General Chemistry 1 *(CHEM 1141)*

Shawnee State University – Fall 2024

October 10, 2024

Exam # 1 A

Name KEY

Please print your full name, and the exam version (1 A) that you have on the scantron sheet!
(Bubble in the best answer choice for each question on the scantron sheet in pencil!)

Please ☑ check the box next to your correct section number.

Section #:

- ❒ 1. (Mon Lab, 11:10 AM – 1:55 PM) } **Fleeman**
- ❒ 2. (Wed Lab, 11:10 AM – 1:55 PM) } **Fleeman**
- ❒ 3. (Tue Lab, 11:00 AM – 1:50 PM) } **Napper**
- ❒ 4. (Thu Lab, 11:00 AM – 1:50 PM) } **Napper**

Multiple Choice:	_____	**/ 50**
Q21:	_____	**/ 10**
Q22:	_____	**/ 10**
Q23:	_____	**/ 10**
Q24:	_____	**/ 10**
Q25:	_____	**/ 10**
BONUS:	_____	**/ 3**
TOTAL:	_____	**/ 100**

Each problem in this section (multiple choice) is worth 2.5 points!

Q1. The SI prefixes meaning 10^6 and 10^{-6} respectively are:

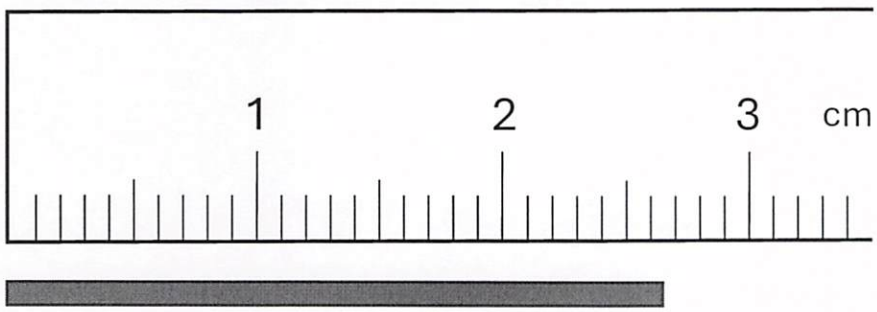
A) M, μ

B) M, m

C) G, μ

D) G, m

Q2. What is the correct reading for the length of the object below:



A) 2.6 cm

B) 2.06 cm

C) 2.64 cm

D) 2.064 cm

always read scales to 1/10 division marks!

2.6cm (markings) + 4/10 of way between 2.6 and 2.7

Q3. An example of a heterogeneous mixture could be:

A) pizza

B) oxygen

C) water

D) saline

Q4. Which of the following would be an example of a chemical property?

A) water boiling

B) ice melting

C) alcohol evaporating

D) iron rusting

} physical props (no change to ID of substance)

Q5. An example of a semi-metal element is:

A) F

B) Si

C) Mg

D) H

aka metalloid

Q6. An example of a naturally occurring diatomic element is:

A) iodine

B) potassium

C) carbon

D) mercury

"HOF BrINCl"

Hof-brin-kl

H_2 N_2 O_2 F_2 Cl_2 Br_2 I_2

Q7. An irregularly shaped object with a mass of 29.6 g was placed into a graduated cylinder filled with 17.0 mL of water. The water level rose to 24.6 mL. Determine the density of the object.

A) 0.257 g/mL

B) 0.712 g/mL

C) 1.20 g/mL

D) 3.89 g/mL

$d = m/V$ — 29.6g

24.6mL − 17.0mL = 7.6mL

Although... 3.99/mL is actually correct since should be 2 s.f. !

Q8. The name given to an ionic compound that retains water molecules in its solid form is:

A) hydrate

B) anhydrous salt

C) soluble salt

D) precipitate

Q9. Using the lowest set of whole number coefficients, balance the following equation and determine the coefficient in front of molecular oxygen.

$$\underline{2}\ C_8H_{18} + \underline{25}\ O_2 \rightarrow \underline{16}\ CO_2 + \underline{18}\ H_2O$$

A) 8

B) 12

C) 16

D) 25

Q10. The number of moles of C_2H_4 in a 12.8 g sample?

