram each arrow picture, simplifying the rule for the function obtained:

a)

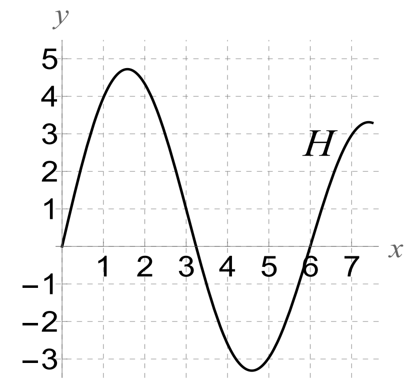


b)

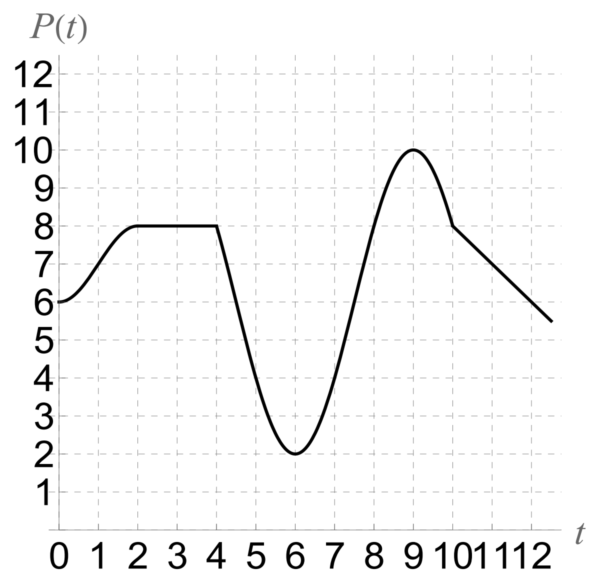


B7. Determine the x- and y-intercept(s) of the function $A(x) = 7 - 3x$.

B8. If H is an odd function whose graph for positive x is shown below, what is $H(-7)$?



B9. Suppose that the price $P(t)$ (in dollars) of a stock t hours after 8:00 AM is given by a function P whose graph is shown here:



Use this graph to compute/estimate the answers to the following:

a) What is the price of the stock at 11:00 AM?

b) At what times is the price of the stock equal to $\$4$?

c) When is the stock price greatest?

d) What is the average rate of change in the stock price between noon and 3:00 PM?

e) What is the instantaneous rate of change in the price of the stock at 12:30 PM?

f) At 3:30 PM, is the stock price increasing or decreasing?

3.3 Practice Exam C

C1. Complete this table of values for the function $p(x) = (2x)^{2/3}$, simplifying answers where appropriate.

x	-4	0	2	4	8
$p(x)$					

C2. Write a rule for the function F which takes half the input and adds the input squared.

C3. a) Apply the function $j(x) = \sqrt[3]{x}$ to both sides of the equation $x^3 + 4 = x^6$, simplifying what you get.

b) What function would have to be applied to both sides of the equation $5 + \frac{x}{4} = 18$, in order to isolate x on the left-hand side?

C4. Determine whether or not each function is one-to-one:

a) The function which assigns to each month the number of days in that month (in the year 2024).

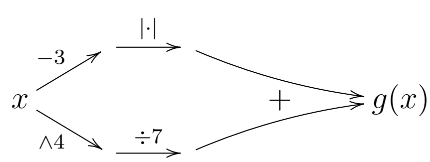
b) $\Psi(x) = 2x + 3$

C5. Substitute truck $x = 5$ into car$^3 x$+ truck$^2 x = 33$, and solve for car x.

C6. Reverse-diagram each arrow picture, simplifying the rule for the function obtained:

a) $x \xrightarrow{\wedge 3} \xrightarrow{\sqrt{\ }} \xrightarrow{1/\cdot} \xrightarrow{\times 3} f(x)$

b)

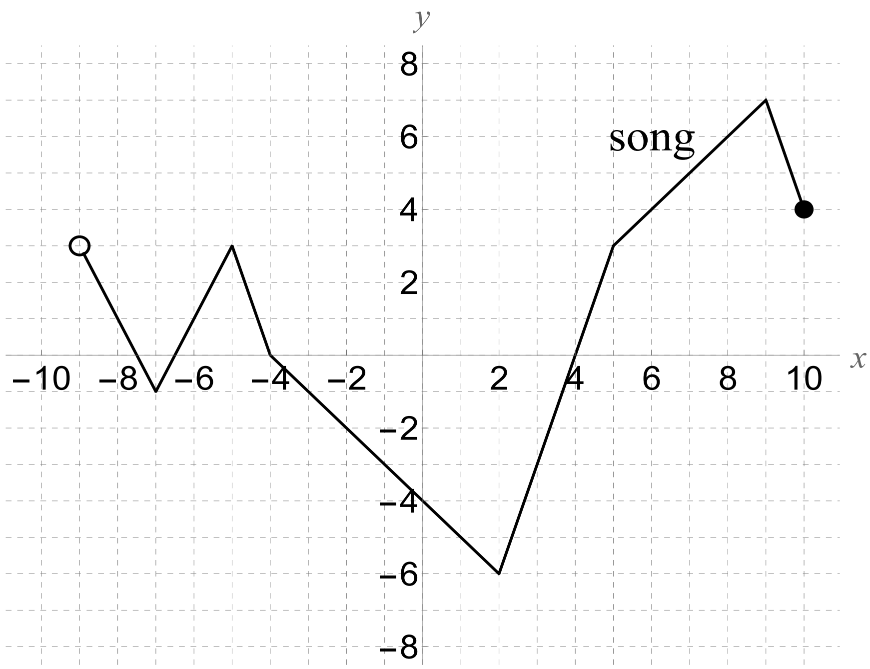


C7. Sketch a graph of the function

$$R(x) = \begin{cases} 5 & x < -2 \\ 3 & -2 < x < 1 \\ -1 & x = 1 \\ 8 & x > 1 \end{cases}.$$

C8. Determine the x- and y-intercept(s) of the function $D(x) = \frac{9}{5} + \frac{x}{2}$.

C9. Throughout this problem, suppose this is the graph of song: $\mathbb{R} \to \mathbb{R}$:



Use this graph to answer these questions:

a) What is the domain of song?
b) What is the range of song?
c) What is the y-intercept of song?
d) Near $x = 3$, is song increasing or decreasing?
e) What is the maximum value of song, for x-values between -8 and -3?
f) At what x is the value of song minimized?

Now, suppose also that fire $x = 8 - x^2$.

