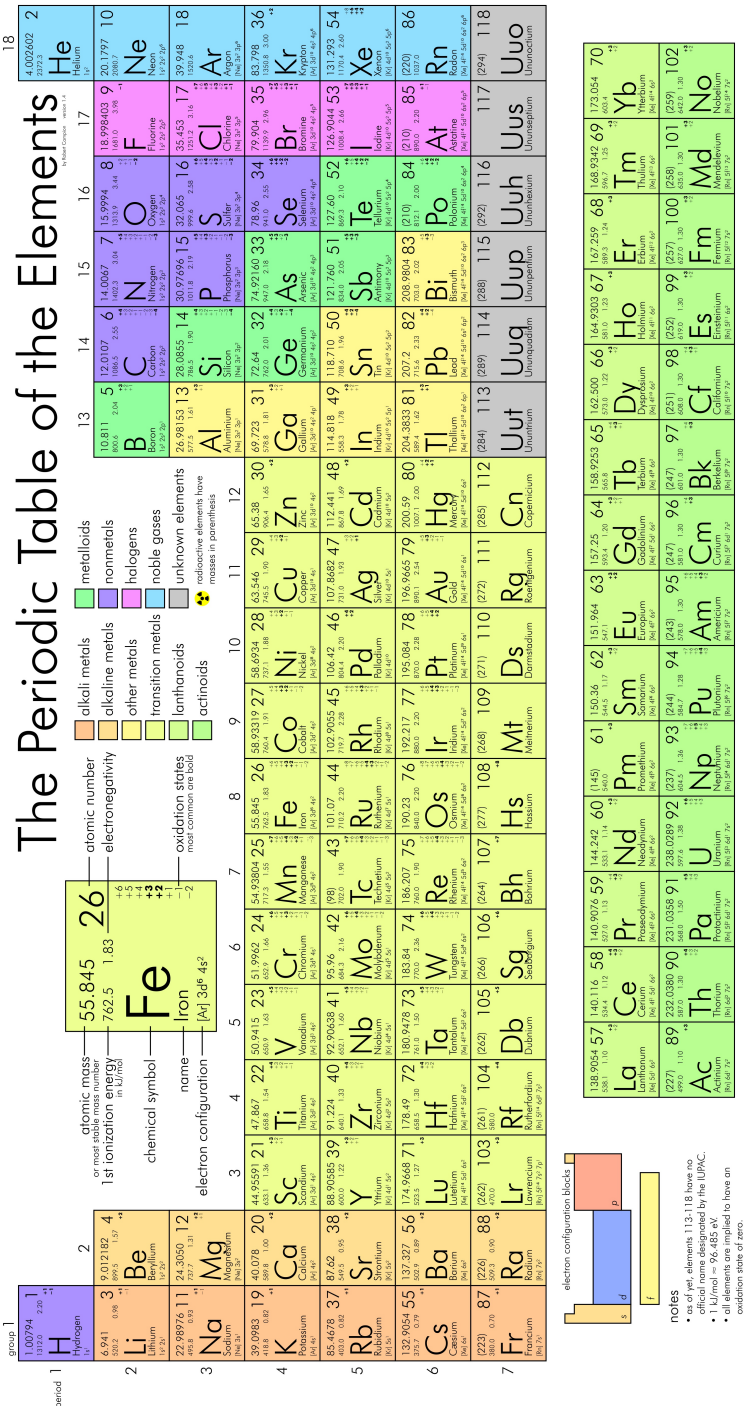
Instructor:	Frank Secretain
Course:	Math 150
Date:	June 18, 2025
Assessment:	Final
Time allowed:	110 minutes
Devices allowed:	Pencil, pen, eraser, calculator
Notes from instructor:	Be neat. Show your work where needed. Box final answers.
Marks allocated:	10 questions worth 30 marks
Percentage of final grade:	30% of final grade



