

## JOINT UNIVERSITIES PRELIMINARY EXAMINATIONS BOARD

### 2015 EXAMINATIONS

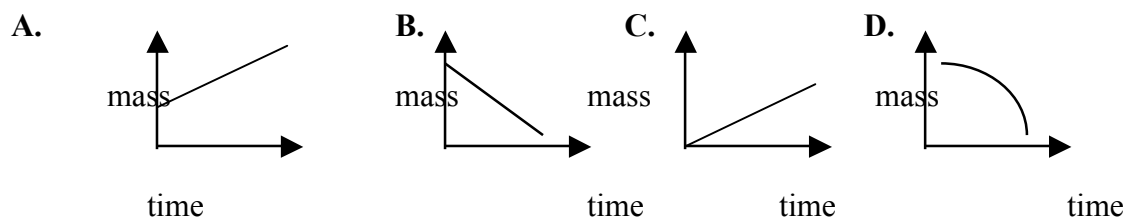
### CHEMISTRY: SCI-J153

#### MULTIPLE CHOICE QUESTIONS: Answer ALL Questions

- A normal body temperature is  $37\text{ }^{\circ}\text{C}$ ,  $K_w = 2.4 \times 10^{-14}$ . Calculate  $[\text{H}_3\text{O}^+]$  and  $[\text{OH}^-]$  for the body fluid at this temperature.
  - $[\text{H}_3\text{O}^+] = [\text{OH}^-] = 2.5 \times 10^{-7}$
  - $[\text{H}_3\text{O}^+] = [\text{OH}^-] = 1.5 \times 10^{-8}$
  - $[\text{H}_3\text{O}^+] = [\text{OH}^-] = 1.5 \times 10^{-6}$
  - $[\text{H}_3\text{O}^+] = [\text{OH}^-] = 1.5 \times 10^{-7}$
- Atoms of elements in a group on the Periodic Table have similar chemical properties. This similarity is most closely related to the atoms'.
  - number of principal energy levels
  - number of valence electrons
  - atomic numbers
  - atomic masses
- How many atoms of Cu are present in 35.4 g of Cu?  $[\text{Cu} = 63.5 \text{ g mol}^{-1}]$ 
  - $1.08 \times 10^{24}$  atoms of Cu
  - $3.27 \times 10^{23}$  atoms of Cu
  - $6.02 \times 10^{23}$  atoms of Cu
  - $1.20 \times 10^{22}$  atoms of Cu
- How would you prepare  $250 \text{ cm}^3$  of 0.25 M aqueous solution of NaCl?  $[\text{Na} = 23 \text{ g mol}^{-1}; \text{Cl} = 35.5 \text{ g mol}^{-1}]$ 
  - Add 3.66 g NaCl to  $250 \text{ cm}^3$  of distilled water
  - Weigh 3.66 g NaCl into 250 ml flask and add distilled water up to the mark
  - Add 14.60 g NaCl to  $250 \text{ cm}^3$  of distilled water
  - Weigh 14.60 g NaCl into 250 ml flask and add distilled water up to the mark
- What is the shape of  $\text{PCl}_3$ ?
  - Trigonal planar
  - Trigonal pyramidal
  - Tetrahedral
  - V-shaped (bent)
- Uranium -233 ( $^{233}\text{U}_{92}$ ) decays by  $\alpha$  – emission. What is the decay product?
  - $^{229}\text{Th}_{90}$
  - $^{231}\text{Th}_{90}$

- C.  $^{231}\text{Ac}_{91}$   
 D.  $^{233}\text{Ac}_{91}$

7. Arrange the following ions in order of decreasing charge density  
 $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{Al}^{3+}$  and  $\text{Ba}^{2+}$
- A.  $\text{Al}^{3+} > \text{Mg}^{2+} > \text{Ca}^{2+} > \text{Ba}^{2+}$   
 B.  $\text{Ba}^{2+} > \text{Ca}^{2+} > \text{Mg}^{2+} > \text{Al}^{3+}$   
 C.  $\text{Al}^{3+} < \text{Mg}^{2+} < \text{Ca}^{2+} < \text{Ba}^{2+}$   
 D.  $\text{Mg}^{2+} > \text{Al}^{3+} > \text{Ba}^{2+} > \text{Ca}^{2+}$
8. Which of the following statements explain why caesium has a lower melting point than sodium?
- A. Sodium is a more electropositive metal  
 B. Sodium has higher ionization energy  
 C. Sodium has a stronger metallic bond  
 D. Caesium has a larger atomic radius
9. Transition metals can form complex ions because:
- A. they have paired electrons in the d subshell  
 B. they have unpaired electrons in the d subshell  
 C. they have empty d orbitals  
 D. they have small charge/size ratio
10. How many equivalent hybrid orbitals are there in  $\text{Sp}^2$ -hybridised carbon?
- A. four  
 B. two  
 C. three  
 D. one
11. When common names are used for acids, the underlined carbon atom in the molecule shown would be designated as the \_\_\_\_\_ C atom.
- $$\text{CH}_3\text{CH}_2\text{CH}_2\text{-}\overset{\text{O}}{\parallel}{\text{C}}\text{-OH}$$
- A. gamma  
 B. alpha  
 C. delta  
 D. beta
12. Purification of a strip of impure copper metal in aqueous  $\text{CuSO}_4$  was carried out using a steady current. Which graph shows the change in mass of the cathode with time?



