Student ID #: _____

# Chem 205: GENERAL CHEMISTRY I
# MIDTERM EXAMINATION

## PLEASE READ THIS PAGE WHILE WAITING TO START

**INSTRUCTIONS:** This test paper includes 7 pages, including a periodic table; please check that your paper is complete. You may detach the periodic table if you wish. For Part A, you do not need to show calculations; for Parts B and C, you must show your calculations to receive full marks. Please write clearly and organize your work logically. Non-programmable calculators are permitted; paper translation dictionaries are allowed, but electronic dictionaries and cell phones are not allowed.
**Duration: 70 minutes** - spend at least half that time on the show-your-work questions. **GOOD LUCK!**

LAST NAME: _____FIRST NAME: _____

STUDENT NUMBER: _____

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Mark breakdown:

| | |
|---|---|
| Page 2. | / 15 |
| Page 3. | / 7 |
| Page 4. | / 11 |
| Page 5. | / 9 |
| Page 6. | / 9 |
| TOTAL: | / 50 (MAXIMUM MARK = 51) |
| PERCENT: | % |
| EARNED towards FINAL GRADE: | / 20 |

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## PART A: ONLY YOUR FINAL ANSWER WILL BE MARKED

**# 1. (__/ 3 marks)** Identify the following statements as true or false. *(Circle T or F.)*

**T / F** Hydrated compounds contain hydrogen gas trapped inside the crystal lattice.

**T / F** To convert from degrees Celsius to Kelvins, subtract 273.15 from the temperature in Celsius.

**T / F** Based on the atomic mass of bromine, its most abundant isotope is probably $^{80}Br$.

**# 2. (__/ 4 marks)** Fill in the blanks:

a) Number of electrons in $^{80}Br$ _____

b) Number of neutrons in $^{126}I$ _____

c) Charge on oxygen in $Li_2O$ _____

d) Oxidation state of C in $HCO_3^-$ _____

**# 3. (__/ 4 marks)** Write <u>each</u> compound's formula or name, **and** circle *ionic* or *molecular* to describe each:

a) bromine trichloride _____ ionic / molecular ?

b) chromium(III) nitrate _____ ionic / molecular ?

c) $Fe_2(SO_4)_3$ _____ ionic / molecular ?

d) $K_3P$ _____ ionic / molecular ?

**# 4. (__/ 4 marks)** Label the following reactions as precipitation, acid-base, gas-forming or redox.

**and:** If precipitation: circle the solid product.
If acid-base: circle the reactant that is the base.
If gas-forming: circle the gaseous product.
If redox: circle the oxidizing agent.

a) $2\ CH_4 + 2\ NH_3 + 3\ O_2 \rightarrow 2\ HCN + 6\ H_2O$

b) $HClO_4 + 2\ Na_2S \rightarrow H_2S + 2\ NaClO_4$

c) $CuSO_4 + Na_2CO_3 \rightarrow CuCO_3 + Na_2SO_4$

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**# 5. (__/ 3 marks)** American pennies made after 1983 are composed of 97.0% Zn and 3.00% copper and have a mass of 2.46 g. How many atoms of Zn are in one penny? *(Circle your choice.)*

a) $6.81 \times 10^{20}$
b) $2.27 \times 10^{22}$
c) $2.20 \times 10^{22}$
d) $4.44 \times 10^{22}$
e) $1.44 \times 10^{24}$

**# 6. (__/ 1 mark)** Which of the following choices contain(s) elements that are all in the same period?

a) F, Cl, Br, I
b) Na, Ca, Fe, Cu
c) Li, Na, K, Rb
d) Ba, W, Au, Pb
e) both (a) and (c)

**# 7. (__/ 1 mark)** Imagine you are trying to remove dissolved $Pb^{2+}$ ions from the waste-water in a water treatment plant. Which ONE of the following substances, if added to the waste-water, would cause the lead ions to precipitate out as an insoluble compound?

a) $KNO_3$
b) $CaCl_2$
c) $NaClO_4$
d) $NH_3$
e) $CH_3COOH$

**# 8. (__/ 1 mark)** Which ONE of the following statements concerning ionic compounds is *incorrect* ?

a) as the ion charges increase, the attraction between the ions increases.
b) ionic compounds exist as extended 3-dimensional networks called crystal lattices.
c) ionic crystals tend to be rigid, and they cleave along planes.
d) positive and negative ions are attracted to each other by electrostatic forces.
e) although not ductile like metals, ionic compounds are often malleable.

