## Math 70 Additional Final Exam Review

1) *Find the inverse of each function.*
   a. $f(x) = 64x^3 - 1$
   b. $g(x) = \sqrt[3]{64x - 1}$
   c. $h(x) = (64x - 1)^3$
   d. $k(x) = 64\sqrt[3]{x} - 1$
   e. $m(x) = 64\sqrt[3]{x - 1}$
2) *Find all intercepts of*
   a. $2x + 3y = 12$
   b. $f(x) = -\frac{1}{4}x - 7$
   c. $f(x) = -2(x - 3)^2 + 4$
3) *Use the function* $f(x) = x^3 - x^2 + x - 1$
   a. *Find f(1)*
   b. *Find f(-1)*
   c. *Find all intercepts.*
4) *Write a linear function with the given characteristics.*
   a. *Slope is* $-\frac{2}{3}$ *and y-intercept is -5*
   b. *Slope is* $-\frac{2}{3}$ *and pass through (1, -5)*
   c. *Pass through (1, -5) and (-2, 3)*
   d. *X-intercept is -5 and y-intercept is 2*
5) *Solve the inequality and write the solution using interval notation.*
   a. $x^2 - 4 < 0$
   b. $x^2 - 9 \leq 0$
   c. $x^2 > 9$
   d. $\frac{x^2-16}{x+3} \geq 0$
   e. $x^3 - x^2 + x - 1 \geq 0$
6) *Write an equation and solve the problem.*
   a. *If you pay $300 for a 64-GB device, this is 20% more than the price of a 32-GB device. What is the price of the 32-GB device?*
   b. *If you pay $120 for a TI-84CE, this is 20% less than the price of a TI-89. What is the price of the TI-89?*
7) *Write equation(s) and solve the problem.*
   a. *A pharmacist needs 70 liters of a 50% alcohol solution. She has available 30% and 80% solutions. How many liters of each solutions should she mix to obtain 70 liters of a 50% alcohol solution?*
   b. *Find how many quarts of 4% butterfat milk and 1% butterfat milk should be mixed to yield 60 quarts of 2% butterfat milk?*
   c. *A pharmacist needs 500 ml of a 20% phenobarbital solution but has only 5% and 25% phenobarbital solutions available. Find how many milliliters of each she should mix to get the desired solution.*
8) *Write an equation and solve the problem.*
   a. *You walk 1.5 mph faster than your friend. You walk 7 miles in the same time that your friend walks 4 miles. Find both speeds.*
   b. *You drive 6 hours on a level highway and then 2 hours more in the mountains. Your speed in the mountains is 20 mph slower. You drive a total of 300 miles. What is your rate in the mountains?*
   c. *You drive 6 hours on a level highway and then 2 hours more in the mountains. Your speed in the mountains is 20 mph slower. You drive 300 miles more on the level than in the mountains. What is your speed in the mountains?*

9) *Solve each equation.*

a. $log_2(x^2 + x) - log_2(x + 1) = 0$

b. $log_2(x^2 + 2) + log_2(x + 1) = 0$

c. $log_2(3x - 1) = 1$

10) *Write an equation and solve the problem.*

a. *y varies directly as the square of x.* $y = 10$ *when* $x = 2$. *Find y when* $x = 3$.

b. *y varies inversely as the square of x.* $y = 10$ *when* $x = 2$. *Find y when* $x = 3$.

c. *y varies jointly as x and inversely as the square of z.* $y = 10$ *when* $x = 2$ *and* $z = 3$. *Find y when* $x = 3$ *and* $z = 5$.