13. Which gas closely approaches ideal behaviour at room temperature and pressure?

- A. helium
- B. carbon dioxide
- C. ammonia
- D. oxygen

14. A sample of a brown gas, a major air pollutant, is found to contain 2.34 g N and 5.34g O. Determine the empirical formula for this substance. [N = 14, O = 16]

- A. NO<sub>2</sub>
- B. NO
- C. N<sub>2</sub>O
- D. N<sub>2</sub>O<sub>3</sub>

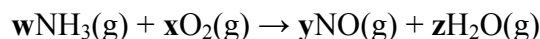
15. Why does the rate of a gaseous reaction increase when the pressure is increased at a constant temperature?

- A. More particles have energy that exceeds the activation energy.
- B. The particles have more space in which to move.
- C. The particles move faster.
- D. There are more frequent collisions between particles.

16. Why is gaseous nitrogen less reactive than gaseous fluorine?

- A. The boiling point of nitrogen is lower than that of fluorine.
- B. The relative molecular mass of nitrogen is lower than that of fluorine.
- C. The atomic radius of nitrogen is greater than that of fluorine.
- D. The bond strength in the molecule is greater in nitrogen than in fluorine.

17. The first stage in the manufacture of nitric acid is the oxidation of ammonia by oxygen.



What values for w, x, y and z are needed to balance the equation?

- A. 4, 5, 4 and 6
- B. 4, 6, 4 and 5
- C. 5, 6, 5 and 4
- D. 6, 5, 6 and 4

18. The reaction of chlorine with methane is carried out in the presence of light.

What is the function of the light?

- A. to break the C – H bonds in methane
- B. to break up the chlorine molecules into atoms
- C. to break up the chlorine molecules into ions
- D. to heat up the mixture

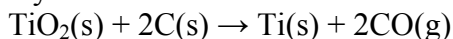
19. In the Solvay process,  

$$\text{NaCl(aq)} + \text{NH}_3(\text{g}) + \text{H}_2\text{O(l)} + \text{CO}_2(\text{g}) \rightarrow \text{NaHCO}_3(\text{s}) + \text{NH}_4\text{Cl(aq)}$$
 What volume of carbon dioxide (at s.t.p) is required to produce 1.00 kg of sodium hydrogencarbonate? (*I mole of gas at s.t.p occupies 22.4 dm<sup>3</sup>*) [Na = 23, Cl = 35.5, C = 12, O = 16, H = 1, N = 14]  
 A. 250 dm<sup>3</sup>  
 B. 762dm<sup>3</sup>  
 C. 267 dm<sup>3</sup>  
 D. 462 dm<sup>3</sup>
20. Which group of particles is in order of increasing size?  
 A. N<sub>2</sub>, O, F  
 B. N<sup>3-</sup>, O<sup>2-</sup>, F<sup>-</sup>  
 C. Na<sup>+</sup>, Mg<sup>2+</sup>, Al<sup>3+</sup>  
 D. Na<sup>+</sup>, Ne, F<sup>-</sup>
21. River water in a chalky agricultural area may contain Ca<sup>2+</sup>, Mg<sup>2+</sup>, CO<sub>3</sub><sup>2-</sup>, HCO<sub>3</sub><sup>-</sup>, Cl<sup>-</sup>, NO<sub>3</sub><sup>-</sup> ions. In a waterworks, such water is treated by adding a calculated quantity of calcium hydroxide. What will be precipitated following the addition of calcium hydroxide?  
 A. CaCl<sub>2</sub>  
 B. CaCO<sub>3</sub>  
 C. Ca(NO<sub>3</sub>)<sub>2</sub>  
 D. Mg(NO<sub>3</sub>)<sub>2</sub>
22. The electronic configuration of the Fe<sup>3+</sup> ion is.....  
 A. 1s<sup>2</sup> 2s<sup>2</sup> 2p<sup>6</sup> 3s<sup>2</sup> 3p<sup>6</sup> 3d<sup>4</sup>  
 B. 1s<sup>2</sup> 2s<sup>2</sup> 2p<sup>6</sup> 3s<sup>2</sup> 3p<sup>6</sup> 3d<sup>5</sup>  
 C. 1s<sup>2</sup> 2s<sup>2</sup> 2p<sup>6</sup> 3s<sup>2</sup> 3p<sup>6</sup> 3d<sup>3</sup>  
 D. 1s<sup>2</sup> 2s<sup>2</sup> 2p<sup>6</sup> 3s<sup>2</sup> 3p<sup>6</sup> 3d<sup>6</sup>
23. An element with an atomic number of 35 is \_\_\_\_\_ block element.  
 A. s-block  
 B. p-block  
 C. d-block  
 D. f-block
24. Iodine trichloride, ICl<sub>3</sub>, is made by reacting iodine with chlorine.  

