

Concordia University CHEM 205

Winter 2017, Dr. C. Rogers, Section 03, Tues/Thurs

LAST NAME:

Rogers

FIRST NAME:

STUDENT ID:

ANSWER KEY

Chem 205 - GENERAL CHEMISTRY I

MIDTERM EXAMINATION

PLEASE READ THIS BOX WHILE WAITING TO START

INSTRUCTIONS:

- Calculators are permitted; cell phones and other electronic devices are not allowed.
- This test paper includes 9 pages; please read over the whole test before starting.
- A periodic table (incomplete) is included and may be detached (not graded).
- Fill in your name & ID # on scansheet, in pencil (fill circles completely).
- Please write clearly and organize your work logically.
- Read the instructions to each section carefully.
- **Duration: 70 minutes. GOOD LUCK!**

(not a "hard" test)

Professor use - Grades:

Pages 2-4: / 40

Page 5: / 11

TOTAL: / 50 (MAX. 51)

PERCENT: 69 %

PART A: MULTIPLE-CHOICE QUESTIONS – 2 marks each
Colour in final answer on scansheet, in pencil. Circle answer here too, as a backup.

1. Which one statement concerning MgBr_2 is true?



- C
- a) F The percentage of Mg in MgBr_2 depends on where the sample is obtained.
 - b) F MgBr_2 has properties similar to magnesium metal and bromine gas. *made of ions!*
 - c) T MgBr_2 is composed of a 1:2 ratio of Mg^{2+} cations and Br^- anions.
 - d) F Solid MgBr_2 is a homogeneous mixture. *no, is an ionic compound = pure substance*

2. Which one of the following statements is false?

- B
- a) T The Curies' experiments with radioactivity proved that atoms are made up of smaller particles.
 - b) F Rutherford's experiments proved that atoms have a negatively charged nucleus at their core.
 - c) T Thomson proposed that atoms' electrons are embedded in a cloud of positive charge.
 - d) T Lavoisier introduced systematic terminology and the law of conservation of matter.

3. ^{12}C is the most abundant stable isotope of carbon, but ^{14}C is radioactive. What is different about them?

- A
- a) ^{12}C has 6 p^+ , 6 n^0 and 6 e^- , whereas ^{14}C has 6 p^+ , 8 n^0 and 6 e^- .
 - b) ^{12}C has 6 p^+ , 6 n^0 and 6 e^- , whereas ^{14}C has 7 p^+ , 7 n^0 and 7 e^- . *≠ Carbon*
 - c) ^{12}C has 6 p^+ , 6 n^0 and 6 e^- , whereas ^{14}C has 8 p^+ , 6 n^0 and 6 e^- . *≠ Carbon*
 - d) ^{12}C has 12 p^+ , 6 n^0 and 12 e^- , but ^{14}C has 14 p^+ , 6 n^0 and 14 e^- . *≠ Carbon*

4. Which one of the following separations requires the use of chemical change?

- D
- a) isolating iron (Fe) from a mixture of iron filings and plastic beads *magnetic properties*
 - b) removing the salt (NaCl) from a mixture of table salt and pepper *solubility*
 - c) removing the carbon dioxide (CO_2) from a carbonated beverage *solubility*
 - d) isolating oxygen (O_2) from a pure sample of sugar ($\text{C}_{12}\text{H}_{24}\text{O}_{12}$) = change in identity required *physical properties*

5. Which one formula represents a covalent compound?

- B
- a) NH_4NO_3 *$\text{NH}_4^+ : \text{NO}_3^-$*
 - b) P_4O_{10} *compound made of molecules*
 - c) NaBr *$\text{Na}^+ : \text{Br}^-$*
 - d) S_8 *element made of molecules*

6. What is used to quantitatively describe the accuracy of a measurement?

- C
- a) average deviation
 - b) significant figures
 - c) relative error
 - d) average

7. The boiling point of oxygen is 90.15 K. At a temperature of -195.8°C , in which state is O_2 found?

- B
- a) a 1:1 mixture of liquid and gas
 - b) liquid
 - c) solid
 - d) gas

$$-195.8 + 273.15 = 77.35 \text{ K} < 90.15 \text{ K}$$

Still liquid b.p.

