

LAST NAME:

FIRST NAME:

STUDENT ID:

## 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).
- Answer the multiple-choice questions on the scan sheet, in pencil.
- Please write clearly and organize your work logically.
- Read the instructions to each section carefully.
- **Duration: 70 minutes. GOOD LUCK!**

##### Professor use - Grades:

Page 2. / 10

Page 3. / 12

Page 4. / 10

Page 5. / 10

Page 6. / 9

TOTAL: / 50 (MAX. 51)

PERCENT: %

**PART A: MULTIPLE-CHOICE QUESTIONS (final answer on scan sheet, in pencil)  
circle answer here too, as a back-up**

# 1. (2 marks) The statements below summarize various landmarks in the development of modern chemistry. Which one statement links the wrong scientist(s) to the work described?

- a) Alchemists made many important discoveries, while pursuing the impossible goal of transforming cheap substances into gold.
- b) Antoine Lavoisier proposed the ill-conceived phlogiston concept, which described a fire-like entity with negative mass that was released from substances when they burned.
- c) Dmitri Mendeleev envisioned the periodic table of the elements, which has helped future generations of scientists remember important trends in elements' properties.
- d) Svante Arrhenius proposed a theory of electrolytes, which describes acids as producers of  $H^+$  ions when dissolved in water and bases as producers of  $OH^-$  ions when dissolved in water.
- e) Ernest Rutherford proposed the nuclear model of the atom, wherein electrons occupy a cloud of space around a central nucleus of close-packed protons and neutrons.

# 2. (2 marks) How many electrons are in a radioactive  $^{123}I^-$  ion (used for treating hyperthyroidism)?

- a) 1
- b) 8
- c) 54
- d) 70
- e) 123

# 3. (2 marks) Which one of the following separations requires the use of chemical change?

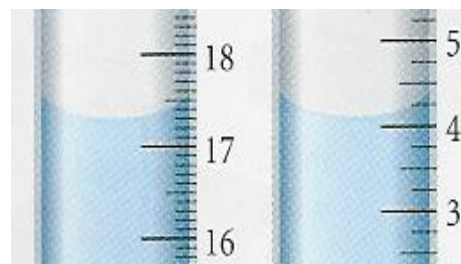
- a) isolating iron filings from sawdust (wood chips)
- b) isolating sugar from a sand/sugar mixture
- c) isolating pure water from dirty seawater
- d) isolating iron from iron oxide (rust)
- e) all require only physical changes

# 4. (2 marks) What is the oxidation state of phosphorus in  $(NH_4)_3PO_4$ ?

- a) -V
- b) -III
- c) 0
- d) +III
- e) +V

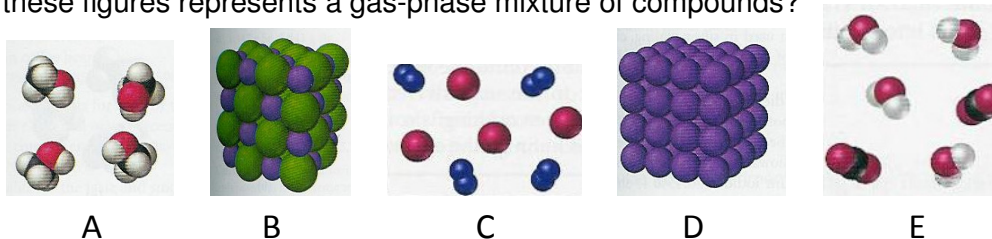
# 5. (2 marks) Suppose you pour the water from these two graduated cylinders into one container. Based on the precision of the two cylinders, how should you report the new total volume to reflect the correct number of significant figures?

- a) 21.400 mL
- b) 21.40 mL
- c) 21.4 mL
- d) 21 mL
- e) 20 mL



# 6. (2 marks) Which one of these figures represents a gas-phase mixture of compounds?

- a) A
- b) B
- c) C
- d) D
- e) E



# 7. (2 marks) When you clean the hard-water deposits in a coffee-maker using vinegar, the following substances react:  $\text{CaCO}_3(\text{s}) + \text{CH}_3\text{COOH}(\text{aq})$ . What type of reaction results?