Formula Sheet

Order of Operations

$$ac + bc = c(a + b)$$

exponents

$$a^n a^m = a^{n+m}$$

$$(a^n)^m = a^{nm}$$

$$(ab)^n = a^n b^n$$

$$a^0 = 1$$

$$a^{-n} = \frac{1}{a^n}$$

radicals

$$a^{\frac{n}{m}} = \sqrt[m]{a^n}$$

Unit Conversions

angles

$$2\pi = 6.28\,\text{rad} = 360^o$$

mass

$$1\,\text{kg} = 2.2\,\text{lbs.}$$

lengths

$$1\,\text{mile} = 1.6\,\text{km}$$
$$1\,\text{inch} = 2.54\,\text{cm}$$
$$1\,\text{m} = 3.3\,\text{ft}$$

volumes

$$1\,\text{gallon} = 3.78\,\text{Litres}$$

Concentrations (assume density of solvent water = 1 g/mL)

$$C = M/V = M/M = V/V$$

percentage (%)

$$x\%(w/v) = \frac{x[g]}{100[mL]} \qquad x\%(v/v) = \frac{x[mL]}{100[mL]} \qquad x\%(w/w) = \frac{x[g]}{100[g]}$$

parts

$$pph = x\%(w/v) \qquad ppt = \frac{x[g]}{1[L]} \qquad ppm = \frac{x[mg]}{1[L]} \qquad ppb = \frac{x[\mu g]}{1[L]}$$

molarity

M = molarity $\frac{[moles]}{[L]}$ FW = formula weight $\frac{[g]}{[mole]}$

Dilutions

$$C_1V_1 = C_2V_2$$

dilution = $\frac{\text{solute volume}}{\text{total/final volume}}$ dilution factor (DF) = $\frac{1}{\text{dilution}}$

(2 marks) Determine

a) the total number of significant digits and

b) re-write the number in scientific notation

for the following number:

200

a) significant digits = _____

b) scientific notation = _____

0.0200

a) significant digits = _____

b) scientific notation = _____

.(4 marks) Solve for x in the following equation.

$$2ax + 14 = c$$

$$\frac{2a}{x} = \frac{w}{v}$$

(4 marks) Given the standard unit conversion table on the formula sheet (1st page), convert each of the numbers to the stated units.

$$12\ \frac{\text{m}}{\text{gallon}} \rightarrow \frac{\text{ft}}{\text{L}}$$

$$74.3\ \frac{\text{lbs.}}{\text{minute}} \rightarrow \frac{\text{kg}}{\text{day}}$$

$$12\ \frac{\text{kg}}{\text{L}} \rightarrow \frac{\text{g}}{100\ \text{mL}}$$

(2 marks) Prepare 1.5 L of a 0.75% (w/v) magnesium chloride solution.

(2 marks) Prepare a 3:2 water:alcohol solution using 84 mL of water.

(2 marks) Prepare a 1.2 M glucose solution using 180 g/mol as the formula weight, and a total volume of 150 mL.

(3 marks) Dilute 15 mL of a 6.0 M NaCl solution to 100 mL. Then take 25 mL of that and dilute it to 250 mL. What is the final concentration?

(3 marks) Dilute 7.0 mL of a 4.5 M $CaCl_2$ solution to 85 mL. Then take 15 mL and dilute it to 250 mL. What is the final concentration in molarity?

(4 marks) You dissolve 180 g of glucose (FW = 180 g/mol) in 400 mL of water and then dilute the solution to 2.0 L. What is the final concentration in % (w/v) and molarity?

(4 marks) Dilute 5.0 mL of a 1.2 % (w/v) $CaCl_2$ solution to 50 mL. Then take 10 mL and dilute it to 250 mL. What is the final concentration in % (w/v) and parts?

(2 marks) Determine

a) the total number of significant digits and

b) re-write the number in scientific notation

for the following number:

200

a) significant digits = 1

b) scientific notation = 2×10^2

0.0200

a) significant digits = 3

b) scientific notation = 2.00×10^{-2}

.(4 marks) Solve for x in the following equation.

$$2ax + 14 = c$$

-14 -14

$$\frac{2ax}{2a} = \frac{c - 14}{2a}$$

$$\boxed{x = \frac{c - 14}{2a}}$$

$$v \cancel{x}\left(\frac{2a}{\cancel{x}}\right) = \left(\frac{w}{\cancel{v}}\right)\cancel{v}x$$

$$\frac{2av}{w} = \frac{wx}{w}$$

$$\boxed{x = \frac{2av}{w}}$$

(4 marks) Given the standard unit conversion table on the formula sheet (1st page), convert each of the numbers to the stated units.