11) *Solve each system. Write each solution as an ordered triple.*

a. $\begin{cases} -x - y - z = 1.6 \\ 2x - y - 3z = 7.2 \\ 2x + 2y + 5z = -6 \end{cases}$

b. $\begin{cases} 5x - 3y + z = -12 \\ x + 2z = -3.75 \\ y - z = 3.75 \end{cases}$

c. $\begin{cases} 4x + y - z = \frac{5}{3} \\ x - 3y + z = \frac{37}{3} \\ 2x + 5z = \frac{8}{3} \end{cases}$

12) *Solve each equation.*

a. $x^2 = 16$

b. $x^2 = -16$

c. $(3x - 1)^2 = 16$

d. $(3x - 1)^2 = 15$

e. $3x^2 - x = 15$

Math 10 Additional Final Exam Review

① find inverses

a) $f(x) = 64x^3 - 1$

step 1: replace $f(x)$ by $y$

step 2: swap $x \leftrightarrow y$

step 3: use algebra to isolate $y$

$y = 64x^3 - 1$

$x = 64y^3 - 1$

$x + 1 = 64y^3$

$\frac{x+1}{64} = y^3$

$\sqrt[3]{\frac{x+1}{64}} = y$

$\frac{\sqrt[3]{x+1}}{\sqrt[3]{64}} = y$

$\frac{\sqrt[3]{x+1}}{4} = y$

step 4: replace $y$ by $f^{-1}(x)$ notation

$$\boxed{f^{-1}(x) = \frac{\sqrt[3]{x+1}}{4}}$$

or $\boxed{f^{-1}(x) = \frac{1}{4}\sqrt[3]{x+1}}$

b) $g(x) = \sqrt[3]{64x - 1}$

$y = \sqrt[3]{64x - 1}$

$x = \sqrt[3]{64y - 1}$

$x^3 = 64y - 1$

$x^3 + 1 = 64y$

$\frac{x^3+1}{64} = y$

$$\boxed{g^{-1}(x) = \frac{x^3+1}{64}}$$

or

$$\boxed{g^{-1}(x) = \frac{1}{64}(x^3+1)}$$

c) $h(x) = (64x-1)^3$

$y = (64x-1)^3$

$x = (64y-1)^3$

$\sqrt[3]{x} = 64y - 1$

$\sqrt[3]{x} + 1 = 64y$

$\frac{\sqrt[3]{x}+1}{64} = y$

$\boxed{h^{-1}(x) = \frac{\sqrt[3]{x}+1}{64}}$ or $\boxed{h^{-1}(x) = \frac{1}{64}\left(1+\sqrt[3]{x}\right)}$

d) $k(x) = 64\sqrt[3]{x} - 1$

$y = 64\sqrt[3]{x} - 1$

$x = 64\sqrt[3]{y} - 1$

$x + 1 = 64\sqrt[3]{y}$

$\frac{x+1}{64} = \sqrt[3]{y}$

$\left(\frac{x+1}{64}\right)^3 = y$

$\boxed{k^{-1}(x) = \left(\frac{x+1}{64}\right)^3}$ or $\boxed{k^{-1}(x) = \frac{(x+1)^3}{262144}}$

e) $m(x) = 64\sqrt[3]{x-1}$

$y = 64\sqrt[3]{x-1}$

$x = 64\sqrt[3]{y-1}$

$\frac{x}{64} = \sqrt[3]{y-1}$

$\left(\frac{x}{64}\right)^3 = y - 1$

$\left(\frac{x}{64}\right)^3 + 1 = y$

$\boxed{m^{-1}(x) = \left(\frac{x}{64}\right)^3 + 1}$ or $\boxed{m^{-1}(x) = \frac{x^3}{262144} + 1}$