Last, let ice : $\mathbb{R} \to \mathbb{R}$ be given by the following table of values:

x	-8	-4	-2	-1	0	1	3	4	7	9
ice x	3	-4	1	5	-2	6	-1	-4	2	8

Use this information about song, fire and ice to compute/estimate the following quantities:

g) song -7

h) song(3)

i) ice 7

j) fire$(\{0, 1, 2, 3\})$

k) 5 song $-3 + 2$

l) ice$^{-1}6$

m) song$^{-1}6$

n) ice fire 2

o) ice 4 song -2

p) song $3 \cdot 2$

q) song$^3 2^2$

r) (ice^{-1}+ ice^2)(1)

s) song $8-$ ice 7

t) fire$^{1/2}2$

u) $(4$ song -2 ice $)(-2)$

v) song(ice 0+fire $(-1) - 2)$

3.4 Practice Exam D

D1. Complete this table of values for the function $Q(x) = 4\tan x - \sin x$, simplifying answers where appropriate.

x	0	$\frac{\pi}{4}$	$\frac{\pi}{2}$	π
$Q(x)$				

D2. Write a rule for the function F that takes the cosine of twice the input, subtracts the sine of the input, and divides all that by the square root of the input to produce the output.

D3. Apply the function $J(x) = x - 5$ to both sides of the equation $4x + 7 = 11$, simplifying what you get.

D4. Let α ("alpha") be the function $\alpha(x) = 4x + 1$ and let β ("beta") be the multifunction $\beta(x) = \pm\sqrt{x}$. Compute and simplify each quantity:

a) $\beta(6)$ b) $\alpha(\{1, 2, 3, 4\})$ c) $\beta \circ \alpha(6)$ d) $\alpha \circ \beta(1)$

D5. Determine whether or not each function is one-to-one:

a) The function S given by this table of values:

x	-3	-2	-1	0	1	2	3
$S(x)$	4	-2	1	5	-3	-8	7

b) The function T given by this table of values:

x	-3	-2	-1	0	1	2	3
$T(x)$	4	-3	1	5	-3	-8	7

D6. Suppose throughout this problem that mike $x = 7 + 3x$ and john $x = x^2 + x$. Compute and simplify the rule for each indicated function:

a) mike -3 john b) mike $\circ$ john c) mike^3

D7. Diagram each function:

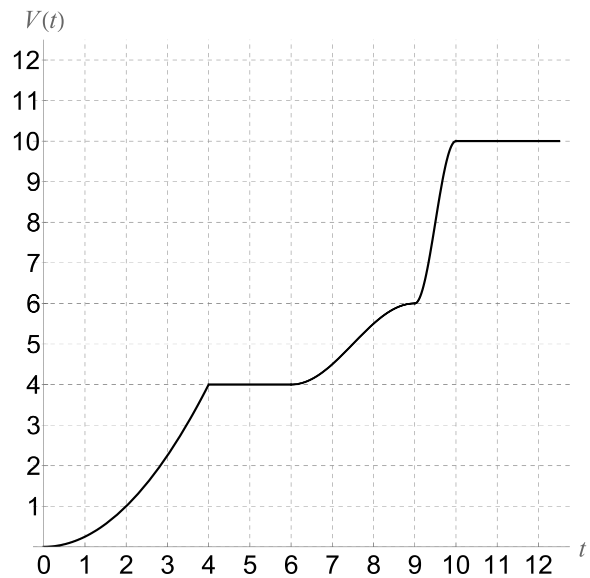
a) $v(x) = \cos^4 8x$

b) $u(x) = x^{2/5}$

c) $w(x) = \sqrt{x^4 \tan 3x}$

D8. Compute the intersection point of the graphs of $f_1(x) = 2x - 3$ and $f_2(x) = 9 - x$.

D9. Suppose that rainwater is filling a cistern so that at time t (in minutes), the volume of water collected in the cistern is $V(t)$ (in liters), where V is a function whose graph is given here:



Use this graph to compute/estimate the answers to the following:

a) How much water is in the cistern at time 3?

b) At what time(s) is there 5 L in the cistern?

c) How much water accumulates in the cistern between times 4 and 11?

d) What is the average rate at which the cistern fills between times 2 and 9?

e) Is it raining harder at time 1 or time 3? Explain your answer.

f) When is it raining hardest? Explain your answer.

3.5 Practice Exam E

E1. Complete this table of values for the function $\Lambda(x) = \begin{cases} 4x^{-2} & x \leq 1 \\ 3 & 1 < x < 4 \\ 10x^{-1/2} & x \geq 4 \end{cases}$:

x	-4	-2	-1	0	1	2	4	6
$\Lambda(x)$								

E2. Write a rule for the function G which subtracts 7 from twice the input, cubes that, and then subtracts 9 to produce the output.

E3. Apply the function $k(x) = x^2$ to both sides of the equation $x^2 = \sqrt{x+1}$, simplifying what you get.

E4. Suppose throughout this problem that $b(x) = 3 - 4x$ and $c(x) = \dfrac{1}{2}x + 1$. Compute and simplify the rule for each indicated function:

a) $b + c$ b) c^2 c) $b \circ c$ d) b^{-1}

E5. Diagram each function:

a) $\rho(x) = \cos x^2 \sin x$ b) $\sigma(x) = 3x^{-4}$

E6. Write and simplify the rule for the function f described by this diagram (i.e. reverse-diagram this arrow picture):

$$x \xrightarrow{\times 3} \xrightarrow{\wedge 2} \xrightarrow{1/\cdot} f(x)$$

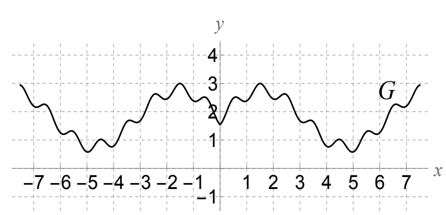
E7. Compute the x-coordinate of the point where the graphs of $g(x) = 4x$ and $h(x) = \dfrac{2}{3}x + 5$ intersect.

E8. Classify each function as even, odd, both (even and odd), or neither:

