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(to be entered by the teacher)

CHEMISTRY 205/2 Section Lec 51

MID TERM EXAMINATION with ANSWERS

Number of pages: 12

October 18, 2017 6:00 - 7:00pm

Instructor: G. DÉNÈS

Materials allowed: Calculators with no storage capacity
Printed translation dictionaries

Materials NOT allowed: Books, notes
Not your own periodic tables. One is attached to the questionnaire.
No sharing of calculators
No technical/scientific dictionary
No electronic dictionary
No scrap paper. There are extra pages for rough calculation on the
questionnaire.

INSTRUCTIONS:

1. This is a multiple choice examination.
 2. Circle only one answer number for each question. There is only one correct answer for each question.
 3. If you circle more than one answer number for a question, you will get a "zero" for that question.
 4. If you have already circled an answer and you change your mind, erase the other answers, or clearly cross them out. Ambiguous answers will be counted as being wrong.
 5. Only the circle around the question number will count. I will not read any calculation or anything else you may write on the questionnaire.
 6. Do not write anything else on the front of the pages. Use the extra pages on the back of the questionnaire for your calculations.
 7. Answer every question.
 8. All the questions are worth the same mark.
 9. All group numbers used throughout this questionnaire are in the current official numbering system defined by the IUPAC.
 10. When you are finished writing your exam, raise your hand and remain seated. The teacher or the invigilator will come to pick up your questionnaire and have you sign the attendance sheet, after checking your ID card. Do NOT leave your seat until the teacher allows you to.
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***** QUESTIONS START HERE *****

1. Give the name of the transformation from solid to gas without going through a liquid phase.

1. Gasification
 2. Vaporization
 3. Sublimation
 4. Solidification
 5. Condensation
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2. Tell which of the following statements is **correct**:

1. For most elements and compounds, the *density* increases when temperature increases.
2. For most elements and compounds, the *density* decreases when temperature increases.
3. For most elements and compounds, the *density* does not change when temperature increases.
4. For most elements and compounds, the *density* decreases when pressure increases.
5. For most elements and compounds, the *density* does not change when pressure increases.

Solution: density = mass / volume

Elements and compounds expand when temperature increases => their volume increases

Temperature increases => density = mass / larger volume => smaller density

3. Tell which of the following statements is **incorrect**:

1. A *compound* is a substance with constant composition
2. A *homogeneous mixture* has a variable composition
3. A *heterogeneous mixture* has a variable composition
4. A *chemical change* results in a complete change of properties
5. A *physical change* results in a bond breaking

Solution : Bond breaking takes places in chemical reactions, not in physical changes

4. Elements A and B combine together to give several compounds. When 1.188 g of B combines with 1.000 g of A, the compound obtained has the formula AB_2 . Tell what is the formula of the compound obtained when 1.782 g of B combines with 1.000 g of A.

1. AB
2. AB_3
3. A_2B_3
4. AB_4
5. AB_6

Solution: 1.188 g of B + 1.000 g of A \Rightarrow AB_2 .
1.782 g of B + 1.000 g of A \Rightarrow AB_x , with $x > 2$ since 1.782 g of B $>$ 1.188 g of B
 $1.782 \text{ g of B} / 1.188 \text{ g of B} = 1.5 \Rightarrow x = 2 \times 1.5 = 3 \Rightarrow AB_x = AB_3$

5. Tell which of the following law was applied in the above question :

1. Proust's law of definite proportions
2. Dalton's law of multiple proportions
3. Dalton's atomic theory
4. Gay-Lussac's law
5. Avogadro's hypothesis

Hint: The composition of two compounds made of the same elements was compared

6. Tell which of the following scientists recognized that electricity was made of two opposite kinds, positive and negative:

1. Ernest Rutherford
 2. Marie Curie
 3. Benjamin Franklin
 4. Henri Becquerel
 5. Antoine Lavoisier
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7. An element that has a mass number of 119 and it has 69 neutrons. Tell how many number of protons it

contains:

1. 119
2. 69
3. 188
4. 50
5. 42

Solution: mass number $A = \text{number of protons } Z + \text{number of neutrons } N$

$$Z = A - N = 119 - 69 = 50$$

8. Give the number of electrons, protons and neutrons contained in $^{31}\text{P}^{3-}$ (circle the question number for the answer of your choice, one only)

