

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!**

MCQ:
check #13
for 2nd
best ans. too.

Professor use - Grades:

→ Pages 2-4: / 40

Page 5: / 11

TOTAL: / 50 (MAX. 51)

PERCENT: %

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 the substance CO₂ is true?

- B
- a) The percentage of C in CO₂ depends on where the sample is obtained.
 - b) CO₂ undergoes sublimation at -78°C and is a gas a room temperature. *true, but even if you didn't know, all the others are false!*
 - c) CO₂ has properties similar to elemental carbon and oxygen gas.
 - d) CO₂ is composed of a 1:2 ratio of C⁴⁺ cations and O²⁻ anions.

2. Which one of the following statements is false?

- D
- a) The Curies' experiments with radioactivity proved that atoms are made up of smaller particles.
 - b) Thomson incorrectly proposed that atoms consist of electrons embedded in a positive cloud.
 - c) Millikan's oil-drop experiment revealed the exact amount of negative charge on the electron.
 - d) Lavoisier believed that alchemy could be used to convert base metals into valuable metals.

3. Which one of the following statements describes a chemical change?

- C
- a) calcium carbonate (CaCO₃) crystallizes from a solution *dissolved → undissolved = physical*
 - b) naphthalene (C₁₀H₈) from mothballs melts at 80°C *Solid → gas = physical*
 - c) octane (C₈H₁₈) from gasoline burns in air *reaction with oxygen*
 - d) sugar (C₁₂H₂₄O₁₂) dissolves in coffee *undissolved → dissolved = physical*

4. What choice below correctly describes percent relative error, which is used to describe accuracy?

- A
- a) $100 \times (\text{measured value} - \text{accepted value}) \div \text{accepted value}$
 - b) $100 \times (\text{measured value} - \text{accepted value}) \div \text{measured value}$
 - c) $100 \times (\text{measured value} - \text{average measured value}) \div \text{average measured value}$
 - d) $100 \times (\text{measured value} - \text{average measured value}) \div \text{measured value}$
- } related to deviation.

5. At atmospheric pressure, propane melts at 85 K and boils at 231 K. In which state is propane at -15°C?

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

$35 - 17 = 18 n^0$
 $37 - 17 = 20 n^0$

above b.p. $\Delta 258 K > b.p.$
 $\frac{273}{258} K$

6. Chlorine has two isotopes: ³⁵Cl and ³⁷Cl. What is different about them? *Same # p⁺*

- A
- a) ³⁵Cl has 17 p⁺, 18 n⁰ and 17 e⁻, whereas ³⁷Cl has 17 p⁺, 20 n⁰ and 17 e⁻.
 - b) ³⁵Cl has 17 p⁺, 35 n⁰ and 35 e⁻, whereas ³⁷Cl has 17 p⁺, 37 n⁰ and 37 e⁻.
 - c) ³⁵Cl has 18 p⁺, 17 n⁰ and 17 e⁻, whereas ³⁷Cl has 20 p⁺, 17 n⁰ and 17 e⁻.
 - d) ³⁵Cl has 18 p⁺, 17 n⁰ and 18 e⁻, whereas ³⁷Cl has 20 p⁺, 17 n⁰ and 20 e⁻.

$Z_{Cl} = 17 \therefore 17 p^+$
 $A = \# p^+ + \# n^0$

7. Chlorine has two isotopes: ³⁵Cl (34.968853 amu) and ³⁷Cl (36.965903 amu). The atomic mass of chlorine on the periodic table is 35.4527 amu. What is the natural abundance of each isotope?

- B
- a) 98.6% ³⁵Cl, 1.4% ³⁷Cl
 - b) 75.8% ³⁵Cl, 24.2% ³⁷Cl
 - c) 65.0% ³⁵Cl, 35.0% ³⁷Cl
 - d) 35.0% ³⁵Cl, 37.0% ³⁷Cl

$35.4527 \text{ amu} = x \cdot 34.968853 \text{ amu} + (1-x) \cdot 36.965903 \text{ amu}$
 $35.4527 = 34.968853x + 36.965903 - 36.965903x$
 $-1.513203 = -1.99705x$

Let $x + y = 1$
↑ fraction ³⁵Cl ↑ fraction ³⁷Cl

$x = 0.7577$
 $\therefore \textcircled{^{35}\text{Cl}} = 75.8\%, \text{ rest } ^{37}\text{Cl}$

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

- a) Transition metals can form cations by losing electrons, but they can also make covalent bonds.
- b) When a halogen reacts, it gains 1 e⁻/atom by making 1 covalent bond or by forming X⁻. *Gp 17 halogen*
- c) When an alkali earth metal reacts, it loses 2 e⁻/atom and forms an M²⁺ cation. *Gp 2 like Mg*
- d) If an alkali metal reacts with a halogen, the product is a covalent compound. *no, ionic!*

9. Which separation technique could be used to separate salty water into its components, to end up with a sample of water and a sample of salt?