or $\boxed{m^{-1}(x) = \frac{x^3+262144}{262144}}$ with CD

② Find all intercepts of

a) $2x + 3y = 12$

x int: set $y = 0$

$2x + 3(0) = 12$

$2x = 12$

$x = 6$ $\boxed{(6, 0)}$

y int: set $x = 0$

$2(0) + 3y = 12$

$3y = 12$

$y = 4$ $\boxed{(0, 4)}$

b) $f(x) = -\frac{1}{4}x - 7$

x-int: $0 = -\frac{1}{4}x - 7$

$7 = -\frac{1}{4}x$

$-28 = x$ $\boxed{(-28, 0)}$

y-int: $f(0) = -\frac{1}{4}(0) - 7$

$= -7$ $\boxed{(0, -7)}$

c) $f(x) = -2(x-3)^2 + 4$

x-int: $0 = -2(x-3)^2 + 4$

$\frac{-4}{-2} = \frac{-2(x-3)^2}{-2}$

$2 = (x-3)^2$

$\pm\sqrt{2} = x - 3$

$3 \pm \sqrt{2} = x$ $\boxed{(3+\sqrt{2}, 0)}$ $\boxed{(3-\sqrt{2}, 0)}$

y-int: $f(0) = -2(0-3)^2 + 4$

$= -2(-3)^2 + 4$

$= -2(9) + 4$

$= -18 + 4$

$= -14$ $\boxed{(0, -14)}$

③ $f(x) = x^3 - x^2 + x - 1$

a) $f(1) = 1^3 - 1^2 + 1 - 1$

$= 1 - 1 + 1 - 1$

$= \boxed{0}$

b) $f(-1) = (-1)^3 - (-1)^2 + (-1) - 1$

$= -1 - (1) - 1 - 1$

$= -1 - 1 - 1 - 1$

$= \boxed{-4}$

c) x-int: $0 = x^3 - x^2 + x - 1$

$0 = x^2(x-1) + 1(x-1)$ factor by grouping

$0 = (x-1)(x^2+1)$

$x - 1 = 0$ $\quad x^2 + 1 = 0$

$x = 1$ $\quad x^2 = -1$

$x = \pm\sqrt{-1}$

$\boxed{(1,0)}$ $\quad x = \pm i$ not real, not an intercept

y-int: $f(0) = 0^3 - 0^2 + 0 - 1$

$= -1$

$\boxed{(0,-1)}$

④ linear functions $f(x) = mx + b$ ⇐ slope-intercept form

↑ function notation, ↑ slope $m$, ↑ y-intercept $b$.

a) slope $\frac{-2}{3}$, y int $-5$

$\boxed{f(x) = -\frac{2}{3}x - 5}$

b) slope $-\frac{2}{3}$ through $(1,-5)$

$f(x) = -\frac{2}{3}x + b$

$f(1) = -\frac{2}{3}(1) + b = -5$

$-\frac{2}{3} + b = -5$

$b = -5 + \frac{2}{3}$

$$b = \frac{-15}{3} + \frac{2}{3}$$

$$b = \frac{-13}{3}$$

$$\boxed{f(x) = -\frac{2}{3}x - \frac{13}{3}}$$

method 2: point-slope formula $y - y_1 = m(x - x_1)$

$$y - (-5) = -\frac{2}{3}(x - 1)$$

$$y + 5 = -\frac{2}{3}x + \frac{2}{3}$$

$$y = -\frac{2}{3}x + \frac{2}{3} - 5$$

$$y = -\frac{2}{3}x + \frac{2}{3} - \frac{15}{3}$$

$$y = -\frac{2}{3}x - \frac{13}{3}$$

$$\boxed{f(x) = -\frac{2}{3}x - \frac{13}{3}}$$

c) Passing through $(1, -5)$ and $(-2, 3)$

find slope $m = \frac{y_2 - y_1}{x_2 - x_1}$

$$= \frac{3 - (-5)}{-2 - 1}$$

$$= \frac{3 + 5}{-3}$$

$$m = -\frac{8}{3}$$

$$y + 5 = -\frac{8}{3}(x - 1)$$

$$y + 5 = -\frac{8}{3}x + \frac{8}{3}$$

$$y = -\frac{8}{3}x + \frac{8}{3} - 5$$

$$y = -\frac{8}{3}x + \frac{8}{3} - \frac{15}{3}$$

$$y = -\frac{8}{3}x - \frac{7}{3}$$

$$\boxed{f(x) = -\frac{8}{3}x - \frac{7}{3}}$$

d) x int is $-5$ and y-int is 2.

