



FACULTY OF SCIENCE

DEPARTMENT OF CHEMISTRY

MODULE

CEM1A3E/3EA1
INTRODUCTION TO GENERAL CHEMISTRY

CAMPUS

APK

SUPPLEMENTARY EXAM

2019

DATE:

WINTER EXAM

SESSION:

08:00 – 11:00

ASSESSOR(S)

DR O ZINYEMBA

INTERNAL MODERATOR

DR A ADEYINKA

DURATION 2½ HOURS

MARKS 82

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY:

1. THIS PAPER CONSISTS OF 6 PAGES AND A PERIODIC TABLE.
2. ANSWER ALL QUESTIONS.
3. ALL ANSWERS MUST BE GIVEN TO THE **CORRECT NUMBER OF SIGNIFICANT FIGURES**.
4. THE USE OF CELL PHONES AND OTHER ELECTRONIC COMMUNICATION DEVICES IS **FORBIDDEN** AND THEY MUST BE SWITCHED OFF. NO DATA/IMAGE STORING DEVICES, INCLUDING CALCULATORS CAPABLE OF SUCH, ARE PERMITTED IN THIS EXAMINATION.
5. THIS IS A CLOSED BOOK EXAMINATION. YOU ARE **NOT ALLOWED** TO HAVE ANY BOOK, MEMORANDUM, NOTES, PAPER, PHOTOGRAPHS, DOCUMENT OR WRITTEN/PRINTED MATERIAL OTHER THAN THE QUESTION PAPER AND THE ANSWER BOOKS PROVIDED BY THE EXAMINER/INVIGILATOR. IF YOU NEED PAPER FOR ROUGH WORK, AN ADDITIONAL EXAM ANSWER SHEET WILL BE GIVEN TO YOU, WHICH MUST BE CLEARLY LABELLED AS **ROUGH WORK: NOT FOR MARKING**, AND HANDED IN TOGETHER WITH THE QUESTION PAPER AND ALL YOUR ANSWER BOOKS.

SECTION A [26 Marks] [Multi choice questions: Only one answer is correct]

1. The Lewis structure for each of the following except _____ contains at least one double bond.
 - A. CS_2
 - B. NO^+
 - C. C_2H_4
 - D. N_2H_2
 - E. O_2

2. For each of the following species except _____, the electronic structure may be adequately described by two resonance formulas.
 - A. O_3
 - B. SO_2
 - C. NO_2^-
 - D. SO_3^{2-}
 - E. C_6H_6

- 3 In which of the following molecules is the octet rule violated?
 - A. PF_3
 - B. SiF_4
 - C. OF_2
 - D. ClF_3
 - E. ClF

4. Which molecule or ion has the same molecular geometry for its central atom as the carbonate ion?
 - A. BrO_3^-
 - B. AsCl_3
 - C. CH_3^-
 - D. H_2CO
 - E. PF_3

5. The volume of 1 mol of nitrogen
 - A. is increased by decreasing the temperature.
 - B. has the value of 22.4 L at 0°C and 1.00 atm.
 - C. is decreased by decreasing the pressure of the gas.
 - D. is lower than that of ammonia at high pressures.
 - E. is decreased by increasing its kinetic energy.

6. How many moles of gas are in a gas sample occupying 0.630 L at 131 mmHg and 22°C?

- A. 0.00448 mol
- B. 45.7 mol
- C. 3.41 mol
- D. 0.000368 mol
- E. 223 mol

7. At equilibrium, it was found that the concentration of H_2 was 0.0572 *M*, the concentration of N_2 was 0.0191 *M*, and the concentration of NH_3 was 0.412 *M*. What is K_p for this equilibrium? ($R = 0.0821 \text{ L} \cdot \text{atm}/(\text{K} \cdot \text{mol})$)

- A. 2.85
- B. 4.28
- C. 1.70×10^{-2}
- D. 1.95×10^{-8}
- E. 2.26×10^{-2}

8. Consider the reaction represented by the equation $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$.

What happens to the equilibrium position when an inert gas is added to this system (as represented above) at equilibrium?