- a) both acid-base & precipitation
- b) both acid-base & gas-forming
- c) precipitation only
- d) gas-forming only
- e) acid-base only

# 8. (2 marks) What is the freezing point of liquid mercury (234.3 K) on the Celsius scale?

- a) -234.3 °C
- b) -38.9 °C
- c) 0.0 °C
- d) 38.9 °C
- e) 234.3 °C

# 9. (2 marks) Which one statement best describes what happens when liquid gasoline (whose main component is octane,  $\text{C}_8\text{H}_{18}$ ) evaporates to form vapour?

- a) The  $\text{C}_8\text{H}_{18}$  molecules' thermal energy decreases relative to their attractions.
- b) Liquid  $\text{C}_8\text{H}_{18}$  molecules are converted into  $\text{CH}_4$ , which is a gas.
- c) Attractions between intact  $\text{C}_8\text{H}_{18}$  molecules are broken.
- d) Covalent bonds within  $\text{C}_8\text{H}_{18}$  molecules are broken.
- e) Ionic bonds within  $\text{C}_8\text{H}_{18}$  molecules are broken.

# 10. (2 marks) What is the molar mass of Epsom salt, which has the formula  $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$  ?

- a) 90.04 g/mol
- b) 120.38 g/mol
- c) 128.40 g/mol
- d) 246.48 g/mol
- e) 860.65 g/mol

# 11. (2 marks) Which one statement describes the characteristic feature of all acid-base reactions?

- a) transfer of electron(s) from reducing agent to oxidizing agent
- b) exchange of soluble ions to form an insoluble salt
- c) transfer of  $\text{H}^+$  from acid to base
- d) formation of salt and water
- e) net formation of gas

**# 12. (2 marks)** Ozone,  $O_3$ , is a strong oxidizing agent used in water purification. What is the balanced chemical equation for the oxidation of the organic compound phenol ( $C_6H_5OH$ ) by ozone?

- a)  $C_6H_5OH(aq) + O_3(g) \rightarrow CO_2(g) + H_2O(\ell) + O_2(g)$
- b)  $C_6H_5OH(aq) + 4 O_3(g) \rightarrow 6 CO_2(g) + 3 H_2O(\ell) + 3 O_2(g)$
- c)  $C_6H_5OH(aq) + 8 O_3(g) \rightarrow 6 CO_2(g) + 5 H_2O(\ell) + 12 O_2(g)$
- d)  $C_6H_5OH(aq) + 14 O_3(g) \rightarrow 6 CO_2(g) + 3 H_2O(\ell) + 14 O_2(g)$
- e)  $C_6H_5OH(aq) + 14 O_3(g) \rightarrow 6 CO_2(g) + 6 H_2O(\ell) + 21 O_2(g)$

**# 13. (2 marks)** Many elements are too reactive towards oxygen and water to exist long-term on Earth in elemental form and are therefore found in nature only in compounds. Which one of the elements listed below is actually found in nature both in compounds and in elemental form?

- a) phosphorus
- b) potassium
- c) chlorine
- d) calcium
- e) sulfur

**# 14. (2 marks)** What is the correct description and formula of iron (III) chromate?

- a) molecular,  $Fe_2(CrO_4)_3$
- b) molecular,  $FeCrO_4$
- c) ionic,  $Fe_2(CrO_4)_3$
- d) ionic,  $Fe_3CrO_4$
- e) ionic,  $FeCrO_4$

**# 15. (2 marks)** What is the correct description and name of  $S_2F_{10}$ ?

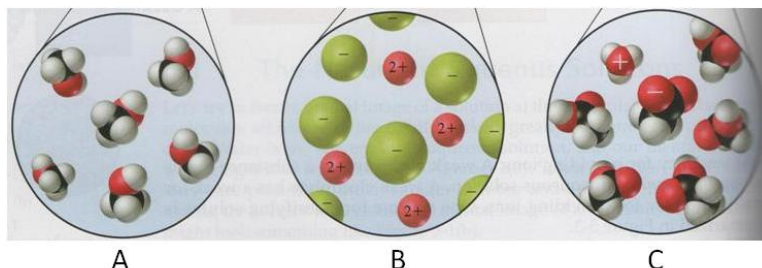
- a) molecular, disulfur decafluoride
- b) ionic, disulfur decafluoride
- c) molecular, sulfur fluoride
- d) ionic, sulfur (V) fluoride
- e) ionic, sulfur fluoride

**# 16. (2 marks)** Imagine you are given 3.25 mL of a liquid and you find that it weighs 5.10 g. If you add this liquid to a test tube that contains some water ( $d = 1.00$  g/mL) and mercury ( $d = 13.5$  g/mL), and the liquid is not miscible with water or mercury, where would the liquid come to rest in the test tube?