$(-5, 0)$ and $(0, 2)$

find slope $m = \frac{y_2 - y_1}{x_2 - x_1}$

$= \frac{2-0}{0-(-5)}$

$= \frac{2}{5}$

slope-intercept: $y = mx + b$

$y = \frac{2}{5}x + 2$

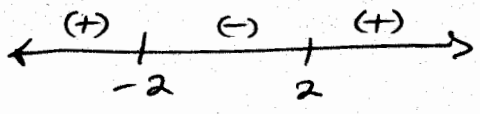
$\boxed{f(x) = \frac{2}{5}x + 2}$

(3) Solve, interval notation

a) $x^2 - 4 < 0$

$(x-2)(x+2) = 0$ temporarily set $= 0$

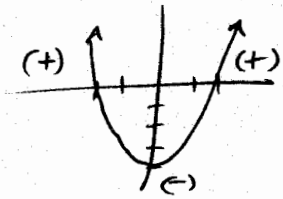
$x = 2 \quad x = -2$ solve for values




plot values on a sign chart

GC $\boxed{y=}$ $y_1 = x^2 - 4$

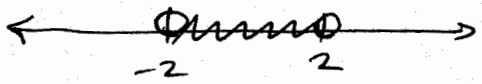
Test by graphing




Test by Table

| x | y | |
|---|---|---|
| −3 | 5 | (+) |
| 0 | −4 | (−) |
| 3 | 5 | (+) |

Original question $< 0$ $\Rightarrow$ want negatives.




Original question $< 0$ $\Rightarrow$ exclude $= 0$.

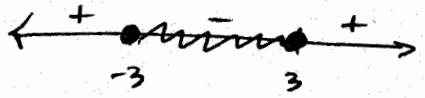
Interval notation

$-2 < x < 2$ set notation

$\boxed{(-2, 2)}$ interval notation

b) $x^2 - 9 \leq 0$

$(x-3)(x+3) \leq 0$




same as previous, only endpoints included with $\leq 0$.

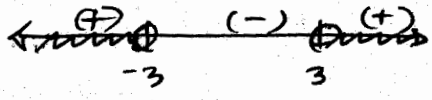
$[-3, 3]$

c) $x^2 > 9$

$x^2 - 9 > 0$

need 0 on RHS to ask (+) or (−)

$(x-3)(x+3) > 0$




same as previous, only exclude endpoints and $> 0$ means (+) are solutions.

$\boxed{(-\infty, -3) \cup (3, \infty)}$

d) $\dfrac{x^2-16}{x+3} \geq 0$

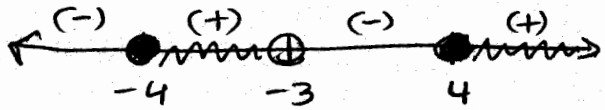
$x \neq -3$ so $-3$ goes on sign chart!! exclude always

$\dfrac{x^2-16}{x+3} = 0$

$x^2 - 16 = 0$

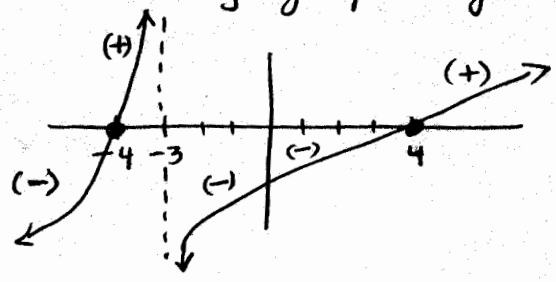
$(x-4)(x+4) = 0$

$x = 4, -4$ also go on sign chart — include because $\geq 0$ (with $=$)




GC [y=] $y_1 = (x^2 - 16) / (x+3)$ parentheses required.

Test by graphing




Test by table

| x | y | |
|---|---|---|
| −5 | −4.5 | (−) |
| −3.5 | 7.5 | (+) |
| 0 | $-5\frac{1}{3}$ | (−) |
| 5 | 1.125 | (+) |

original $\geq 0$ means (+) are solutions.

$\boxed{[-4, -3) \cup [4, \infty)}$

e) $x^3 - x^2 + x - 1 \geq 0$

Factor by grouping

$x^2(x-1) + 1(x-1) \geq 0$

$(x^2+1)(x-1) \geq 0$

$x^2 + 1 = 0$

$x^2 = -1$

$x = \pm\sqrt{-1}$

$x = \pm i$

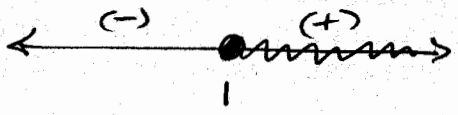
not real

$x - 1 = 0$

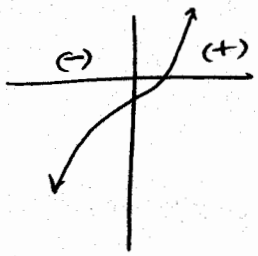
$x = 1$

only this on sign chart

included because $\geq 0$ (with =)