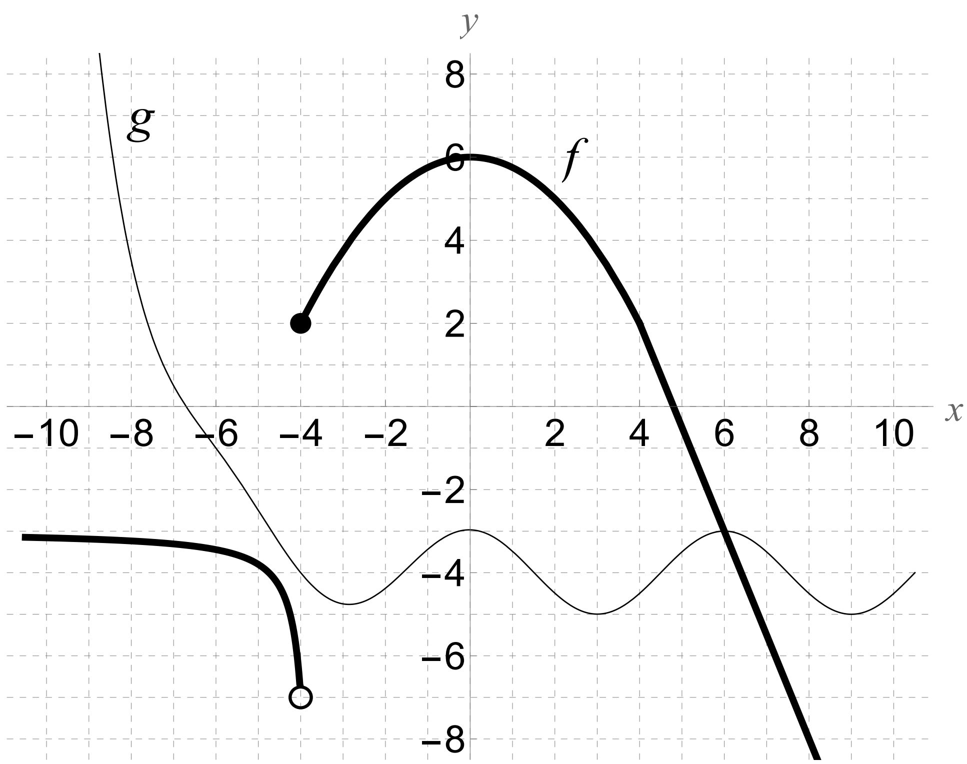
(a) $Y(x) = \cos x$

(b) $r(x) = \dfrac{2}{3}x^3$

(c) The function G whose graph is shown at right.



E9. Suppose that f and g are the functions graphed here (f is the thick graph with two pieces, g is the thin graph).



Use these graphs to answer the following questions:

a) What is/are the solution(s) of the equation $f(x) = g(x)$?

b) For what values of x is $f(x) > g(x)$?

c) What is the range of f?

d) What is the minimum value of g?

e) For what x is $f(x)$ maximized?

f) What is/are the x-intercept(s) of g?

g) What is/are the y-intercept(s) of g?

h) As x goes from 3 to 5, does g increase or decrease?

i) As x goes from 2 to 8, by how much does f increase or decrease?

j) What is the average rate of change of f from $x = -4$ to $x = 0$?

k) What is the instantaneous rate of change of g when $x = -5$?

l) For what value(s) of x is $g(x) = -3$?

m) Is f a one-to-one function?

E10. Let f and g be the same functions as in the previous question. Also, suppose that h is given by the table of values

x	-6	-4	-3	-2	-1	0	1	2	3	4	6
$h(x)$	3	4	2	2	0	-1	2	-3	3	2	-4

and finally, suppose j and k are the functions

$$j(x) = 12x^{-1} \qquad \text{and} \qquad k(x) = \begin{cases} 2x^2 & x < 3 \\ 8 - 2x & x \geq 3 \end{cases}.$$

Use all this information to compute/estimate the following quantities:

a) $j(3)$
b) $f(-6)$
c) $k(\{2, 3, 4\})$
d) $h(2) + k(3)$
e) $h \circ j(3)$
f) $(f + 2g)(0)$
g) $k^3(1)$
h) $g^{-1}(-7)$
i) $4f(3 - 5)$
j) $h(-4) + 2$
k) $\dfrac{h}{f - g}(3)$
l) $k(h(2) + g(6))$
m) $(h \circ h + k)(1)$
n) $h^2(2) + 3f(-4)$
o) $h{-}1(0)$
p) $\dfrac{f}{h} \circ k(4)$
q) $j(2 + f(8))$
r) $\dfrac{1 - 4f(0)}{g(0) + 2h(-3)}$

3.6 Practice Exam F

F1. Complete this table of values for the function $\Gamma(x) = \begin{cases} -\sin\frac{x}{2} & x \le 0 \\ \cos 4x & x > 0 \end{cases}$:

x	$-\pi$	$-\frac{\pi}{2}$	$-\frac{\pi}{3}$	0	$\frac{\pi}{12}$	$\frac{\pi}{6}$	π
$\Gamma(x)$							

F2. What function would have to be applied to both sides of the equation $11\sqrt{x} = 2$, in order to isolate x on the left-hand side?

F3. a) If you know $x = 3$, how does pick $x + 2$ simplify?

b) If you know pick $x = 3$, how does pick $x + 2$ simplify?

F4. Diagram each function:

a) $\widehat{g}(x) = \dfrac{(x^2+2)^2}{(5-x)^3}$

b) $\widehat{k}(x) = \tan^2 x^3$

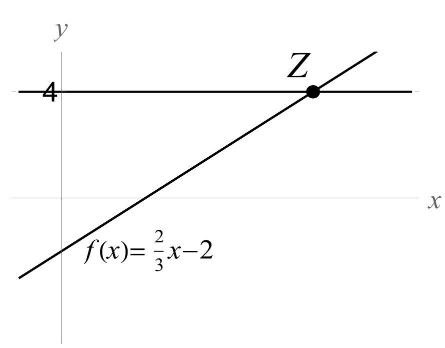
c) $\widehat{m}(x) = \sin^3 \sqrt{5x + \cos x}$

F5. Determine the x- and y-intercept(s) of each function:

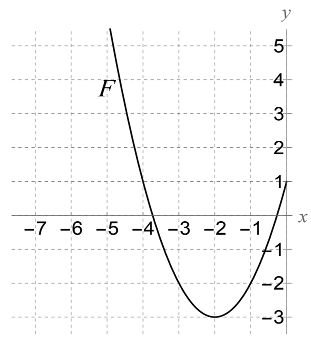
a) $B(x) = 8$

b) $C(x) = \dfrac{3}{7}x - \dfrac{5}{4}$

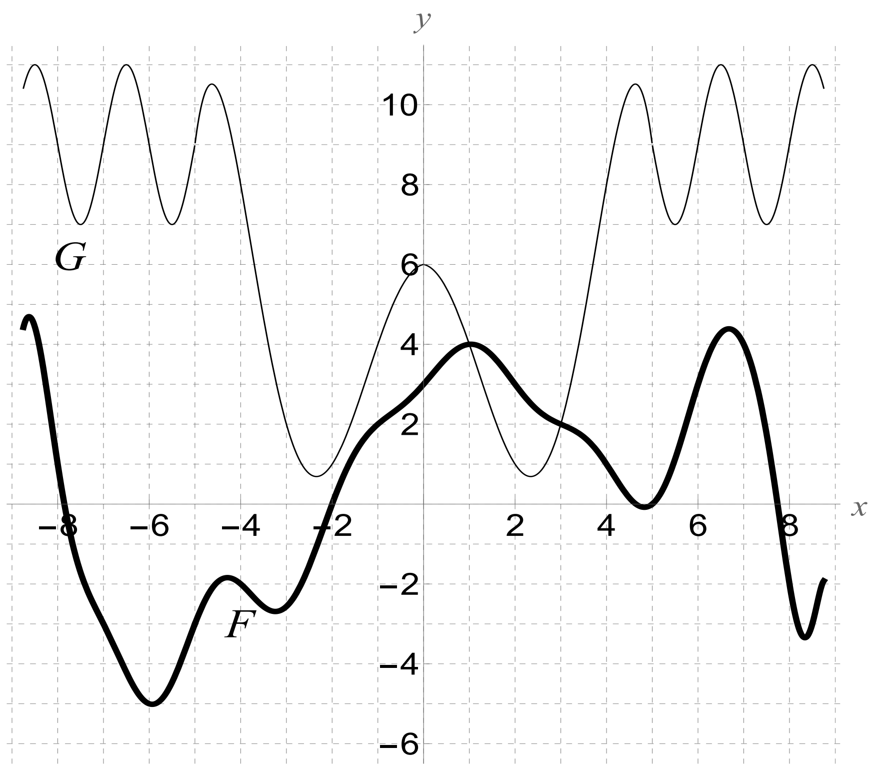
F6. Compute the x-coordinate of point Z in this picture:



F7. If F is an even function whose graph for negative x is shown below, what is $F(3)$?