- a) mixed evenly throughout the water and mercury
- b) in between the water and mercury layers
- c) below the mercury layer
- d) above the water layer
- e) impossible to predict

**PART B: DRAWINGS & BRIEF WRITTEN ANSWERS (answer on exam)**

**# 17.** The diagrams to the right represent different kinds of substances dissolved in water. For simplicity, the water molecules are not shown.



a) **(1 mark)** Which diagram represents a solution of  $\text{CaCl}_2$ ? How can you tell?

b) **(1 mark)** Which diagram represents a solution of a non-electrolyte? How can you tell?

c) **(2 marks)** Which diagram represents a weak electrolyte? Which is it: a weak acid or a weak base? How can you tell?

**# 18. (3 marks)** When an iron object rusts, its mass increases. When a match burns, its mass decreases. Do these observations violate the law of conservation of mass? Explain briefly.

**# 19.** Imagine you mix two aqueous solutions, one containing  $\text{BaCl}_2$  and the other containing  $\text{CuSO}_4$ .

a) **(1 mark)** Write the molecular equation for the reaction; include phase indicators (states).

b) **(1 mark)** Write the net ionic equation for the reaction; include phase indicators (states).

c) **(1 mark)** Which species are spectator ions in the reaction? Explain in a few key words.

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

**# 20. (9 marks)** Indigo, the dye used for blue jeans, has a percent composition by mass of 73.27 % C, 3.84 % H, 10.68% N and remainder oxygen. Its molar mass is 262.3 g/mol. What are the empirical and molecular formulas of indigo? **Show full calculations and explanatory comments for each step.**

CHEM 205 Fall 2012 MIDTERM EXAM  
Dr. C. Rogers, Section 02, Wed/Fri

Student ID #: \_\_\_\_\_

**EXTRA SPACE FOR ROUGH WORK**

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**POTENTIALLY USEFUL INFORMATION**Atomic mass unit: 1 amu =  $1.66054 \times 10^{-27}$  kgAvogadro's number:  $N = 6.022 \times 10^{23}$  mol<sup>-1</sup>**PERIODIC TABLE OF THE ELEMENTS – missing 1<sup>st</sup> 20 elements**  
(this will not be graded)