$$12\ \frac{\text{m}}{\text{gallon}} \rightarrow \frac{\text{ft}}{\text{L}}$$

$$12\ \frac{\text{m}}{\text{gal}}\left(\frac{3.3\ \text{ft}}{1\ \text{m}}\right)\left(\frac{1\ \text{gal}}{3.78\ \text{L}}\right) = 10.476\ \frac{\text{ft}}{\text{L}}$$

$$\boxed{1.0 \times 10^{1}\ \frac{\text{ft}}{\text{L}}}$$

$$74.3\ \frac{\text{lbs.}}{\text{minute}} \rightarrow \frac{\text{kg}}{\text{day}}$$

$$74.3\ \frac{\text{lbs.}}{\text{min.}}\left(\frac{1\ \text{kg}}{2.2\ \text{lbs.}}\right)\left(\frac{60\ \text{min}}{1\ \text{hour}}\right)\left(\frac{24\ \text{hours}}{1\ \text{day}}\right) = 48\,632.7\ \frac{\text{kg}}{\text{day}}$$

$$\boxed{48600\ \frac{\text{kg}}{\text{day}}}$$

$$12\ \frac{\text{kg}}{\text{L}} \rightarrow \frac{\text{g}}{100\ \text{mL}}$$

$$12\ \frac{\text{kg}}{\text{L}}\left(\frac{1000\ \text{g}}{1\ \text{kg}}\right)\left(\frac{1\ \text{L}}{1000\ \text{mL}}\right)\left(\frac{100\ \text{mL}}{100\ \text{mL}}\right) = 1200\ \frac{\text{g}}{100\ \text{mL}}$$

$$\boxed{1200\ \frac{\text{g}}{100\text{mL}}}$$

(2 marks) Prepare 1.5 L of a 0.75% (w/v) magnesium chloride solution.

units:

$$0.75\,\%(w/v) = 0.75\ \frac{g}{100\,mL} = \frac{0.75\,g}{100\,mL}$$

concentration:

$$C = \frac{m}{V}$$

$$\left[\frac{0.75\,g}{100\,mL}\right] = \frac{m}{[1.5\,L]}$$

$$m = \frac{(0.75\,g)(1.5\,\cancel{L})}{100\,\cancel{mL}}\left(\frac{1000\,\cancel{mL}}{1\,\cancel{L}}\right)$$

$$m = 11.25\,g$$

$$\boxed{m = 11\,g}$$

(2 marks) Prepare a 3:2 water:alcohol solution using 84 mL of water.

total parts = 3 + 2 = 5 parts

concentration (water):

$$C = \frac{\forall_{water}}{\forall_{total}}$$

$$\left[\frac{3 \text{ parts}}{5 \text{ parts}}\right] = \frac{[84 \text{ mL}]}{\forall_{total}}$$

$$\forall_{total} = \frac{(5 \text{ parts})(84 \text{ mL})}{3 \text{ parts}} = 140 \text{ mL}$$

$$\boxed{\forall_{total} = 140 \text{ mL}}$$

concentration (alcohol):

$$C = \frac{\forall_{alcohol}}{\forall_{total}}$$

$$\left[\frac{2 \text{ parts}}{5 \text{ parts}}\right] = \frac{\forall_{alcohol}}{[140 \text{ mL}]}$$

$$\forall_{alcohol} = \frac{(2 \text{ parts})(140 \text{ mL})}{5 \text{ parts}} = 56 \text{ mL}$$

$$\boxed{\forall_{alcohol} = 56 \text{ mL}}$$

(2 marks) Prepare a 1.2 M glucose solution using 180 g/mol as the formula weight, and a total volume of 150 mL.

units:

$$1.2\ M = 1.2\ \frac{\cancel{mol}}{L}\left(\frac{180\ g}{1\ \cancel{mol}}\right) = 216\ \frac{g}{L} = \frac{216\ g}{1L}$$

concentration:

$$C = \frac{m}{\cancel{V}}$$

$$\left[\frac{216\ g}{1L}\right] = \frac{m}{[150\ mL]}$$

$$m = \frac{(216\ g)(150\ \cancel{mL})}{\cancel{1L}}\left(\frac{\cancel{1L}}{1000\ \cancel{mL}}\right) = 32.4\ g$$

$$\boxed{m = 32\ g}$$

(3 marks) Dilute 15 mL of a 6.0 M NaCl solution to 100 mL. Then take 25 mL of that and dilute it to 250 mL. What is the final concentration?