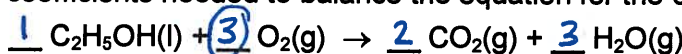
8. Four of the following statements are true. Which statement is not true?

- a) T When an ionic compound dissolves, ionic bonds break and ions are surrounded by solvent.
- b) T When a molecular compound dissolves, the covalent bonds within molecules do not break.
- c) T When a solute dissolves in a solvent, the resulting solution is a homogeneous mixture.
- d) F When a solute dissolves, the solute chemically reacts with the solvent molecules. no change in identity
- e) T If the solvent is evaporated from a solution, the solute is recovered unchanged. i.e.

9. The atomic mass of the element rhenium (Re) is 186.2 g/mol. Given that 37.1% of naturally occurring rhenium is rhenium-185, what is the other stable isotope (assuming 2 isotopes in total)? i.e. other is 187

- a) 183-Re
 - b) 185-Re
 - c) 186-Re
 - d) 187-Re
 - e) 189-Re
- $186.2 = 0.371(185 \text{ amu}) + 0.629x$
 $186.2 = 68.635 + 0.629x$
 $x = 186.91 \text{ amu}$
 "187"

10. What are the smallest coefficients needed to balance the equation for the combustion of ethanol?

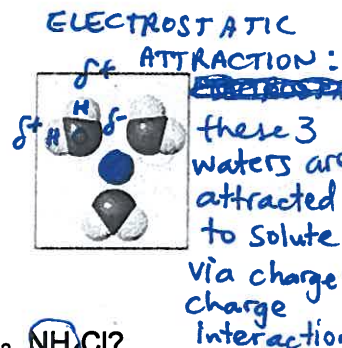


- a) x 2, 7, 4, 6
- b) 1, 3, 2, 3
- c) x 2, 2, 1, 4
- d) 1, 2, 3, 2
- e) x 2, 4, 4, 2

$1 + y = 4 + 3$ oxygen atoms
 $y = 6 \text{ atoms} \therefore 3 \text{ O}_2$

11. Consider the image in the box, where three water molecules surround an unidentified sphere. Based on the arrangement of the waters, what is the central sphere?

- a) a bubble of hydrogen gas x H₂(g)
- b) a bubble of water vapour x H₂O(g)
- c) a fourth water molecule x H₂O(l)
- d) a dissolved cation M⁺
- e) a dissolved anion Y⁻



• δ⁻ O's aimed at sphere
 ↓
 ⊕ charge!

12. Which of these are likely to be insoluble in water: Na₂CO₃, AgNO₃, ZnS, KOH, Cu(OH)₂, NH₄Cl?

- a) ZnS and NH₄Cl
- b) KOH and Cu(OH)₂
- c) AgNO₃, Cu(OH)₂ and NH₄Cl
- d) Na₂CO₃, ZnS and KOH
- e) ZnS and Cu(OH)₂

- "always soluble" ions circled here
 - leaves only two options as insoluble

13. The density of metallic lead (Pb) is 11.35 g/cm³. If you have a cube of metallic lead (Pb) that is 1.00 cm long on each side, how many atoms of lead are in the sample?

- a) 5.48 × 10⁻¹
- b) 2.56 × 10²⁰
- c) 3.30 × 10²²
- d) 6.83 × 10²⁴
- e) 1.42 × 10²⁷

$d = \frac{m}{V} \therefore m = d \times V$
 $= (11.35 \frac{\text{g}}{\text{cm}^3}) (1.00 \times 1.00 \times 1.00 \text{ cm}^3)$
 $= 11.35 \text{ g}$

$n = \frac{m}{MM} \therefore n = \frac{11.35 \text{ g}}{207.2 \text{ g/mol Pb}} = 0.05478 \text{ mol}$

$\# \text{ atoms} = n \times N_A$
 $= (0.05478 \text{ mol}) (6.022 \times 10^{23} \text{ mol}^{-1})$
 $= 3.30 \times 10^{22}$