- a) chromatography
- b) sublimation
- c) distillation = boil of water + condense steam; residue = solid salt
- d) filtration

10. Which of these are strong electrolytes: NH₄Br, PbCl₂, Na₂SO₄, Fe₂O₃, KNO₃, Ca(OH)₂ ?

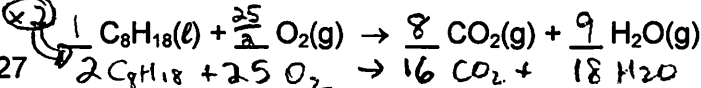
- a) NH₄Br, Na₂SO₄, KNO₃, Ca(OH)₂
- b) Na₂SO₄, KNO₃, Ca(OH)₂
- c) PbCl₂, Fe₂O₃, Ca(OH)₂
- d) NH₄Br, Na₂SO₄, KNO₃

= soluble ionic compounds OR strong acid/base

these ions ALWAYS yield soluble salts

11. Combustion is a reaction with oxygen that releases large amounts of heat and light energy (i.e., fire). What are the smallest whole-number coefficients needed to balance the equation for burning octane?

- a) 3, 50, 24, 27
- b) 2, 25, 16, 18
- c) 1, 12, 8, 9
- d) 1, 3, 2, 2



12. Which choice is an incorrect way to describe what happens when you mix CdCl₂(aq) with NaOH(aq)?

- a) Cd²⁺(aq) + 2 Cl⁻(aq) + 2 Na⁺(aq) + 2 OH⁻(aq) → Cd(OH)₂(s) + 2 Na⁺(aq) + 2 Cl⁻(aq)
- b) CdCl₂(aq) + 2 NaOH(aq) → Cd(OH)₂(s) + 2 NaCl(aq)
- c) Cd²⁺(aq) + 2 OH⁻(aq) → Cd(OH)₂(s)
- d) Na⁺(aq) + Cl⁻(aq) → NaCl(aq) *spectator ions (i.e. this is what does NOT change)*

13. Your doctor has diagnosed you as anemic (low blood iron), so you need to take iron supplements.

Would you get more iron per 100. mg tablet if you took iron(II) sulfate, FeSO₄ or if you took iron(II) gluconate, Fe(C₆H₁₁O₇)₂ (a soluble compound)? How can you tell? *dosed by mass, not by moles*

- a) Both provide the same (1 Fe per formula unit); solubility plays no role in nutrient absorption.
- b) Fe(C₆H₁₁O₇)₂ provides more (higher mass % Fe) and you would absorb it well (it is soluble).
- c) FeSO₄ provides more (higher mass % Fe) and you would absorb it well (it is quite soluble).
- d) FeSO₄ provides more (higher mass % Fe) but you might not absorb it all (it is insoluble).

Fe 55.85 x 1
S 32.07 x 1
O 15.999 x 4

FeSO₄ 151.92 g/mol

mass% 36.8% Fe

Fe $\left(\frac{55.85 \text{ g/mol Fe}}{151.92 \text{ g/mol FeSO}_4} \times 100 \right)$

Fe 55.85 x 1
C 12.01 x 12
H 1.008 x 22
O 15.999 x 14

Fe gluconate 446.144 g/mol

mass% 12.5% Fe

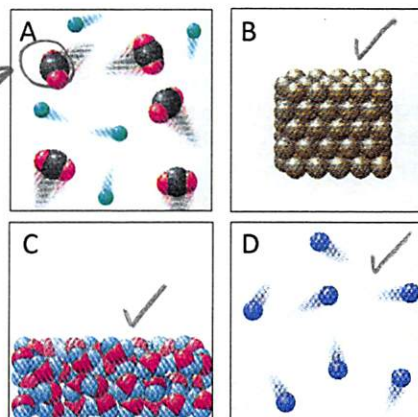
Fe $\left(\frac{55.85 \text{ g/mol Fe}}{446.144 \text{ g/mol gluconate}} \times 100 \right)$

OR: can solve using # mol (n_{Fe}) in 100. mg each

less iron per 100. mg

14. Which statement about diagrams A-B-C-D (at right) is wrong?

- A
- a) Diagram A = a mixture of two gas-phase elements \rightarrow X
- b) Diagram B = a pure solid element
- c) Diagram C = a pure liquid compound
- d) Diagram D = a pure gas-phase element

# 15. Which one of the following compounds is named incorrectly?

- D
- a) KMnO_4 , potassium permanganate
- b) $(\text{NH}_4)_2\text{CO}_3$, ammonium carbonate
- c) HgS , mercury(II) sulfide
- d) ClF_3 , chlorine fluoride

16. Which statement related to chemical formulae is incorrect?

- C
- a) A substance with empirical formula CH and molar mass 26 g/mol has molecular formula C_2H_2 .
- b) In a covalent compound, the molecular formula describes the composition of each molecule.
- c) Formulae of ionic compounds show the maximum ratio of ions that yields a neutral crystal. *Smallest*
- d) The formula MnO_4^- indicates that the anion has a central Mn atom with 4 O's bonded to it.