$$\text{I}_2(\text{s}) + \text{Cl}_2(\text{g}) \rightarrow 2\text{ICl}(\text{s}) ; \Delta H_{\theta} = +14 \text{ kJ mol}^{-1}$$

$$\text{ICl}(\text{s}) + \text{Cl}_2(\text{g}) \rightarrow \text{ICl}_3(\text{s}) ; \Delta H_{\theta} = -88 \text{ kJ mol}^{-1}$$
 By using the data above, what is the enthalpy change of the formation for solid iodine trichloride?  
 A. -162 kJ mol<sup>-1</sup>  
 B. -81 kJ mol<sup>-1</sup>  
 C. -74 kJ mol<sup>-1</sup>  
 D. -60 kJ mol<sup>-1</sup>

25. The standard enthalpy changes of formation of  $\text{TiO}_2(\text{s})$  and  $\text{CO}(\text{g})$  are  $-940 \text{ kJ mol}^{-1}$  and  $-110 \text{ kJ mol}^{-1}$  respectively.



What is the standard enthalpy change of this reaction?

- A.  $-830 \text{ kJ mol}^{-1}$
- B.  $-720 \text{ kJ mol}^{-1}$
- C.  $+720 \text{ kJ mol}^{-1}$
- D.  $+830 \text{ kJ mol}^{-1}$

26. The standard enthalpy changes of formation of  $\text{HCl}$  and  $\text{HI}$  are  $-93 \text{ kJ mol}^{-1}$  and  $+25 \text{ kJ mol}^{-1}$  respectively. Which statement is most important in explaining this difference?

- A. The bond energy of  $\text{Cl}_2$  is smaller than the bond energy of  $\text{I}_2$ .
- B. The activation energy for the  $\text{H}_2 / \text{Cl}_2$  reaction is much less than that for the  $\text{H}_2 / \text{I}_2$  reaction.
- C. The bond energy of  $\text{I}_2$  is smaller than the bond energy of  $\text{Cl}_2$ .
- D. The bond energy of  $\text{HI}$  is smaller than the bond energy of  $\text{HCl}$ .

27. What is the catalyst used in the Contact process?

- A. Pd
- B. Pt
- C.  $\text{Fe}_2\text{O}_3$
- D.  $\text{V}_2\text{O}_5$

28. The main purpose of adding cryolite to the ore (bauxite) during the preparation of aluminium metal by electrolysis is?

- A. minimizes the release of oxygen at the graphite anode
- B. reduce the melting point of the bauxite
- C. increase the melting point of the bauxite
- D. enable the aluminum discharge at the anode

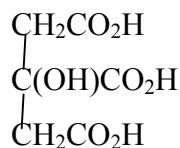
29. What type of bond needs to be broken for magnesium oxide to melt?

- A. Co-ordinate
- B. covalent
- C. ionic
- D. metallic

30. A substance which contains the following elements by mass: C, 17.8%; H, 1.5%; Cl, 52.6%; F, 28.1% has molecular mass of 135. Determine the molecular formula.

- A.  $\text{C}_2\text{H}_2\text{FCl}$
- B.  $\text{C}_2\text{H}_2\text{F}_2\text{Cl}$
- C.  $\text{C}_2\text{H}_2\text{F}_2\text{Cl}_2$
- D.  $\text{C}_2\text{HFCl}_3$

31. How many chiral centres does the compound below possess?



- A. 0  
B. 1  
C. 2  
D. 3
32. 0.200 mol of a hydrocarbon undergo complete combustion to give 35.2 g of carbon dioxide and 14.4 g of water as the only products. What is the molecular formula of the hydrocarbon?
- A.  $\text{C}_2\text{H}_4$   
B.  $\text{C}_2\text{H}_6$   
C.  $\text{C}_4\text{H}_4$   
D.  $\text{C}_4\text{H}_8$
33. One of the original postulates of Dalton's Atomic Theory is:
- A. An Atom reacts to attain electronic configuration of the noble gas closest to it.  
B. When atoms of different elements react to form chemical compound, the atoms are combined in simple whole number ratio.  
C. The isotopes of an element are in whole number ratio.  
D. Atoms of different elements differ in terms of number of protons in their nuclei.
34. The ions in a mass spectrophotometer are separated based on their mass:charge ratio by the;
- A. ion source  
B. mass analyzer  
C. deflector  
D. detector
35. Which of the following terms accurately describes the energy associated with the process:
- $$\text{Li}_{(g)} \rightarrow \text{Li}^+_{(g)} + e^-$$
- A. electron affinity  
B. binding energy  
C. ionization energy  
D. electronegativity
36. If the activation energy in the forward direction of an elementary step is 52 kJ and the activation energy in the reverse direction is 74 kJ, what is the energy of reaction  $\Delta E$  for this step?
- A. 22 kJ