|                           |                           |                          |                           |                           |                           |                            |                           |                           |                           |                           |                           |                           |                           |                           |                           |                           |                           |
|---------------------------|---------------------------|--------------------------|---------------------------|---------------------------|---------------------------|----------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| 1.008                     |                           |                          |                           |                           |                           |                            |                           |                           |                           |                           |                           |                           |                           |                           |                           |                           | 4.00                      |
| 6.941                     | 9.012                     |                          |                           |                           |                           |                            |                           |                           |                           |                           |                           | 10.81                     | 12.01                     | 14.007                    | 15.999                    | 18.998                    | 20.18                     |
| 22.99                     | 24.31                     |                          |                           |                           |                           |                            |                           |                           |                           |                           |                           | 26.98                     | 28.09                     | 30.97                     | 32.07                     | 35.45                     | 39.95                     |
| 39.10                     | 40.08                     | 21<br><b>Sc</b><br>44.96 | 22<br><b>Ti</b><br>47.87  | 23<br><b>V</b><br>50.94   | 24<br><b>Cr</b><br>52.00  | 25<br><b>Mn</b><br>54.94   | 26<br><b>Fe</b><br>55.85  | 27<br><b>Co</b><br>58.93  | 28<br><b>Ni</b><br>58.69  | 29<br><b>Cu</b><br>63.55  | 30<br><b>Zn</b><br>65.39  | 31<br><b>Ga</b><br>69.72  | 32<br><b>Ge</b><br>72.61  | 33<br><b>As</b><br>74.92  | 34<br><b>Se</b><br>78.96  | 35<br><b>Br</b><br>79.90  | 36<br><b>Kr</b><br>83.80  |
| 37<br><b>Rb</b><br>85.47  | 38<br><b>Sr</b><br>87.62  | 39<br><b>Y</b><br>88.91  | 40<br><b>Zr</b><br>91.22  | 41<br><b>Nb</b><br>92.91  | 42<br><b>Mo</b><br>95.94  | 43<br><b>Tc</b><br>(97.91) | 44<br><b>Ru</b><br>101.07 | 45<br><b>Rh</b><br>102.91 | 46<br><b>Pd</b><br>106.42 | 47<br><b>Ag</b><br>107.87 | 48<br><b>Cd</b><br>112.41 | 49<br><b>In</b><br>114.82 | 50<br><b>Sn</b><br>118.71 | 51<br><b>Sb</b><br>121.76 | 52<br><b>Te</b><br>127.60 | 53<br><b>I</b><br>126.90  | 54<br><b>Xe</b><br>131.29 |
| 55<br><b>Cs</b><br>132.91 | 56<br><b>Ba</b><br>137.33 | <b>La-Lu</b>             | 72<br><b>Hf</b><br>178.49 | 73<br><b>Ta</b><br>180.95 | 74<br><b>W</b><br>183.84  | 75<br><b>Re</b><br>186.21  | 76<br><b>Os</b><br>190.2  | 77<br><b>Ir</b><br>192.22 | 78<br><b>Pt</b><br>195.08 | 79<br><b>Au</b><br>196.97 | 80<br><b>Hg</b><br>200.59 | 81<br><b>Tl</b><br>204.38 | 82<br><b>Pb</b><br>207.2  | 83<br><b>Bi</b><br>208.98 | 84<br><b>Po</b><br>208.98 | 85<br><b>At</b><br>209.99 | 86<br><b>Rn</b><br>222.02 |
| 87<br><b>Fr</b><br>223    | 88<br><b>Ra</b><br>226.03 | <b>Ac-Lr</b>             | 104<br><b>Rf</b><br>(261) | 105<br><b>Db</b><br>(262) | 106<br><b>Sg</b><br>(263) | 107<br><b>Bh</b><br>(262)  | 108<br><b>Hs</b><br>(265) | 109<br><b>Mt</b><br>(266) |                           |                           |                           |                           |                           |                           |                           |                           |                           |

|                           |                           |                           |                           |                          |                           |                           |                           |                           |                           |                           |                           |                           |                           |                           |
|---------------------------|---------------------------|---------------------------|---------------------------|--------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| 57<br><b>La</b><br>138.91 | 58<br><b>Ce</b><br>140.12 | 59<br><b>Pr</b><br>140.91 | 60<br><b>Nd</b><br>144.24 | 61<br><b>Pm</b><br>(145) | 62<br><b>Sm</b><br>150.35 | 63<br><b>Eu</b><br>151.97 | 64<br><b>Gd</b><br>157.25 | 65<br><b>Tb</b><br>158.93 | 66<br><b>Dy</b><br>162.50 | 67<br><b>Ho</b><br>164.93 | 68<br><b>Er</b><br>167.26 | 69<br><b>Tm</b><br>168.93 | 70<br><b>Yb</b><br>173.04 | 71<br><b>Lu</b><br>174.97 |
| 89<br><b>Ac</b><br>227.03 | 90<br><b>Th</b><br>232.04 | 91<br><b>Pa</b><br>231.04 | 92<br><b>U</b><br>238.03  | 93<br><b>Np</b><br>(237) | 94<br><b>Pu</b><br>(245)  | 95<br><b>Am</b><br>(243)  | 96<br><b>Cm</b><br>(247)  | 97<br><b>Bk</b><br>(247)  | 98<br><b>Cf</b><br>(251)  | 99<br><b>Es</b><br>(252)  | 100<br><b>Fm</b><br>(257) | 101<br><b>Md</b><br>(258) | 102<br><b>No</b><br>(259) | 103<br><b>Lr</b><br>(260) |