F8. Suppose that F and G are the functions graphed here (F is the thick graph, G is the thin graph):



Use these graphs to answer the following questions:

a) Is G even, odd, neither, or both?

b) How many solutions does the equation $F(x) = G(x)$ have?

c) What is the solution set of the inequality $F(x) > G(x)$?

d) How many solutions does the equation $G(x) = 6$ have?

e) What is the smallest positive solution of $F(x) = 4$?

f) Which is larger, $F(-3)$ or $F(-6)$?

g) As x changes from 3 to 4, does $G(x)$ increase or decrease?

h) What is/are the x-intercept(s) of G?

i) What is/are the y-intercept(s) of F?

j) What is the maximum value of G?

k) What is the minimum value of F?

l) For what x is $F(x)$ minimized?

m) What is the net change in F between $x = -3$ and $x = 1$?

n) What is the average rate of change of G from $x = 0$ to $x = 6$?

F9. Use the same graphs as in the previous question to compute/estimate each quantity:

a) $F(6)$

b) $G(2) + G(-2)$

c) $4F(-4) + 5$

d) $F^2(-5)$

e) $G^{-1}(4)$

f) $F(\{0, 3, 6\})$

g) $FG(-5)$

h) $F \circ F \circ G(0)$

i) $F(-7) + G(-3 \cdot -2)$

j) $(F - G)(2) + (G - F)(-6)$

k) $\dfrac{G}{G - F}(4)$

l) $3F^2(-1)$

3.7 Solutions to Practice Exam A

A1. Recall that $x^{-2} = \frac{1}{x^2}$, so $q(x) = \dfrac{4}{x^2} + 1$. Using this, we have

x	-4	-1	0	1	2	5
$q(x)$	$\dfrac{5}{4}$	5	DNE	5	2	$\dfrac{29}{25}$

.

A2. $\boxed{H(x) = \begin{cases} 2x^2 & x < 0 \\ 4 & x = 0 \\ \sqrt[3]{x+1} & x > 0 \end{cases}}$

A3. a) $g(2) = 2 \pm 3 = \{2+3, 2-3\} = \boxed{\{5, -1\}}$.

b) $h(\{-3, 1, 4\}) = \{2(-3)^2, 2(1^2), 2(4^2)\} = \boxed{\{18, 2, 32\}}$.

c) $(g \circ h)(1) = g(h(1)) = g(2(1^2)) = g(2) = 2 \pm 3 = \boxed{\{5, -1\}}$.

d) $(h \circ g)(1) = h(g(1)) = h(1 \pm 3) = h(\{4, -2\}) = \{2(4^2), 2(-2)^2\} = \boxed{\{32, 8\}}$.

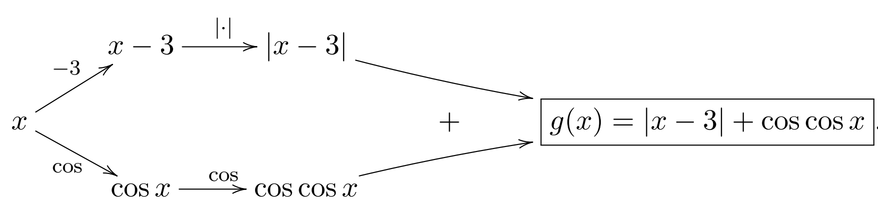
A4. a) $\dfrac{F}{G}(x) = \dfrac{F(x)}{G(x)} = \dfrac{\frac{1}{4}\sqrt{x}}{8x^2} = \dfrac{1}{32}x^{1/2-2} = \boxed{\dfrac{1}{32}x^{-3/2}}$.

b) $(8F + G)(x) = 8F(x) + G(x) = 8\left(\frac{1}{4}\sqrt{x}\right) + 8x^2 = \boxed{2\sqrt{x} + 8x^2}$.

c) $(G \circ F)(x) = G(F(x)) = G\left(\dfrac{1}{4}\sqrt{x}\right) = 8\left(\dfrac{1}{4}\sqrt{x}\right)^2 = 8\left(\dfrac{1}{16}x\right) = \boxed{\dfrac{1}{2}x}$.

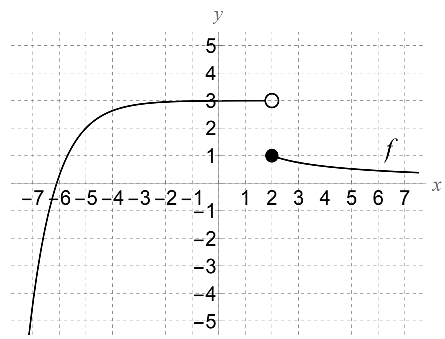
d) Since F takes a square root, then divides by 4, it must be that F^{-1} multiplies by 4 and then squares. Thus $F^{-1}(x) = (4x)^2 = \boxed{16x^2}$.

A5. a) $x \xrightarrow{\times -2} -2x \xrightarrow{+3} -2x+3 \xrightarrow{\wedge 5} (-2x+3)^5 \xrightarrow{\cos} \cos(-2x+3)^5 \xrightarrow{\wedge 8} \boxed{f(x) = \cos^8(-2x+3)^5}$.

b) 

.

A6. Take the part of the graph of y to the left of $x = 2$, and the part of the graph of z to the right of $x = 2$ to get this:



A7. a) H is $\boxed{\text{even}}$ since it has only an even power of x.

b) n is $\boxed{\text{odd}}$ since $\sin(-x) = -\sin x$.

c) F is $\boxed{\text{neither}}$ even nor odd.

A8. Set the functions equal and solve for x:

$$\begin{aligned} f(x) &= g(x) \\ 2x + 7 &= \frac{1}{2}x + 1 \\ 6 &= -\frac{3}{2}x \\ -\frac{2}{3}(6) &= x \\ -4 &= x \end{aligned}$$

Therefore $y = f(-4) = 2(-4) + 7) = -1$, so the point is $\boxed{(-4, -1)}$.