Test by Graphing




test by table

| x | y | |
|---|---|---|
| 0 | −1 | (−) |
| 2 | 5 | (+) |

want (+) because $\geq 0$

$\boxed{[1, \infty)}$

⑥ Equation, solve.

a) \$300 for 64 GB is 20% more than 32 GB.

$$\begin{pmatrix}\text{32 GB}\\ \text{price}\end{pmatrix} + 20\% \begin{pmatrix}\text{32 GB}\\ \text{price}\end{pmatrix} = \begin{pmatrix}\text{64 GB}\\ \text{price}\end{pmatrix}$$

Percent increase

$x + .2x = 300$

$1 + .2$ combine like terms

$\frac{1.2x}{1.2} = \frac{300}{1.2}$

$x = \boxed{\text{\$250 for 32 GB}}$

b) $120 for TI-84 CE is 20% less than TI-89. Find TI-89.

(TI-89) − 20%(TI-89) = (TI-84 CE)  percent decrease

$x - .2x = 120$

1 − .2 combine like terms

$\frac{.8x}{.8} = \frac{120}{.8}$

$x =$ **$150 for TI-89**

⑦ Equation(s), solve

a) Need 70 L of 50%, have 30% and 80%
($x$ and $y$)

$x + y = 70$  Volume

30% of $x$ + 80% of $y$ = 50% of 70

$.3x + .8y = .5(70)$ ← alcohol

* every term has % of volume *

$$\begin{cases} x + y = 70 \\ .3x + .8y = 35 \end{cases}$$

2x3 matrix ⇒ RREF

$$\begin{bmatrix} 1 & 0 & 42 \\ 0 & 1 & 28 \end{bmatrix}$$

$x =$ **42 L of 30%**

$y =$ **28 L of 80%**

b) Need 60 qts 2%, have 4% and 1%
($x$ and $y$)

$x + y = 60$

$.04x + .01y = .02(60)$

$$\begin{cases} x + y = 60 \\ .04x + .01y = 1.2 \end{cases}$$

$$\begin{bmatrix} 1 & 0 & 20 \\ 0 & 1 & 40 \end{bmatrix}$$

$x =$ **20 L 4% milk**

$y =$ **40 L 1% milk**

c) Need 500 ml of 20%, have 5% and 25%.
$x$ $y$

$$x + y = 500$$
$$.05x + .25y = .20(500)$$

$$\begin{cases} x + y = 500 \\ .05x + .25y = 100 \end{cases}$$

$$\begin{bmatrix} 1 & 0 & 125 \\ 0 & 1 & 375 \end{bmatrix}$$

$x =$ 125 ml of 5%
$y =$ 375 ml of 25%

(B) eqn, solve.

a) I am 1.5 mph faster than friend.
I walk 7 miles, same time as friend 4 miles.
Find speeds

$D = R \cdot T$ $\qquad T = \frac{D}{R}$

| | D | R | T |
|---|---|---|---|
| me | 7 | $r+1.5$ | $\frac{7}{r+1.5}$ |
| friend | 4 | $r$ | $\frac{4}{r}$ |

(Same)

set times equal

$$\frac{7}{r+1.5} = \frac{4}{r}$$

rational equation → mult by LCD $r(r+1.5)$
OR cross-multiply.

$$7r = 4(r+1.5)$$

$$7r = 4r + 6$$
$$-4r \quad -4r$$
$$3r = 6$$

$r =$ 2 mph meg friend

$r + 1.5 =$ 3.5 mph me

b) 6 hrs level
2 hrs mtns 20 mph slower
total 300 miles
rate in mountains?

$D = R \cdot T$

| | | | |
|---|---|---|---|
| level | $6(R+20)$ | $R+20$ | 6 |
| mtns | $2R$ | $R$ | 2 |

$6(R+20) + 2R = 300$ total distance
$6R + 120 + 2R = 300$
$8R + 120 = 300$
$\frac{8R}{8} = \frac{180}{8}$
$R = \boxed{22.5 \text{ mph}}$

c) 6 hrs level
2 hrs mtns, 20 mph slower.
300 miles more on level.
rate in mountains?