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

- D
- a) Atoms lose or gain electrons until they have the same number of electrons as a noble gas.
- b) The nonmetals with strongest pull on electrons are at the top right of the periodic table. *largest X*
- c) The metals with weakest pull on electrons are at the bottom left of the periodic table. *lowest X*
- d) In reactions, metals gain electrons, by forming covalent bonds or forming anions. \times

18. Which of the following statements about elements is incorrect?

- B
- a) Oxygen exists as O_2 and O_3 , both of which steal electrons from other atoms during reactions.
- b) Elemental carbon has multiple allotropes, including diamond, graphite and carbon dioxide. *a compound*
- c) At 25°C , metals exist as solids made of tightly packed atoms, except Hg, which is a liquid.
- d) Except for gold, all metals react with oxygen, even if the reaction happens quite slowly.

19. Which solution of 1 mole compound per 1 L water contains the lowest concentration of ions?

- B
- a) $\text{Na}_3\text{PO}_4(\text{aq}) \rightarrow 3\text{Na}^+(\text{aq}) + 1\text{PO}_4^{3-}(\text{aq}) \Rightarrow 4 \text{ mol/L ions}$
- b) $\text{NH}_4\text{Br}(\text{aq}) \rightarrow 1\text{NH}_4^+(\text{aq}) + 1\text{Br}^-(\text{aq}) \Rightarrow 2 \text{ mol/L ions}$
- c) $\text{K}_2\text{SO}_4(\text{aq}) \rightarrow 2\text{K}^+(\text{aq}) + 1\text{SO}_4^{2-}(\text{aq}) \Rightarrow 3 \text{ mol/L ions}$
- d) $\text{CuCl}_2(\text{aq}) \rightarrow 1\text{Cu}^{2+}(\text{aq}) + 2\text{Cl}^-(\text{aq}) \Rightarrow 3 \text{ mol/L ions}$

20. Which of the following directions correctly describes the preparation of 0.750 L of 0.125 M KMnO_4 from a 5.00 M stock solution?

- A
- a) Add water to 18.8 mL of 5.00 M KMnO_4 to make a total volume of 0.750 L.
- b) Add water to 46.8 mL of 5.00 M KMnO_4 to make a total volume of 0.750 L.
- c) Mix together 18.8 mL of 5.00 M KMnO_4 and 0.750 L of water.
- d) Mix together 46.8 mL of 5.00 M KMnO_4 and 0.750 L of water.

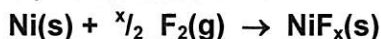
$$C = \frac{n}{V}$$

— solute
— total solution volume (not solvent)
molarity

want
 $n = CV$
 $= (0.125 \frac{\text{mol}}{\text{L}})(0.750 \text{L})$
 $= 0.09375 \text{ mol}$
From $C = 5.00 \text{ mol/L}$
 $V = \frac{n}{C}$
 $= \frac{0.09375 \text{ mol}}{5.00 \text{ mol/L}}$
 $\therefore V = 0.01875 \text{ L}$

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

21. (7 marks) A piece of nickel foil is fully consumed in a reaction with fluorine to produce a nickel fluoride:

a) (3 marks) If the nickel foil had dimensions 0.550 mm \times 1.25 cm \times 1.25 cm, how many moles of nickel were used? Note that the density of nickel is 8.902 g/cm³.

$$n = \frac{m}{MM}$$

so find: $m = d \times V$

$$= \left(\frac{8.902 \text{ g}}{\text{cm}^3} \right) \left(\frac{0.550 \text{ mm} \times 1 \text{ cm}}{10 \text{ mm}} \times 1.25 \text{ cm} \times 1.25 \text{ cm} \right)$$

$$m = 0.7650 \text{ g of Ni}$$

$$n = \frac{0.7650 \text{ g}}{58.69 \text{ g/mol}}$$

$$\therefore n = 0.01303 \text{ mol Ni} \Rightarrow n_{\text{Ni}} = 0.0130 \text{ mol to 3SF}$$

b) (4 marks) If the reaction produced 1.261 g of NiF_x, what is the value of x?

$$\textcircled{1} M_{\text{NiF}_x} = 1.261 \text{ g} = m_{\text{Ni}} + m_{\text{F}} \Rightarrow m_{\text{F}} = 1.261 - 0.7650 \text{ g Ni} = 0.496 \text{ g F in NiF}_x$$

$$\textcircled{2} \text{Formula} = \text{mole ratio, } \therefore \text{Find: } n_{\text{F}} = \frac{0.496 \text{ g F}}{18.998 \text{ g/mol F}} = 0.02611 \text{ mol F}$$

vs
F₂
37.996 g/mol

$$\textcircled{3} \text{mole ratio } x = \frac{n_{\text{F}}}{n_{\text{Ni}}} = \frac{0.02611 \text{ mol}}{0.01303 \text{ mol}} \Rightarrow \text{formula} = \text{NiF}_2$$

$$\therefore x = 2.00$$

SF not graded here

(MANY APPROACHES TO PART B ...)

22. (4 marks) In the lab, you mix solutions of Ni(NO₃)₂(aq) and Na₃PO₄(aq), and a solid forms.a) (2 marks) What is the balanced molecular equation for the reaction that occurred?b) (2 marks) 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?

- Solid = nickel (II) phosphate
- Soluble product = sodium nitrate