A9. a) $F(7) = \boxed{-3}$.

b) $F(3 + 5) + 2 = F(8) + 2 = -4 + 2 = \boxed{-2}$.

c) $(H_1 + F)(2) = H_1(2) + F(2) = 0 + 3 = \boxed{3}$.

d) $H_1 \circ H_1(0) = H_1(H_1(0)) = H_1(3)$ which $\boxed{\text{DNE}}$.

e) $F \circ (F + G)(3) = F(F(3) + G(3)) = F(1 + (3^2 - 2(3) + 3)) = F(1 + 6) = F(7) = \boxed{-3}$.

f) $H_2^{-1}(0) = \boxed{0}$.

g) $H_1^2 \circ G(3) = H_1^2(G(3)) = H_1^2(3^2 - 2(3) + 3) = H_1^2(6) = (H_1(6))^2 = 5^2 = \boxed{25}$.

h) $\dfrac{3F(6)}{F(12)} + 3 = \dfrac{3(-2)}{8} + 3 = -\dfrac{3}{4} + 3 = \boxed{\dfrac{9}{4}}$.

i) $G(H_1(6) + 2) = G(5 + 2) = G(7) = 7^2 - 2(7) + 3 = 49 - 14 + 3 = \boxed{38}$.

j) $H_2(10) - 2G(1) = 7 - 2(1^2 - 2(1) + 3) = 7 - 2(1 - 2 + 3) = 7 - 2(2) = \boxed{3}$.

k) $FG \circ H_1(6) = FG(H_1(6)) = FG(5) = F(5)G(5) = -1(5^2 - 2(5) + 3) = -(25 - 10 + 3) = \boxed{-18}$.

l) $F(10) + H_2 \circ G(1) = 5 + H_2(G(1)) = 5 + H_2(1^2 - 2(1) + 3) = 5 + H_2(2) = 5 + 4 = \boxed{9}$.

3.8 Solutions to Practice Exam B

B1. Multiply each input by 2, then take cosine, then multiply by 8 to get this:

x	$-\frac{\pi}{2}$	$-\frac{\pi}{4}$	0	$\frac{\pi}{6}$	$\frac{\pi}{4}$	$\frac{\pi}{2}$	π
$r(x)$	-8	0	8	4	0	-8	8

B2. We need to divide both sides by 2 to isolate x. This is the function $\boxed{f(x) = \frac{x}{2}}$.

B3. a) $Q(x) = \tan x$ is $\boxed{\text{not}}$ one-to-one since $Q(0) = Q(\pi) = 0$, so 0 and π are different inputs with the same output.

b) $H(x) = x^4$ is $\boxed{\text{not}}$ one-to-one since $H(1) = H(-1) = 1$, so -1 and 1 are different inputs with the same output.

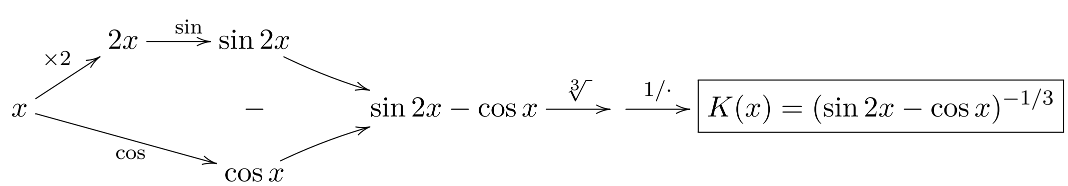
B4. a) If $x = -5$, robber $x + 4 = \boxed{\text{robber } -5 + 4}$. (This does not simplify further.)

b) If robber $x = -5$, robber $x + 4 = -5 + 4 = \boxed{1}$.

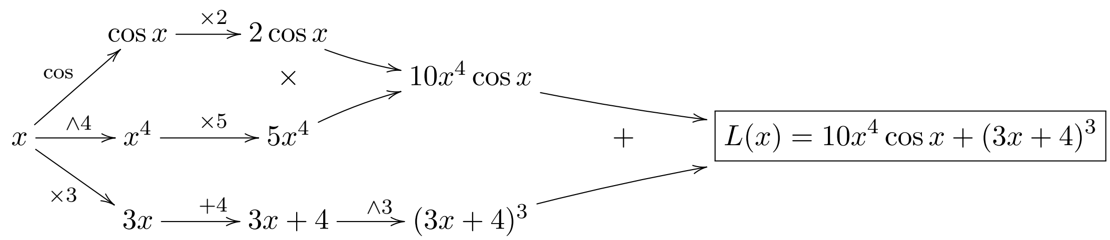
c) If robber $x = -5$, robber$^2 x + 4 = (-5)^2 + 4 = \boxed{29}$.

B5. a) $\boxed{x \xrightarrow{\times 3} \xrightarrow{\cos} \xrightarrow{1/\cdot} \Sigma(x)}$.

b) $\boxed{x \xrightarrow{\sqrt[3]{\ }} \xrightarrow{+3} \xrightarrow{\sqrt[3]{\ }} \Phi(x)}$

B6. a) 

b)



B7. For the x-intercepts, set $y = A(x) = 0$ to get $0 = 7 - 3x$. Solve for x to get $x = \frac{7}{3}$, so the x-intercept is $\boxed{\left(\frac{7}{3}, 0\right)}$. For the y-intercept, $A(0) = 7 - 3(0) = 7$ so the y-intercept is $\boxed{(0,7)}$.

B8. Since H is odd, $H(-7) = -H(7) = \boxed{-3}$.

B9. a) The price of the stock at 11:00 AM is $P(3) = \boxed{\$8}$.

b) $P^{-1}(4) = \{5, 7\}$ which is 5 and 7 hours after 8:00 AM, i.e. $\boxed{\{\text{1:00 PM, 3:00 PM}\}}$.

c) The maximum value is at $t = 9$ which is 9 hours after 8:00 AM, i.e. $\boxed{\text{5:00 PM}}$.

d) The average rate of change from $t = 4$ to $t = 7$ is

$$\frac{P(7) - P(4)}{7 - 4} = \frac{4 - 8}{3} = \boxed{-\frac{4}{3} \text{ dollars/hr}}.$$

e) At 12:30 PM, which is $t = 4.5$, the tangent line to the graph has a slope of about -3. So the instantaneous rate of change is about $\boxed{-3 \text{ dollars/hr}}$.

f) At 3:30 PM, which is $t = 7.5$, the graph of P is going up from left to right, so the stock price is $\boxed{\text{increasing}}$.

3.9 Solutions to Practice Exam C

C1. Recall $\square^{2/3} = \left(\sqrt[3]{\square}\right)^2$. Use this to fill out the chart as:

x	-4	0	2	4	8
$p(x)$	4	0	$4^{2/3}$	4	$16^{2/3}$

.

C2. $\boxed{F(x) = \frac{1}{2}x + x^2}$.

C3. a) Apply the function to both sides to get $\sqrt[3]{x^3+4} = \sqrt[3]{x^6}$. The left-hand side doesn't simplify, but the right-hand side is $(x^6)^{1/3} = x^2$, so the equation becomes $\boxed{\sqrt[3]{x^3+4} = x^2}$.