$D = R \cdot T$

| | | | |
|---|---|---|---|
| level | $D+300$ | $R+20$ | 6 |
| mtns | $D$ | $R$ | 2 |

$$\begin{cases} D+300 = 6(R+20) & \text{(A)} \\ D = 2R \end{cases}$$

(A) $D+300 = 6R+120$
$D = 6R - 180$

system of equations
$$\begin{cases} D = 6R-180 \\ D = 2R \end{cases}$$

$6R - 180 = 2R$

$-180 = -4R$

$\frac{-180}{-4} = R$

$R = \boxed{45 \text{ mph}}$ in mts

⑨ Solve

a) $\log_2(x^2+x) - \log_2(x+1) = 0$

Method 1: $\log_2\left(\frac{x^2+x}{x+1}\right) = 0$ $\quad \log_b a - \log_b c = \log_b\left(\frac{a}{c}\right)$

$2^0 = \frac{x^2+x}{x+1}$ exponential form

$1 = \frac{x^2+x}{x+1}$ rational equation

$x+1 = x^2+x$ quadratic equation

$x^2 - 1 = 0$

$(x+1)(x-1) = 0$

$x = -1$ $\quad \boxed{x=1}$

↑ extraneous

Method 2: $\log_2\left(\frac{x^2+x}{x+1}\right) = 0$ notice $x^2+x$ factors! $x(x+1)$

$\log_2\left(\frac{x(x+1)}{(x+1)}\right) = 0$ cancel common factor.

$\log_2(x) = 0$

$2^0 = x$

$\boxed{x=1}$

b) $\log_2(x+2) + \log_2(x+1) = 0$

$\log_2[(x+2)(x+1)] = 0$

$2^0 = (x+2)(x+1)$

$1 = x^2 + 3x + 2$

$0 = x^2 + 3x + 1$

$x = \dfrac{-3 \pm \sqrt{9-4(1)(1)}}{2(1)}$

$x = \dfrac{-3 \pm \sqrt{9-4}}{2}$

$\boxed{x = \dfrac{-3+\sqrt{5}}{2}}$

$\dfrac{-3+\sqrt{5}}{2} \approx -.38$ ok.

extraneous

$\dfrac{-3-\sqrt{5}}{2} \approx -2.6$ NO.

c) $\log_2(3x-1) = 1$

$2^1 = (3x-1)$

$2 = 3x - 1$

$3 = 3x$

$\boxed{1 = x}$

(10) write eqn, solve

a) $y$ varies directly as square of $x$.
$y = 10$ when $x = 2$

$y = kx^2$

$10 = k(2)^2$

$10 = k \cdot 4$

$\frac{10}{4} = k$

$\frac{5}{2} = k$

find $y$ when $x = 3$ $\quad y = \frac{5}{2}(3)^2$

$y = \frac{5}{2} \cdot 9$

$y = \boxed{\frac{45}{2}}$

(10) b) $y$ varies inversely as $x^2$. $y = \frac{k}{x^2}$

$y = 10$ when $x = 2$ $10 = \frac{k}{2^2}$

$10 = \frac{k}{4}$

$40 = k$

find $y$ when $x = 3$ $y = \frac{k}{x^2} = \frac{40}{x^2}$

$y = \frac{40}{3^2} = \boxed{\frac{40}{9}}$

c) $y$ varies jointly as $x$ and inversely as square of $z$: $y = \frac{k \cdot x}{z^2}$

$y = 10$ and $x = 2$ and $z = 3$ $10 = \frac{k(2)}{3^2}$

$10 = \frac{2k}{9}$

$90 = 2k$

$45 = k$

find $y$ when $x = 3$ and $z = 5$ $y = \frac{kx}{z^2} = \frac{45x}{z^2}$

$y = \frac{45(3)}{5^2}$

$y = \boxed{5.4} = \boxed{\frac{27}{5}}$

(11) Solve, ordered triples.