A) 28.1 mol

B) 2.19 mol

C) 0.600 mol

D) 0.456 mol

C_2H_4

$2 \times C = 2 \times 12.01$

$4 \times H = 4 \times 1.008$

$28.05\ g/mol$

$$12.8\ g\ C_2H_4 \left| \frac{1\ mol\ C_2H_4}{28.05\ g\ C_2H_4} \right. = 0.456\ mol \quad (3sf.)$$

Q11. The number of hydrogen atoms in a 12.8 g sample of C_2H_4?

A) 2.75×10^{23}

B) 1.10×10^{24}

C) 6.02×10^{23}

D) 3.94×10^{24}

$$12.8\ g\ C_2H_4 \left| \frac{1\ mol\ C_2H_4}{28.05\ g\ C_2H_4} \right| \frac{4\ mol\ H}{1\ mol\ C_2H_4} \left| \frac{6.022 \times 10^{23}}{1\ mol} \right. = 1.10 \times 10^{24}$$

Q12. The mass percent of carbon in $C_2H_5NO_2$ is:

A) 81.3%

B) 75.2%

C) 32.0%

D) 16.1%

$2 \times C = 2 \times 12.01 = 24.02$

$5 \times H = 5 \times 1.008$

$1 \times N = 1 \times 14.01$

$2 \times O = 2 \times 16.00$

$75.07\ g/mol$

$$\%\ C = \frac{24.02}{75.07} \times 100 = 32.00\%$$

Q13. The number 0.0005230 has how many significant digits?

x x x x ✓ ✓ ✓ ✓

A) 3

B) 4

C) 7

D) 8

Q14. Of the following symbol/name combination of the elements, which is incorrect?

A) F/fluorine

B) Na/sodium

C) Mn/magnesium

D) Fe/iron

Mn = manganese

Mg = magnesium

Q15. The molar mass of $CoCl_2 \cdot 6H_2O$?

A) 129.8 g/mol

B) 141.9 g/mol

C) 238.0 g/mol

D) 296.9 g/mol

$1 \times Co = 1 \times 58.93$
$2 \times Cl = 2 \times 35.45$
$12 \times H = 12 \times 1.008$
$6 \times O = 6 \times 16.00$
$237.93\ g/mol$

Q16. The limiting reagent in a chemical reaction

A) is in excess

B) is consumed completely

C) has the largest molar mass

D) has the smallest molar mass

→ is all used up & limits amount of product that can be made!

Q17. A species has 22 protons, 20 electrons, and 26 neutrons. Determine its nuclide symbol.

A) $^{48}_{22}Ti^{2+}$

B) $^{46}_{26}Ca^{2-}$

C) $^{48}_{22}Ca^{2+}$

D) $^{46}_{20}Ti^{2-}$

$22p^+$, $Z = 22$ (Ti)

$20e^- \Rightarrow$ 2 fewer -ves, so 2+ charge

$A = \#p^+ + \#n^0 = 22 + 26 = 48$

→ $^{48}_{22}Ti^{2+}$

Q18. The elements in Group 1A (1), 2A (2), and 8A (18) are called, _____, respectively.

A) alkaline-earth metals, alkali metals, noble gases

B) halogens, alkali metals, noble gases

C) alkali metals, transition metals, halogens

D) alkali metals, alkaline-earth metals, noble gases

Q19. Find the number of protons, neutrons, and electrons in the platinum isotope, Pt-195.

A) 195 protons, 78 neutrons, 195 electrons

B) 78 protons, 78 neutrons, 117 electrons

C) 78 protons 156 neutrons, 117 electrons

D) 78 protons, 117 neutrons, 78 electrons

78 Pt → $78p^+$ (Z)

$A = 195 = \#p^+ + \#n^0$

$\rightarrow \#n^0 = A - Z$
$= 195 - 78$
$= 117\ n^0$

Q20. Which of the following compounds is most likely to be ionic?