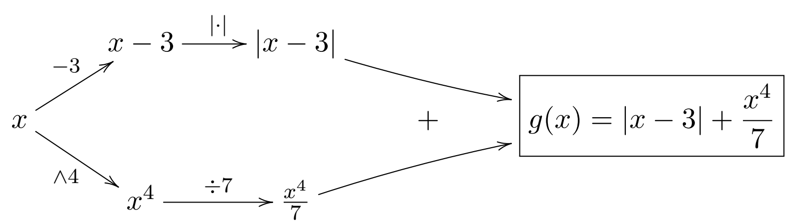
b) Since the left-hand side divides by 4, then adds 5, to isolate x we must subtract 5, then multiply by 4. This is the function $\boxed{f(x) = 4(x-5)}$.

C4. a) This function is $\boxed{\text{not}}$ one-to-one, since the number of days in January is the same as the number of days in March (namely, 31).

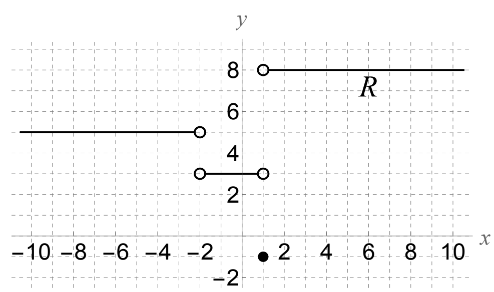
b) $\Psi(x) = 2x+3$ $\boxed{\text{is}}$ one-to-one, since different inputs go to different outputs.

C5. Substitute truck $x = 5$ into the equation to get $\text{car}^3 x + 5^2 = 33$. Then $\text{car}^3 x + 25 = 33$, so $\text{car}^3 x = 8$ so car $x = \sqrt[3]{8} = \boxed{2}$.

C6. a) $x \xrightarrow{\wedge 3} x^3 \xrightarrow{\sqrt{\ }} x^{3/2} \xrightarrow{1/\cdot} x^{-3/2} \xrightarrow{\times 3} \boxed{f(x) = 3x^{-3/2}}$.

b) 

C7.



C8. For the x-intercept, set $0 = y = D(x)$ to get $0 = \frac{9}{5} + \frac{x}{2}$. Solve for x to get $\frac{x}{2} = -\frac{9}{5}$, i.e. $x = -\frac{18}{5}$. Thus the $x-$intercept is $\boxed{\left(-\frac{18}{5}, 0\right)}$. For the y-intercept, compute $D(0) = \frac{9}{5}$ so the y-intercept is $\boxed{\left(0, \frac{9}{5}\right)}$.

C9. a) This is the set of inputs (x-values) of song, which is $\boxed{(-9, 10]}$.

b) This is the set of outputs (y-values) of song, which is $\boxed{[-6, 7]}$.

c) $\boxed{(0, -4)}$

d) Near $x = 3$, song is $\boxed{\text{increasing}}$.

e) $\boxed{3}$ (which occurs when $x = -5$).

f) The value of song minimized when $x = \boxed{2}$.

g) song $-7 = \boxed{-1}$.

h) song$(3) = \boxed{-3}$.

i) ice $7 = \boxed{2}$.

j) fire$(\{0, 1, 2, 3\}) = \{8 - 0^2, 8 - 1^2, 8 - 2^2, 8 - 3^2\} = \boxed{\{8, 7, 4, -1\}}$.

k) 5 song $-3 + 2 = 5(-1) + 2 = -5 + 2 = \boxed{-3}$.

l) ice$^{-1}6 = \boxed{1}$.

m) song$^{-1}6 = \boxed{\{8, 9.5\}}$.

n) ice fire $2 =$ ice $(8 - 2^2) =$ ice $4 = \boxed{-4}$.

o) ice 4 song $-2 = (-4)(-2) = \boxed{8}$

p) song $3 \cdot 2 =$ song $6 = \boxed{4}$.

q) song$^3 2^2 =$ song$^3 4 =$ (song $4)^3 = 0^3 = \boxed{0}$.

r) (ice^{-1}+ ice^2)(1) =ice$^{-1}(1) +$ (ice $1)^2 = -2 + 6^2 = \boxed{34}$.

s) song $8-$ ice $7 = 6 - 2 = \boxed{4}$.

t) fire$^{1/2}2 = \sqrt{\text{fire } 2} = \sqrt{8 - 2^2} = \sqrt{4} = \boxed{2}$.

u) (4 song -2 ice $)(-2) = 4(-2) - 2(1) = -8 - 2 = \boxed{-10}$.

v) song(ice 0+fire $(-1) - 2) =$ song$(-2 + (8 - (-1)^2) - 2) =$ song $3 = \boxed{-3}$.

3.10 Solutions to Practice Exam D

D1.

x	0	$\frac{\pi}{4}$	$\frac{\pi}{2}$	π
$Q(x)$	0	$4 - \frac{\sqrt{2}}{2}$	DNE	0

D2. $\boxed{F(x) = \dfrac{\cos 2x - \sin x}{\sqrt{x}}}$.

D3. Subtract 5 from both sides to get $\boxed{4x + 2 = 6}$.

D4. a) $\beta(6) = \pm\sqrt{6} = \boxed{\{-\sqrt{6}, \sqrt{6}\}}$.

b) $\alpha(\{1,2,3,4\}) = \{4(1)+1, 4(2)+1, 4(3)+1, 4(4)+1\} = \boxed{\{5,9,13,17\}}$.

c) $\beta \circ \alpha(6) = \beta(\alpha(6)) = \beta(4(6)+1) = \beta(25) = \pm\sqrt{25} = \boxed{\{-5,5\}}$.

d) $\alpha \circ \beta(1) = \alpha(\pm\sqrt{1}) = \alpha(\{-1,1\} = \{4(-1)+1, 4(1)+1\} = \boxed{\{-3,5\}}$.

D5. a) S $\boxed{\text{is}}$ one-to-one, since different inputs always go to different outputs.

b) T is $\boxed{\text{not}}$ one-to-one since $T(-2) = T(1)$.

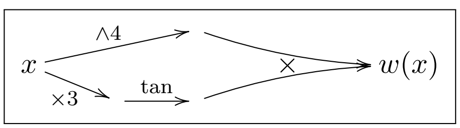
D6. a) $(\text{mike} - 3\,\text{john})(x) = 7 + 3x - 3(x^2 + x) = 7 + 3x - 3x^2 - 3x = \boxed{7 - 3x^2}$.

b) $\text{mike} \circ \text{john}(x) = \text{mike}(x^2 + x) = 7 + 3(x^2 + x) = \boxed{7 + 3x^2 + 3x}$.

c) $\text{mike}^3(x) = (\text{mike}\ x)^3 = \boxed{(7 + 3x)^3}$.

D7. a) $\boxed{x \xrightarrow{\times 8} \xrightarrow{\cos} \xrightarrow{\wedge 4} v(x)}$.

b) $\boxed{x \xrightarrow{\wedge 2} \xrightarrow{\sqrt[5]{\ }} u(x)}$. *Note:* In this problem, the two arrows can be done in either order.

c) 

D8. Set the functions equal and solve for x:

$$\begin{aligned} f_1(x) &= f_2(x) \\ 2x - 3 &= 9 - x \\ 3x &= 12 \\ x &= 4 \end{aligned}$$

The y-coordinate of the intersection point is $f_1(4) = 2(4) - 3 = 5$, so the intersection point is $\boxed{(4,5)}$.