a) $\begin{cases} -x - y - z = 1.6 \\ 2x - y - 3z = 7.2 \\ 2x + 2y + 5z = -6 \end{cases}$

Matrix input $\begin{bmatrix} -1 & -1 & -1 & 1.6 \\ 2 & -1 & -3 & 7.2 \\ 2 & 2 & 5 & -6 \end{bmatrix}$

Matrix output with [MATH] 1. > frac $\begin{bmatrix} 1 & 0 & 0 & 56/45 \\ 0 & 1 & 0 & -86/45 \\ 0 & 0 & 1 & -14/15 \end{bmatrix}$

translate $1x + 0y + 0z = \frac{56}{45}$ means $x = \frac{56}{45}$

$0x + 1y + 0z = \frac{-86}{45}$ means $y = \frac{-86}{45}$

$0x + 0y + 1z = \frac{-14}{15}$ means $z = \frac{-14}{15}$

solution as ordered triple: $\boxed{\left(\frac{56}{45}, \frac{-86}{45}, \frac{-14}{15}\right)}$

b) $\begin{cases} 5x - 3y + z = -12 \\ x + 2z = -3.75 \\ y - z = 3.75 \end{cases}$

← This equation has no y! Need placeholder $0y$.

This equation has no x! Need placeholder $0x$. →

$$\begin{cases} 5x - 3y + 1z = -12 \\ 1x + 0y + 2z = -3.75 \\ 0x + 1y - 1z = 3.75 \end{cases}$$

Input matrix $\begin{bmatrix} 5 & -3 & 1 & -12 \\ 1 & 0 & 2 & -3.75 \\ 0 & 1 & -1 & 3.75 \end{bmatrix}$

Output matrix $\begin{bmatrix} 1 & 0 & 0 & -.75 \\ 0 & 1 & 0 & 2.25 \\ 0 & 0 & 1 & -1.5 \end{bmatrix}$ OR $\begin{matrix} -3/4 \\ 9/4 \\ -3/2 \end{matrix}$

solution $\boxed{(-.75, 2.25, -1.5)}$ or $\boxed{\left(\frac{-3}{4}, \frac{9}{4}, \frac{-3}{2}\right)}$

c) $\begin{cases} 4x + y - z = 5/3 \\ x - 3y + z = 37/3 \\ 2x + 5z = 8/3 \end{cases}$

Input matrix $\begin{bmatrix} 4 & 1 & -1 & 5/3 \\ 1 & -3 & 1 & 37/3 \\ 2 & 0 & 5 & 8/3 \end{bmatrix}$

Output matrix $\begin{bmatrix} 1 & 0 & 0 & \frac{4}{3} \\ 0 & 1 & 0 & \frac{-11}{3} \\ 0 & 0 & 1 & 0 \end{bmatrix}$

Solution $\boxed{\left(\frac{4}{3}, \frac{-11}{3}, 0\right)}$

(12) Solve.

a) $x^2 = 16$

$x = \pm\sqrt{16}$

$\boxed{x = \pm 4}$

b) $x^2 = -16$

$x = \pm\sqrt{-16}$

$\boxed{x = \pm 4i}$

c) $(3x-1)^2 = 16$

$3x - 1 = \pm\sqrt{16}$

$3x - 1 = \pm 4$

$3x - 1 = 4$ $\qquad$ $3x - 1 = -4$

$3x = 5$ $\qquad$ $3x = -3$

$\boxed{x = 5/3}$ $\qquad$ $\boxed{x = -1}$

d) $(3x-1)^2 = 15$

$3x - 1 = \pm\sqrt{15}$

$3x = 1 \pm \sqrt{15}$

$\boxed{x = \frac{1 \pm \sqrt{15}}{3}}$ or $\boxed{x = \frac{1}{3} \pm \frac{\sqrt{15}}{3}}$

e) $3x^2 - x = 15$

$3x^2 - x - 15 = 0$

Quadratic formula

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{-(-1) \pm \sqrt{(-1)^2 - 4(3)(-15)}}{2(3)}$$

$$x = \frac{1 \pm \sqrt{1 + 180}}{6}$$

$$\boxed{x = \frac{1 \pm \sqrt{181}}{6}}$$

181 is prime!