A) $SiCl_4$ (metalloid)

B) $AlBr_3$ → metal + non-metal

C) IF_7

D) N_2O_5

Each problem in this section (short answer) is worth 10 points!
All work must be shown to receive credit!
You must use the factor–label (conversion–factor) method for all conversions!
Be sure to include units where applicable!
All numeric answers must be rounded to the correct number of significant figures!

Q21. **(a) Write out the chemical formulas for the following substances:**

(i) sodium carbonate decahydrate $Na_2CO_3 \cdot 10H_2O$

$Na^+ \quad CO_3^{2-}$ (2, 1)

(ii) trichlorine pentabromide Cl_3Br_5

(iii) aluminum sulfide Al_2S_3

$Al^{3+} \quad S^{2-}$ (2, 3)

(iv) iron(II) phosphate $Fe_3(PO_4)_2$

$Fe^{2+} \quad PO_4^{3-}$ (3, 2)

(v) cuprous sulfate Cu_2SO_4

$Cu^+ \quad SO_4^{2-}$ (2, 1)

(b) Name the following substances:

(vi) NH_4NO_3 ammonium nitrate

(vii) N_4S_9 tetranitrogen nonasulfide — nona, not nano!

(viii) $H_2SO_4(aq)$ sulfuric acid — one of three acids to memorize! (also, see Q22...)

(ix) $Fe(HCO_3)_2$ iron(II) bicarbonate

(x) P_6N_7 hexaphosphorus heptanitride

Q22. The formation of sulfuric acid, $H_2SO_4(aq)$, can be achieved via:

$$3\ SO_2 + 2\ HNO_3 + 2\ H_2O \rightarrow 3\ H_2SO_4 + 2\ NO$$

(a) If 1.4 mol of HNO_3 react completely, how many moles of H_2SO_4 can be formed?

$$1.4\ mol\ HNO_3 \times \frac{3\ mol\ H_2SO_4}{2\ mol\ HNO_3} = 2.1\ mol\ H_2SO_4$$

(b) If 39.2 g of SO_2 react completely, how many grams of H_2SO_4 can be formed?

SO_2
$1 \times S = 32.07$
$2 \times O = 2 \times 16.00$
$64.07\ g/mol$

$$39.2\ g\ SO_2 \left| \frac{1\ mol\ SO_2}{64.07\ g\ SO_2} \right| \frac{3\ mol\ H_2SO_4}{3\ mol\ SO_2} \left| \frac{98.09\ g\ H_2SO_4}{1\ mol\ H_2SO_4} \right. = 60.0\ g\ H_2SO_4\ (3\ s.f.)$$

H_2SO_4
$2 \times H$
$1 \times S$
$4 \times O$
$98.09\ g/mol$

(c) If 1.8 mol of SO_2 and 1.4 mol of HNO_3 react with an excess of H_2O, what's the theoretical yield of H_2SO_4 (in moles)?

$$1.8\ mol\ SO_2 \left| \frac{3\ mol\ H_2SO_4}{3\ mol\ SO_2} \right. = 1.8\ mol\ H_2SO_4$$

← smallest, so SO_2 would run out first (LR)

→ theoretical yield!

$$1.4\ mol\ HNO_3 \left| \frac{3\ mol\ H_2SO_4}{2\ mol\ HNO_3} \right. = 2.1\ mol\ H_2SO_4$$

(d) In part (c) above, if 0.750 mol of H_2SO_4 is actually formed, what is the percent yield of the reaction?

$$\%\ yield = \frac{actual}{theoretical} \times 100 = \frac{0.750\ mol}{1.8\ mol} \times 100 = 42\%\ (2\ s.f.)$$

Q23. Provide the results of the following calculations with the correct significant figures and units if applicable.

A) 125.465 m − 32.74 m = 92.73m (2d.p.)

3dp 2dp

B) 0.000461 ft × 0.00233 ft = 1.07×10^{-6} ft^2 (3s.f.)

3sf 3sf

OR: 0.000 001 07 ft^2

do (−) 1st then (÷) 2nd

C) (2.312 − 1.44) / 3.2×10^{-2} = 27 (2s.f.)