D9. a) This is $V(3) = \boxed{2\text{ L}}$.

b) This is $V^{-1}(5) = \boxed{7.5\text{ min}}$.

c) $V(11) - V(4) = 10 - 4 = \boxed{6\text{ L}}$.

d) The average rate of change is $\dfrac{V(9) - V(2)}{9 - 2} = \dfrac{6 - 1}{7} = \boxed{\dfrac{5}{7}\text{ L/min}}$.

e) At time 3, the graph of V is steeper than it is at time 1, so the rate of change (i.e. the rate of rainfall) is greater $\boxed{\text{at time 3}}$.

f) Using similar reasoning as (e), the hardest rain is when the graph of V is steepest, which is at $t = \boxed{9.5\text{ min}}$.

3.11 Solutions to Practice Exam E

E1. Recall that $4x^{-2} = \dfrac{4}{x^2}$ and $10x^{-1/2} = \dfrac{10}{\sqrt{x}}$. Applying this, we have

x	-4	-2	-1	0	1	2	4	6
$\Lambda(x)$	$\frac{1}{4}$	1	4	DNE	4	3	5	$\frac{10}{\sqrt{6}}$

E2. $\boxed{G(x) = (2x-7)^3 - 9}$.

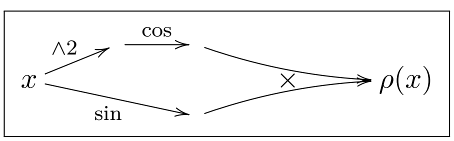
E3. Square both sides to get $(x^2)^2 = (\sqrt{x+1})$, which simplifies to $\boxed{x^4 = x+1}$.

E4. a) $(b+c)(x) = b(x) + c(x) = 3 - 4x + \frac{1}{2}x + 1 = \boxed{4 - \dfrac{7}{2}x}$.

b) $c^2(x) = (c(x))^2 = \boxed{\left(\dfrac{1}{2}x + 1\right)^2}$.

c) $(b \circ c)(x) = b(c(x)) = b\left(\dfrac{1}{2}x + 1\right) = 3 - 4\left(\dfrac{1}{2}x + 1\right) = 3 - 2x - 4 = \boxed{-2x - 1}$.

d) Since b multiplies by -4 and then adds 3, b^{-1} must subtract 3 and then divide by -4. Therefore $b^{-1}(x) = \boxed{\dfrac{x-3}{-4}}$.

E5. a) 

b) $\boxed{x \xrightarrow{\wedge 4} \xrightarrow{1/\cdot} \xrightarrow{\times 3} \sigma(x)}$.

E6. $x \xrightarrow{\times 3} 3x \xrightarrow{\wedge 2} (3x)^2 = 9x^2 \xrightarrow{1/\cdot} f(x) = \dfrac{1}{9x^2} = \boxed{\dfrac{1}{9}x^{-2}}$.

E7. Set the functions equal and solve for x:

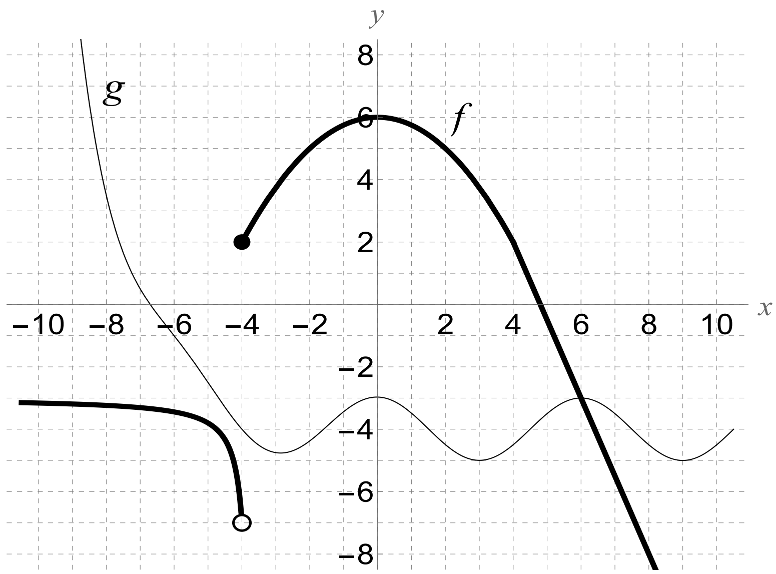
$$\begin{aligned} g(x) &= h(x) \\ 4x &= \frac{2}{3}x + 5 \\ \left(4 - \frac{2}{3}\right) x &= 5 \\ \frac{10}{3}x &= 5 \\ x &= 5\left(\frac{3}{10}\right) = \boxed{\frac{3}{2}}. \end{aligned}$$

E8. a) Y is $\boxed{\text{even}}$ since $\cos(-x) = \cos x$.

b) r is $\boxed{\text{odd}}$ since it has only odd exponents in it.

c) G is $\boxed{\text{even}}$ since its graph is symmetric about the y-axis.

E9.



a) These graphs intersect at $x = \boxed{6}$.

b) The graph of f is above the graph of g for x in the interval $\boxed{[-4, 6)}$.

c) The range of f is its set of outputs (y-values), which is $\boxed{(-\infty, 6]}$.

d) The minimum value of g is $\boxed{-5}$.

e) $f(x)$ is maximized when $x = \boxed{0}$.

f) The x-intercept of g is $\boxed{(-6.8, 0)}$.

g) The y-intercept of g is $\boxed{(0, -3)}$.

h) As x goes from 3 to 5, g $\boxed{\text{increases}}$.

i) As x goes from 2 to 8, f $\boxed{\text{decreases by}}$ $f(2) - f(8) = 5 - (-8) = \boxed{13}$.

j) The average rate of change is $\dfrac{f(0) - f(-4)}{0 - (-4)} = \dfrac{6 - 2}{4} = \boxed{1}$.

k) When $x = -5$, the line tangent to g has a slope of about -2, so the instantaneous rate of change of g when $x = -5$ is approximately $\boxed{-2}$.

l) $\boxed{x = -4.8, 0, 6}$.

m) f is $\boxed{\text{not}}$ one-to-one because its graph fails the HLT.