	Number of electrons	Number of protons	Number of neutrons
1.	15	16	18
2.	15	16	18
3.	15	18	16
4.	18	15	31
5.	18	15	16

Solution: $Z = 15$ (from periodic table) $\Rightarrow 15$ protons

$3-$ sign $\Rightarrow 15 + 3 = 18$ electrons

number of neutrons = mass number - number of protons = $31 - 15 = 16$

9. Choose the correct name of Hg_2Cl_2 .

1. Mercuric chloride
2. Dimercury dichloride
3. Mercury dichloride
4. Mercury(I) chloride
5. Mercury(II) chloride

Solution: metal with non-metal \Rightarrow nomenclature of ionic compounds (no prefixes)

Cl has the highest electronegativity EN, in group 17 $\Rightarrow \text{EN}(\text{Cl}) = 17 - 18 = -1 \Rightarrow -2$ for 2 Cl

=> +2 for 2 Hg => +1 for each Hg => mercury(I) chloride

10. An element reacts violently with water. It is a soft solid at ambient temperature, and it conducts electricity well. Tell what group it belongs to:

1. Group 1
2. Group 11
3. Group 15
4. Group 16
5. Group 17

Solution: Conducts electricity well => metal or graphite

Reacts violently with water => not graphite, must be a metal from group 1

Soft solid at ambient temperature => metal from group 1.

11. Europium (Eu) is a lanthanide that has two stable isotopes, ^{151}Eu (atomic mass = 150.9196 u) and ^{153}Eu (atomic mass = 152.9209 u). Tell what is the natural abundance of ^{153}Eu .

1. 47.5 %
2. 52.5 %
3. 57.9%
4. 42.1 %
5. 37.4 %

Solution: $[\text{FA}(^{151}\text{Eu}) \times \text{atomic mass } 150.9196 \text{ u}] + [\text{FA}(^{153}\text{Eu}) \times \text{atomic mass } 152.9209 \text{ u}] = \text{AM}(\text{Eu})$

FA are fractional abundances = % abundances / 100

$\text{AM}(\text{Eu}) = 151.97 \text{ u}$ (weighed average of the atomic masses of the two isotopes, from the periodic table)

Only two stable isotopes => $\text{FA}(^{151}\text{Eu}) + \text{FA}(^{153}\text{Eu}) = 1$ => $\text{FA}(^{151}\text{Eu}) = 1 - \text{FA}(^{153}\text{Eu})$

=> $[\{1 - \text{FA}(^{153}\text{Eu})\} \times 150.9196 \text{ u}] + [\text{FA}(^{153}\text{Eu}) \times 152.9209 \text{ u}] = 151.97 \text{ u}$

$150.9196 \text{ u} - [\text{FA}(^{153}\text{Eu}) \times 150.9196 \text{ u}] + [\text{FA}(^{153}\text{Eu}) \times 152.9209 \text{ u}] = 151.97 \text{ u}$

$[\text{FA}(^{153}\text{Eu}) \times [-150.9196 \text{ u} + 152.9209 \text{ u}]] = 151.97 \text{ u} - 150.9196 \text{ u}$

$\text{FA}(^{153}\text{Eu}) = 1.0504 \text{ u} / 2.0013 \text{ u} = 0.52486$ => % (^{153}Eu) = 52.5 %

12. An unknown compound was analyzed and found to contain (in mass %):

C: 40.9 %

H: 4.58 %

O: 54.5 %

Determine its empirical formula.

1. $C_5H_4O_5$
2. $C_4H_5O_4$
3. $C_3H_4O_3$
4. $C_3H_5O_4$
5. $C_4H_6O_5$

Solution: In 100 g of compound, there are:

$$m(C) = 40.9 \text{ g}, n(C) = m(C) / M(C) = 40.9 \text{ g} / 12.01 \text{ g}\cdot\text{mol}^{-1} = 3.4055 \text{ mol}(C)$$

$$m(H) = 4.58 \text{ g}, n(H) = m(H) / M(H) = 4.59 \text{ g} / 1.008 \text{ g}\cdot\text{mol}^{-1} = 4.5536 \text{ mol}(H)$$

$$m(O) = 54.5 \text{ g}, n(O) = m(O) / M(O) = 54.5 \text{ g} / 15.999 \text{ g}\cdot\text{mol}^{-1} = 3.4065 \text{ mol}(O)$$

$$\text{mol}(C) \text{ smaller} \Rightarrow C : H : O = 1 : 1.337 : 1.000 \Rightarrow CH_{1.33}O \Rightarrow C_3H_4O_3$$