- A. If the container is rigid, nothing happens to the equilibrium position. If the container is fitted with a movable piston, the equilibrium position shifts.
- B. If the container is rigid, the equilibrium position shifts. If the container is fitted with a movable piston, nothing happens to the equilibrium position.
- C. The equilibrium position shifts no matter what the container is like.
- D. Nothing happens to the equilibrium position no matter what the container is like.
- E. The value of the equilibrium constant must be known to answer this question.

9. In the following list of pairs of ions, which is the more acidic?

Cr^{3+} or Cr^{3+} ; Cu^{2+} or Cu^+ ; Co^{2+} or Co^{3+}

- A. Fe^{3+} , Cu^+ , Co^{2+}
- B. Fe^{2+} , Cu^{2+} , Co^{3+}
- C. Fe^{3+} , Cu^{2+} , Co^{3+}
- D. Fe^{2+} , Cu^{2+} , Co^{2+}
- E. None of the above

10. Which of the following statements is incorrect?

- A. An Arrhenius base is an electron-pair acceptor.
- B. An Arrhenius acid increases the concentration of hydronium ion.
- C. A Brønsted–Lowry base is a proton acceptor.
- D. A Brønsted–Lowry acid is a proton donor.
- E. Acids tend to be sour, and bases tend to be bitter.

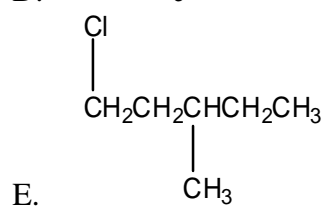
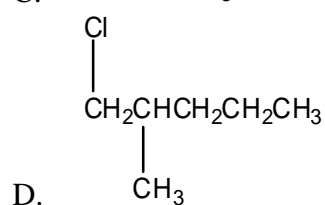
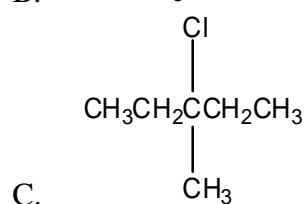
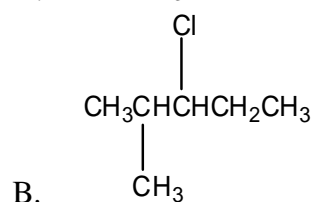
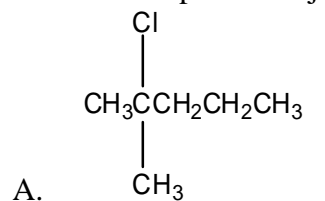
11. What is the conjugate acid of $\text{H}_2\text{PO}_4^-(aq)$?

- A. H_3O^+
- B. H_3PO_4
- C. HPO_4^{2-}
- D. H_3P
- E. PO_4^{3-}

12. Which of the following statements is incorrect?

- A. One reason why HCl is a stronger acid than HF is that Cl has a larger atomic radius than F.
- B. One reason why HCl is a stronger acid than HF is that the H–Cl bond is weaker than the H–F bond.
- C. One reason why HCl is a stronger acid than HF is that Cl is more electronegative than F.
- D. The acids HBr and HI both appear equally strong in water.
- E. F^- is a stronger base than Cl^- .