E10. a) $j(3) = 12(3^{-1}) = 12 \cdot \frac{1}{3} = \boxed{4}$.

b) $f(-6) = \boxed{-3.4}$.

c) $k(\{2,3,4\}) = \{2(2^2), 8-2(3), 8-2(4)\} = \boxed{\{8,2,0\}}$.

d) $h(2) + k(3) = -3 + (8 - 2(3)) = -3 + 2 = \boxed{-1}$.

e) $h \circ j(3) = h(12(3^{-1})) = h(4) = \boxed{2}$.

f) $(f + 2g)(0) = f(0) + 2g(0) = 6 + 2(-3) = \boxed{0}$.

g) $k^3(1) = (k(1))^3 = 2^3 = \boxed{8}$.

h) $g^{-1}(-7)\ \boxed{\text{DNE}}$.

i) $4f(3-5) = 4f(-2) = 4(5) = \boxed{20}$.

j) $h(-4) + 2 = 4 + 2 = \boxed{6}$.

k) $\dfrac{h}{f-g}(3) = \dfrac{h(3)}{f(3)-g(3)} = \dfrac{3}{\frac{7}{2}-(-5)} = \dfrac{3}{\frac{17}{2}} = 3 \cdot \dfrac{2}{17} = \boxed{\dfrac{6}{17}}$.

l) $k(h(2) + g(6)) = k(-3 + (-3)) = k(-6) = 2(-6)^2 = \boxed{72}$.

m) $(h \circ h + k)(1) = h(h(1) + k(1)) = h(2+2) = h(4) = \boxed{2}$.

n) $h^2(2) + 3f(-4) = (-3)^2 + 3(2) = 9 + 6 = \boxed{15}$.

o) $h{-1}(0) = \boxed{-1}$.

p) $\dfrac{f}{h} \circ k(4) = fh(0) = f(0)h(0) = 6(-1) = \boxed{-6}$.

q) $j(2 + f(8)) = j(2 + (-8)) = j(-6) = 12(-6)^{-1} = 12\left(\frac{1}{-6}\right) = \boxed{-2}$.

r) $\dfrac{1-4f(0)}{g(0)+2h(-3)} = \dfrac{1-4(6)}{-3+2(2)} = \dfrac{-23}{1} = \boxed{-23}$.

3.12 Solutions to Practice Exam F

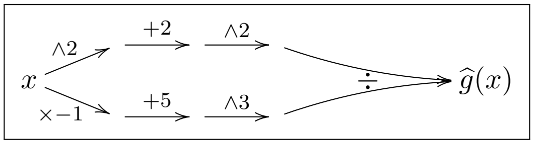
F1.

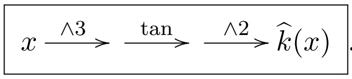
x	$-\pi$	$-\frac{\pi}{2}$	$-\frac{\pi}{3}$	0	$\frac{\pi}{12}$	$\frac{\pi}{6}$	π
$\Gamma(x)$	1	$\frac{\sqrt{2}}{2}$	$\frac{1}{2}$	0	$\frac{1}{2}$	$-\frac{1}{2}$	1

F2. Since the left-hand side takes the square root of x, then multiplies by 11, to isolate x we need to divide by 11 then square. This function is $f(x) = \left(\dfrac{x}{11}\right)^2 = \boxed{\dfrac{x^2}{121}}$.

F3. a) If $x = 3$, pick $x + 2 = \boxed{\text{pick } 3+2}$. This does not simplify further.

b) If pick $x = 3$, pick $x + 2 = 3 + 2 = \boxed{5}$.

F4. a) 

b) 

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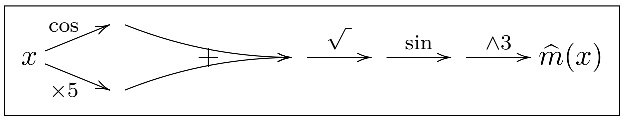
c) 

F5. a) For the x-intercept(s), set $B(x) = 0$ and solve for x. Here, we get $0 = 8$ which has no solution, so B $\boxed{\text{has no } x\text{-intercept}}$. For the y-intercept, compute $B(0) = 8$, so the y-intercept is $\boxed{(0, 8)}$.

b) For the x-intercept(s), set $C(x) = 0$ and solve for x. Here, we get $0 = \frac{3}{7}x - \frac{5}{4}$, i.e. $\frac{3}{7}x = \frac{5}{4}$, i.e. $x = \frac{5}{4} \cdot \frac{7}{3} = \frac{35}{12}$. Therefore the x-intercept of C is $\boxed{\left(\frac{35}{12}, 0\right)}$. For the y-intercept, compute $C(0) = -\frac{5}{4}$, so the y-intercept is $\boxed{\left(0, -\frac{5}{4}\right)}$.

F6. Set $f(x) = 4$ and solve for x:

$$\begin{aligned} \frac{2}{3}x - 2 &= 4 \\ \frac{2}{3}x &= 6 \\ x &= \frac{3}{2} \cdot 6 = \boxed{9}. \end{aligned}$$

F7. Since F is even, $F(3) = F(-3) = \boxed{-2}$.

F8. a) G is $\boxed{\text{even}}$ since its graph is symmetric across the y-axis.

b) $F(x) = G(x)$ has $\boxed{2}$ solutions (at least) since the graphs intersect in 2 points.

c) The graph of F is above the graph of G on the interval $\boxed{(1, 3)}$.

d) $G(x) = 6$ has $\boxed{3}$ solutions, since the graph of G hits height 6 three times.

e) The smallest positive solution of $F(x) = 4$ is $\boxed{x = 1}$.

f) $\boxed{F(-3)} > F(-6)$.

g) G $\boxed{\text{increases}}$ as x goes from 3 to 4.

h) G $\boxed{\text{has no } x\text{-intercept}}$.

i) The y-intercept of F is $\boxed{(0,3)}$.

j) The maximum value of G is $\boxed{11}$.

k) The minimum value of F is $\boxed{-5}$.

l) $F(x)$ is minimized when $\boxed{x=-6}$.

m) The net change in F from $x=-3$ to $x=1$ is $F(1)-F(-3)=4-(-2.5)=\boxed{6.5}$.

n) The average rate of change of G from $x=0$ to $x=6$ is $\dfrac{G(6)-G(0)}{6-0}=\dfrac{9-6}{6}=\dfrac{3}{6}=\boxed{\dfrac{1}{2}}$.

F9. a) $F(6)=\boxed{3}$.

b) $G(2)+G(-2)=1+1=\boxed{2}$.

c) $4F(-4)+5=4(-2)+5=\boxed{-3}$.

d) $F^2(-5)=(F(-5))^2=(-3)^2=\boxed{9}$.

e) $G^{-1}(4)=\boxed{\{-3.4,-1,1,3.4\}}$.

f) $F(\{0,3,6\})=\{3,2,3\}=\boxed{\{2,3\}}$.

g) $FG(-5)=F(-5)G(-5)=(-3)9=\boxed{-27}$.

h) $F\circ F\circ G(0)=F(F(G(0)))=F(F(6))=F(2)=\boxed{3}$.

i) $F(-7)+G(-3\cdot -2)=-3+G(6)=-3+9=\boxed{6}$.

j) $(F-G)(2)+(G-F)(-6)=F(2)-G(2)+G(-6)-F(-6)=3-1+9-(-5)=\boxed{16}$.

k) $\dfrac{G}{G-F}(4)=\dfrac{G(4)}{G(4)-F(4)}=\dfrac{1}{1-8}=\boxed{-\dfrac{1}{7}}$.

l) $3F^2(-1)=3(F(-1)^2)=3(2^2)=3(4)=\boxed{12}$.