13. Tell what is the formula of aluminum nitride.

1. AlN
2. Al_2N
3. AlN_2
4. Al_3N
5. AlN_3

Al, metal in group 13, electronegativity lower than that of N. $13 - 10 \Rightarrow +3 \Rightarrow Al^{3+}$

N, non-metal in group 15, electronegativity higher than that of Al. $15 - 18 = -3 \Rightarrow N^{3-}$

Al^{3+} and N^{3-} gives AlN , for electroneutrality.

14. Tell which of the following compounds contains an unexpected oxidation state for the least electronegative element.

1. ClF_5
2. Cl_2O_3
3. PbO
4. N_2O_3
5. Se_2O_5

Solution: Allowed oxidation numbers: Cl +5 in ClF_5 , Cl +3 in Cl_2O_3 , Pb +2 in PbO and N +3 in N_2O_3 .
Se: allowed: +6, +4, +2 and -2; not allowed: +5

15. Tell which of the following compounds is a mixed oxidation state compound

1. In_2O_3
2. In_2O
3. PbO
4. H_2O_2
5. InO

Solution: Allowed oxidation numbers: In +3 in In_2O_3 , In +1 in In_2O , Pb +2 in PbO .
In H_2O_2 , H +1 and O -1 (because of O-O bond)
In: allowed: +3 and +1; not allowed: +2 => InO is actually In_2O_2 , i.e. In(I)In(III)O_2 .

16. Tell who measured the mass of the electron.

1. Rutherford
2. Thomson
3. Millikan
4. Becquerel
5. None of the above

Solution: Thomson measured the ratio charge/mass, Millikan measured the charge, hence the mass could be calculated.

17. Tell which of the following compounds is the most likely to be insoluble in water

1. Hydrogen fluoride
2. Calcium bicarbonate
3. Magnesium perchlorate
4. Potassium iodide

5. Magnesium fluoride

Hint: Use Coulomb's law: product of the charges of the ions equal to -4 in magnesium fluoride, and to -1 or -2 in the others. HF is molecular, highly polar.

18. All the following are oxidation-reduction reactions EXCEPT:

1. $\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow 2\text{HCl}(\text{g})$
2. $2 \text{NaBr}(\text{aq}) + \text{F}_2(\text{g}) \rightarrow 2 \text{NaF}(\text{aq}) + \text{Br}_2(\text{g})$
3. $\text{Ca}(\text{s}) + 2 \text{HBr}(\text{aq}) \rightarrow \text{CaBr}_2(\text{aq}) + \text{H}_2(\text{g})$
4. $\text{Pb}^{2+}(\text{aq}) + 2\text{I}^{-}(\text{aq}) \rightarrow \text{PbI}_2(\text{s})$
5. $2\text{Na}(\text{s}) + \text{Cl}_2(\text{g}) \rightarrow 2\text{NaCl}(\text{s})$

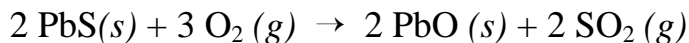
Solution: There is a change of oxidation numbers in all equations except in the 4th.

19. Tell which of the following is a strong acid in water

1. HF
2. KOH
3. HClO_4
4. HClO
5. CH_3COOH

Solution: HF, HClO and CH_3COOH are weak acids, KOH is a strong base

20. Determine which of the following statements is correct in the balanced equation below:



1. Pb is oxidized and PbS is the reducing agent
2. Pb is reduced and PbS is the oxidizing agent
3. S is oxidized and PbS is the reducing agent
4. S is reduced and PbS is the oxidizing agent

5. O oxidized and O_2 is the oxidizing agent

Solution: Look at the change of oxidation number: S changes from -2 to +4 =>S is oxidized => PbS is a reducing agent.