3dp 2dp 0.87 2dp 2sf 2sf

D) 122.240 + 1.8 = 124.0 (1dp)

3dp 1dp

Q24. A can of Pepsi contains 7.0×10^3 drops of pop. How many cubic meters of pop is this? Use the conversion-factor method when solving this problem.

(1 mL = 20 drops) (1 mL= 1 cm^3)

Treat both of this conversions as exact.

$$7.0\times10^{3}\ \text{drops} \times \left(\frac{1\text{mL}}{20\ \text{drops}}\right) \times \left(\frac{1\text{cm}^3}{1\text{mL}}\right) \times \left(\frac{1\text{m}}{100\text{cm}}\right)^3 = 3.5\times10^{-4}\ \text{m}^3 \quad (2\text{s.f.})$$

OR:

$$7.0\times10^{3}\ \text{drops} \times \left(\frac{1\text{mL}}{20\ \text{drops}}\right) \times \left(\frac{1\text{cm}^3}{1\text{mL}}\right) \times \left(\frac{10^{-2}\text{m}}{1\text{cm}}\right)^3 = \text{"}$$

Q25. NutraSweet Natural, an artificial sweetener used in many beverages and foods, is 57.14% C (by mass), 6.16% H (by mass), 9.52% N (by mass), and 27.18% O (by mass).

(a) Calculate the empirical formula of NutraSweet Natural. **Show all work.**

Assume 100 g sample

$57.14\,g\,C \times \frac{1\,mol\,C}{12.01\,g\,C} = 4.758\,mol\,C$

$6.16\,g\,H \times \frac{1\,mol\,H}{1.008\,g\,H} = 6.11\,mol\,H$

$9.52\,g\,N \times \frac{1\,mol\,N}{14.01\,g\,N} = 0.680\,mol\,N$

$27.18\,g\,O \times \frac{1\,mol\,O}{16.00\,g\,O} = 1.699\,mol\,O$

$\div 0.680\,mol$

7.00 C ≈ 14 C

8.99 H ≈ 18 H

1.00 N → 2 N

2.500 → 5 O

$\times 2$

→ $C_{14}H_{18}N_2O_5$

(b) If the molar mass of NutraSweet Natural is 294.3 g/mol, what is its molecular formula? **Show all work.**

empirical formula mass =

$14 \times C = 14 \times 12.01$

$18 \times H = 18 \times 1.008$

$2 \times N = 2 \times 14.01$

$5 \times O = 5 \times 16.00$

$\Big\}$ 294.39 g/mol

→ empirical formula must also be molecular formula!

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3 Point Bonus Question

Thallium sulfate exists as both Tl_2SO_4 and $Tl_2(SO_4)_3$ – where the first form is thallium(I) sulfate and the second is thallium(III) sulfate. If the percent by mass of sulfur in a pure sample of "thallium sulfate" is 13.8%, which form must you have?

thallium(I) sulfate

$2 \times Tl = 2 \times 204.4$
$1 \times S = 32.07$
$4 \times O = 4 \times 16.00$
$504.87\ g/mol$

thallium(III) sulfate

$2 \times Tl = 2 \times 204.4$
$3 \times S = 3 \times 32.07$
$12 \times O = 12 \times 16.00$
$697.01\ g/mol$

$\%\ S = \frac{32.07}{504.87} \times 100 = 6.352\%$

$\%\ S = \frac{3 \times 32.07}{697.01} \times 100 = 13.8\%$ matches!

So, unknown was thallium(III) sulfate

Exam checklist:

(Check the boxes to certify the following:)

- ☐ My full name is written legibly on the front page
- ☐ My correct lab section has been indicated on the front page
- ☐ My full name is written legibly on the scantron sheet
- ☐ My exam version (A, B, C, or D) is written on the scantron sheet
- ☐ I have shown work for all problems (where appropriate), paying attention to
  - Significant figures / decimal places
  - Units
- ☐ I have used the conversion-factor method for all conversions
- ☐ If I have torn off the back page (periodic table), I will not turn it in with my exam!

Thank you from the Chemistry Professors and Good Luck!