13. What is the expected major product from the reaction of 2-methyl-2-pentene with HCl?



SECTION B [56 Marks] [Answer all Questions]

Question 1 [14 Marks]

1.1 Describe the kinds of exceptions to the octet rule that we encounter in compounds of the main –group elements. Give an example in each case. (6)

1.2 With the aid of formal charges, draw the best representative Lewis structure for BrO_4^- .
Show all the steps of how you reach your conclusion. (8)

Question 2 [6 Marks]

- (a) Draw the Lewis structure of XeF_2 . (3)
- (b) What is the electron domain geometry of XeF_2 ? (1)
- (c) What is the molecular geometry of XeF_2 ? (1)
- (d) By visually analysing the Lewis structure you have drawn, determine the hybridisation of XeF_2 . (1)

Question 3 [9 Marks]

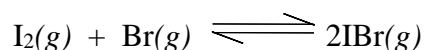
3.1 A sample of gaseous substance at 25 °C and 0.862 atm has a density of 2.26 g/L. What is the molecular mass of the substance? (4)

3.2 A 10.0-L flask contains 1.031 g O_2 and 0.572 g CO_2 at 18 °C.

- (a) What are the partial pressures of oxygen and carbon dioxide? (4)
- (b) What is the mole fraction of oxygen in the mixture? (1)

Question 4 [9 Marks]

Iodine and bromine react to give iodine monobromide, IBr ,



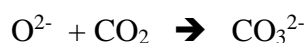
What is the equilibrium composition of mixture at 150 °C that initially contained 0.0015 mol each of iodine and bromine in a 5.0-L vessel? The equilibrium constant K_c for this reaction at 150 °C is 1.2×10^2 .

Question Five [11 Marks]

5.1 Determine the direction of the following reaction from the relative strengths of acids and bases. Briefly explain your answer. (Hint: See Table attached) (4)

5.2 (a) Identify the Lewis acid and Lewis base in the following reaction. (1)

(b) Write the chemical equation, using electron –dot formulas. (3)



5.3 A saturated solution of calcium hydroxide has a hydroxide-ion concentration of 0.025 *M*.

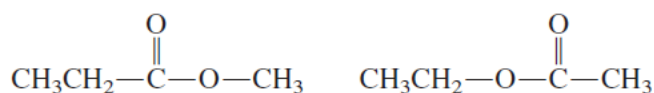
What is the pH of the solution? (3)

Question 6 [7 Marks]

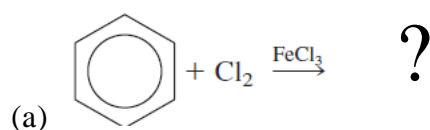
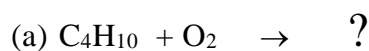
6.1 Write the IUPAC name of the following compound: (1)



6.2 Consider the following formulas of two esters: One is ethyl ethanoate (ethyl acetate) and the other is methyl propanoate (methyl propionate). Which is which? (Redraw and name them) (2)



6.3 Complete and balance the following equations. (4)



CONSTANTSGas constant = $0.08206 \text{ L} \cdot \text{atm} / \text{K} \cdot \text{mol}$

TABLE 15.2		Relative Strengths of Acids and Bases	
	Acid	Base	
Strongest acids ↓ Weakest acids	HClO_4	ClO_4^-	Weakest bases ↑ Strongest bases
	H_2SO_4	HSO_4^-	
	HI	I^-	
	HBr	Br^-	
	HCl	Cl^-	
	HNO_3	NO_3^-	
	H_3O^+	H_2O	
	HSO_4^-	SO_4^{2-}	
	H_2SO_3	HSO_3^-	
	H_3PO_4	H_2PO_4^-	
	HNO_2	NO_2^-	
	HF	F^-	
	$\text{HC}_2\text{H}_3\text{O}_2$	$\text{C}_2\text{H}_3\text{O}_2^-$	
	$\text{Al}(\text{H}_2\text{O})_6^{3+}$	$\text{Al}(\text{H}_2\text{O})_5\text{OH}^{2+}$	
	H_2CO_3	HCO_3^-	
	H_2S	HS^-	
	HClO	ClO^-	
	HBrO	BrO^-	
	NH_4^+	NH_3	
	HCN	CN^-	
	HCO_3^-	CO_3^{2-}	
	H_2O_2	HO_2^-	
	HS^-	S^{2-}	
	H_2O	OH^-	

The Periodic Table

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