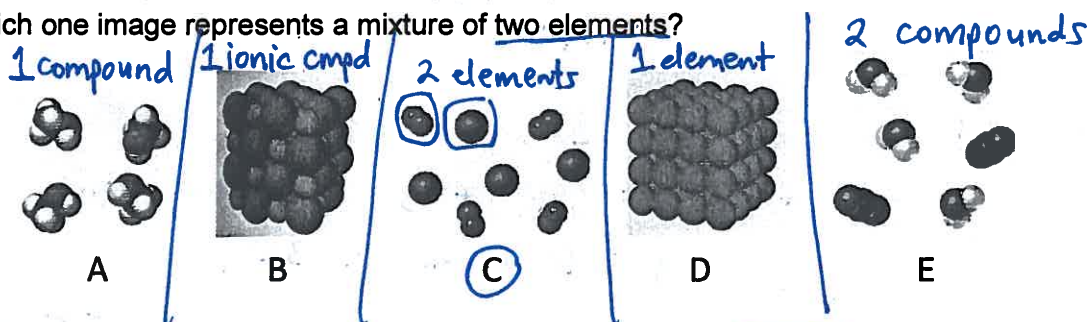
14. Which one of the following compounds is named incorrectly?

- A
- a) $\text{Fe}_3(\text{PO}_4)_2$, iron (III) phosphate $3 \text{Fe}^{2+} : 2 \text{PO}_4^{3-}$ should be iron (II) phosphate
- b) NH_4Cl , ammonium chloride $1 \text{NH}_4^+ : 1 \text{Cl}^-$
- c) N_2O_5 , dinitrogen pentoxide \rightarrow molecular
- d) K_3P , potassium phosphide $3 \text{K}^+ : 1 \text{P}^{3-}$
- e) SO_3 , sulfur trioxide \rightarrow molecular

15. Which of the following observations of aluminum metal does not describe a physical property?

- A
- a) Aluminum "dissolves" in hydrochloric acid to produce hydrogen gas and AlCl_3 . change in identity = rxn
- b) A freshly cut surface of aluminum is extremely lustrous. ✓
- c) Aluminum is a good electrical conductor. ✓
- d) The density of aluminum is 2.70 g/cm^3 . ✓
- e) Aluminum metal melts at 660°C . ✓

16. Which one image represents a mixture of two elements?

# 17. Which statement about the trends in reactivity of elements is incorrect?

- C
- a) T Atoms lose or gain electrons until they have the same number of electrons as a noble gas.
- b) T The nonmetals with strongest pull on electrons are at the top right of the periodic table.
- c) F The metals with weakest pull on electrons are at the bottom right of the periodic table. @ bottom LEFT
- d) T In reactions, nonmetals gain electrons, by forming covalent bonds or forming anions.
- e) T In reactions, metals tend to lose electrons, thereby forming cations.

18. Which of the following descriptions of elements is incorrect?

- E
- a) T Hydrogen, nitrogen, oxygen, fluorine, chlorine, bromine and iodine are all diatomic molecules.
- b) T Potassium metal is violently reactive with water, but K^+ is found in large amounts in bananas.
- c) T $\text{N}_2(\text{g})$ is very unreactive but is pulled from the air by nitrogen-fixing bacteria in some plants.
- d) T Chromium (Cr), iron (Fe), nickel (Ni) and copper (Cu) are examples of transition metals.
- e) F Oxygen gas (O_2) is abundant in Earth's atmosphere because it is quite unreactive. NOT TRUE. IT IS NO, IS QUITE REACTIVE. CONSTANTLY MADE BY PLANTS, SO LOTS IS PRESENT, DESPITE IT BEING VERY REACTIVE.

19. Which of the following directions correctly describes the preparation of 0.500 L of 0.150 M NaOH from a 6.00 M stock solution?

- C
- a) X Combine 12.5 mL of 6.00 M NaOH with 0.500 L of water.
- b) Combine 0.200 L of 6.00 M NaOH with 0.500 L of water.
- c) Dilute 12.5 mL of 6.00 M NaOH to a volume of 0.500 L.
- d) Dilute 0.200 L of 6.00 M NaOH to a volume of 0.500 L.
- e) Dilute 475 mL of 6.00 M NaOH to a volume of 0.500 L.