assume $100\ mL = 1.00 \times 10^2\ mL$

dilution 1:

$$C_1 V_1 = C_2 V_2$$

$$[6.0\,M][15\,mL] = C_2[100\,mL]$$

$$C_2 = \frac{(6.0\,M)(15\,\cancel{mL})}{100\,\cancel{mL}} = 0.9\,M$$

dilution 2:

$$C_2 V_2 = C_3 V_3$$

$$[0.9\,M][25\,mL] = C_3[250\,mL]$$

$$C_3 = \frac{(0.9\,M)(25\,\cancel{mL})}{250\,\cancel{mL}} = 0.09\,M$$

$$\boxed{C_3 = 0.090\,mL}$$

(3 marks) Dilute 7.0 mL of a 4.5 M $CaCl_2$ solution to 85 mL. Then take 15 mL and dilute it to 250 mL. What is the final concentration in molarity?

dilution 1:

$$C_1 V_1 = C_2 V_2$$

$$[4.5\ M][7.0\ mL] = C_2[85\ mL]$$

$$C_2 = \frac{(4.5\ M)(7.0\ \cancel{mL})}{85\ \cancel{mL}} = 0.3706\ M$$

dilution 2:

$$C_2 V_2 = C_3 V_3$$

$$[0.3706\ M][15\ mL] = C_3[250\ mL]$$

$$C_3 = \frac{(0.3706\ M)(15\ \cancel{mL})}{250\ \cancel{mL}} = 0.02224\ M$$

$$\boxed{C_3 = 0.022\ M}$$

(4 marks) You dissolve 180 g of glucose (FW = 180 g/mol) in 400 mL of water and then dilute the solution to 2.0 L. What is the final concentration in % (w/v) and molarity?

assume $400\ mL = 4.00 \times 10^2\ mL$

concentration:

$$C_1 = \frac{m}{v} = \frac{180\ g}{400\ mL} = 0.45\ \frac{g}{mL} = \frac{0.45\ g}{1\ mL}$$

dilution:

$$C_1 V_1 = C_2 V_2$$

$$\left[\frac{0.45\ g}{1\ mL}\right]\left[400\ mL\right] = C_2\left[2.0\ L\right]$$

$$C_2 = \frac{(0.45\ g)(400\ mL)}{(1\ mL)(2.0\ L)} = 90\ \frac{g}{L}$$

units:

$$C_2 = 90\ \frac{g}{L}\left(\frac{1\ L}{1000\ mL}\right)\left(\frac{100\ mL}{100\ mL}\right) = 9\ \frac{g}{100\ mL} = 9\%\ (w/v)$$

$$\boxed{C_2 = 9.0\%\ (w/v)}$$

$$C_2 = 90\ \frac{g}{L}\left(\frac{1\ mol}{180\ g}\right) = 0.5\ \frac{mol}{L} = 0.5\ M$$

$$\boxed{C_2 = 0.5\ M}$$

(4 marks) Dilute 5.0 mL of a 1.2 % (w/v) $CaCl_2$ solution to 50 mL. Then take 10 mL and dilute it to 250 mL. What is the final concentration in % (w/v) and parts?

assume: $50\ mL = 5.0 \times 10^1\ mL$ & $10\ mL = 1.0 \times 10^1\ mL$

dilution 1:

$$C_1 V_1 = C_2 V_2$$

$$[1.2\%][5\ mL] = C_2[50\ mL]$$

$$C_2 = \frac{(1.2\%)(5\ mL)}{50\ mL} = 0.12\ \%\ (w/v)$$

dilution 2:

$$C_2 V_2 = C_3 V_3$$

$$[0.12\%][10\ mL] = C_3[250\ mL]$$

$$C_3 = \frac{(0.12\%)(10\ mL)}{250\ mL} = 0.0048\ \%\ (w/v)$$

$$\boxed{C_3 = 0.0048\ \%\ (w/v)}$$

units:

$$C_3 = 0.0048\ \%\ (w/v) = 0.0048\ \frac{g}{100\ mL}\left(\frac{1000\ mL}{1L}\right)\left(\frac{1000\ mg}{1\ g}\right)$$

$$= 48\ \frac{mg}{L} = 48\ ppm$$

$$\boxed{C_3 = 48\ ppm}$$