**# 9. (__/ 1 mark)** Mothballs contain naphthalene, which has a molar mass of 128.17 g/mol. The empirical formula of naphthalene is $C_5H_4$. What is its molecular formula?

a) $C_5H_4$
b) $C_8H_{10}$
c) $C_9H_{20}$
d) $C_{10}H_8$
e) not enough information provided

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## PART B: Short written answers

**# 10. (__/ 6 marks)** Imagine you swallow a spoonful of an antacid preparation containing milk of magnesia to settle your upset stomach. The preparation is an aqueous suspension of $Mg(OH)_2$, which will react with your excess stomach acid (aqueous HCl).

a) **(1.5 marks)** Would you describe $Mg(OH)_2$ as an acid or a base? Why?

b) **(1.5 marks)** Would you describe $Mg(OH)_2$ as a weak or strong electrolyte? Why?

c) **(1 mark)** Is HCl a strong acid or a weak acid?

d) **(2 marks)** Write the complete ionic and net ionic equations for the reaction between $Mg(OH)_2$ and HCl:

**# 11. (__/ 3 marks)** The reaction between iron(III) ion and permanganate ion shown below does not occur. Provide two reasons why the equation shown below cannot describe a real reaction.

$$Fe^{3+}(aq) + MnO_4^-(aq) + H^+(aq) \rightarrow Mn^{2+}(aq) + Fe^{2+}(aq) + H_2O(l)$$

**# 12. (__/ 2 marks)** Imagine you read a newspaper article about an accidental spill of hydrochloric acid in an area where sodium hydroxide solution is also present. The article describes the potential for the formation of hazardous chlorine gas if the two solutions come into contact. Is this an accurate description of the potential danger of the situation? Why or why not?

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## PART C: Problems – SHOW YOUR WORK TO GET FULL CREDIT

**# 13. (__/ 9 marks)** A side reaction in the manufacture of rayon from wood pulp is:

$$3\ CS_2 + 6\ NaOH \rightarrow 2\ Na_2CS_3 + Na_2CO_3 + 3\ H_2O$$

If 92.5 mL of liquid $CS_2$ ( *d* = 1.26 g/mL ) is reacted with 110 g of solid NaOH, and the reaction occurs with 73% yield, what mass of $Na_2CS_3$ is produced?

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**# 14. (__/ 9 marks)** HCN is a poisonous gas. A lethal dose of HCN can be inhaled if you breathe air that contains about 300 mg of HCN per 1 kg of air.

a) **(5 marks)** Imagine you are working in a small lab room that measures 5m × 6m × 3m. How much HCN (in grams) would cause room's air to be lethal? *Assume the density of air is 0.00118 g/cm$^3$, and that the room's entire volume is filled with air.*

b) **(4 marks)** HCN is formed when NaCN comes into contact with acid (usually by accident). If HCN forms by the reaction below (*unbalanced*), what mass of NaCN would cause the lethal dose of HCN from part (a) to be released into the air?

*Note: if you could not do part (a), use a mass of 75 g of HCN (which is incorrect) to attempt part (b).*

$$NaCN(s) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + HCN(g)$$

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## POTENTIALLY USEFUL INFORMATION

Atomic mass unit: 1 amu = $1.66054 \times 10^{-27}$ kg

Avogadro's number: N = $6.022 \times 10^{23}$ $mol^{-1}$