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

$\hookrightarrow n = C \times V$

$= 0.0750 \text{ mol}$

from stock:

$V = \frac{n}{C} = \frac{0.0750 \text{ mol}}{6.00 \text{ M}}$

$= 0.0125 \text{ L} = 12.5 \text{ mL}$

20. Which solution of 0.10 mol compound per 1 L water contains the highest concentration of ions?

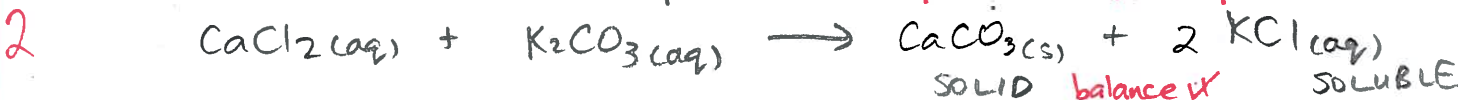
- B
- a) $\text{CaI}_2(\text{aq}) \rightarrow \text{Ca}^{2+} + 2\text{I}^- \Rightarrow 0.30 \text{ mol/L ions}$
- b) $\text{FeCl}_3(\text{aq}) \rightarrow \text{Fe}^{3+} + 3\text{Cl}^- \Rightarrow 0.40 \text{ M ions}$
- c) $\text{NH}_4\text{Br}(\text{aq}) \rightarrow \text{NH}_4^+ + \text{Br}^- \Rightarrow 0.20 \text{ M ions}$
- d) $\text{NaNO}_3(\text{aq}) \rightarrow \text{Na}^+ + \text{NO}_3^- \Rightarrow 0.20 \text{ M ions}$
- e) $\text{C}_{12}\text{H}_{24}\text{O}_{12}(\text{aq}) \rightarrow \text{no ions!}$

Molarity, $\frac{\text{mol}}{\text{L}}$

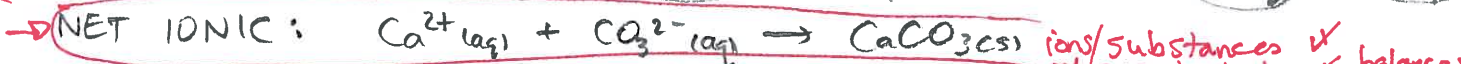
PART B: SHOW COMPLETE WORK TO GET FULL CREDIT (answer on exam)

21. You mix together aqueous solutions of calcium chloride and potassium carbonate, and a solid forms.

a) (2 marks) Write the molecular equation for the reaction when aqueous CaCl_2 and K_2CO_3 are mixed.
= written as compounds *products ✓* *phases ✓*



b) (2 marks) Write the net ionic equation for the reaction when aqueous CaCl_2 and K_2CO_3 are mixed.



c) (1 mark) What is the name of the insoluble product that could be collected by filtration, and what is the name of the soluble product that could be collected by evaporating the solvent from the filtrate?

- 1 ✓ insoluble = calcium carbonate
✓ soluble = potassium chloride

grades for the names, phases already graded.

22. (6 marks) Elemental analysis shows that Vitamin C contains 40.9% C and 4.58% H and remainder O by mass. Separate experiments reveal its molar mass to be about 180 g/mol. What is the empirical formula of Vitamin C, and what is its molecular formula?

Empirical formula = simplest whole # MOLE RATIO of elements in compound.

element mass %	mass in 100g	÷ MM (g/mol)	= moles	ratio from normalizing	whole #s
40.9% C	40.9g	÷ 12.01	= 3.405	1.00 (x3)	3
4.58% H	4.58g	÷ 1.008	= 4.544	1.335 (x3)	4
54.52% O	54.52g	÷ 15.999	= 3.408	1.0011 (x3)	3

$100 - (40.9 + 4.58) = 54.52\% \text{ O}$

DIVIDE BY SMALLEST MOLES = carbon's 3.405 mol

$\text{C}_3\text{H}_4\text{O}_3$ empirical formula

empirical formula $\text{C}_3\text{H}_4\text{O}_3$ MM = 88.059 g/mol
experimentally measured MM = 180 g/mol $\rightarrow \approx \frac{1}{2.04}$
∴ multiply empirical formula by 2 to get
molecular formula = $\text{C}_6\text{H}_8\text{O}_6$