- B. -22 kJ
- C. 52 kJ
- D. -52 kJ

37. Sodium peroxide dissolves in water in accordance with the following reaction:



The pH of the solution after reaction will be:

- A. 7-8
  - B. 6-7
  - C. < 2
  - D. >10
38. Gunpowder is a mixture of saltpetre, sulphur and woodcharcoal in the ratio of 6:1:1 by mass. The mixture burns with explosion because it produces a large volume of gases. Saltpetre in the mixture acts as:
- A. modifier
  - B. reducing agent
  - C. oxidising agent
  - D. Fuel
39. The oxidation state of Au in  $\text{K}[\text{Au}(\text{OH})_4]$  is:
- A. +1
  - B. +2
  - C. +3
  - D. +4
40. The most common type of chemical reaction which alkanes undergo is
- A. substitution
  - B. addition
  - C. condensation
  - D. elimination.
41. The boiling point of water is higher than that of methanol because
- A. water is oxide while methanol is an alcohol
  - B. inter molecular forces in water are stronger than those in methanol
  - C. water is an inorganic compound while methanol is organic
  - D. water is an ionic compound while methanol is covalent
42. In the Rutherford scattering experiment, Rutherford bombarded a thin piece of gold foil with a beam of \_\_\_\_\_.
- A. electrons
  - B. neutrons
  - C. protons
  - D. alpha particles

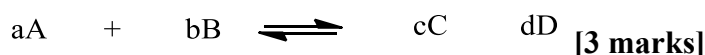
43. When azimuthal quantum number ( $l = 2$ ), what set of orbitals is designated?
- A. p
  - B. d
  - C. f
  - D. g
44. Sodium hydroxide is an Arrhenius base because it contains \_\_\_\_\_.
- A.  $\text{Na}^+$
  - B.  $\text{OH}^-$
  - C. NaOH
  - D. Na
45. The standard state of an element or compound is determined at a pressure of and a temperature of \_\_\_\_\_.
- A. 760 mmHg,  $0^\circ\text{C}$
  - B. 1 atm,  $273^\circ\text{C}$
  - C. 760 mmHg, 0 K
  - D. 1 atm, 298 K
46. Which of the following is a state function?
- A. enthalpy
  - B. work
  - C. heat
  - D. power
47. The method that cannot be used for removing permanent hardness of water is \_\_\_\_\_.
- A. adding sodium carbonate
  - B. boiling
  - C. adding caustic soda
  - D. adding slaked lime
48. In which of the following characteristics does hydrogen resemble halogens?
- A. Hydrogen is the lightest
  - B. Hydrogen forms ionic hydrides with alkali metals
  - C. Hydrogen atom contains one electron each
  - D. Hydrogen has three isotopes.
49. Which alkali metal react directly with Nitrogen to form nitride?
- A. Na
  - B. K
  - C. Rb
  - D. Li
50. The isomerism which exists between  $\text{CH}_3\text{CHCl}_2$  and  $\text{CH}_2\text{Cl}$ .  $\text{CH}_2\text{Cl}$  is \_\_\_\_\_.
- A. chain isomerism
  - B. functional group isomerism
  - C. positional isomerism
  - D. metamerism



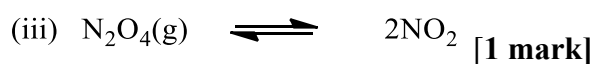
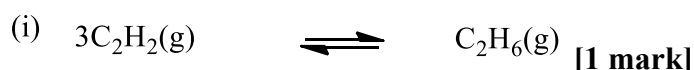
## ESSAY QUESTIONS\; Answer FOUR Questions in all; One from each Course

### CHM 002

1. (a) Explain the condition of chemical equilibrium using the hypothetical equilibrium equation;



- (b) Write the equilibrium constant,  $K_c$  expressions for the following reactions

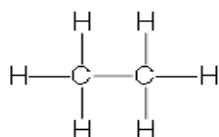


- (c) A mixture of 0.003 mol of  $H_2$  and 0.002 mole of  $I_2$  were reacted to attain equilibrium in a 2- L container at 400 °C. Analysis of the equilibrium mixtures shows that the concentration of HI is 0.0022 M. Calculate  $K_c$  for the reaction at 400 °C.

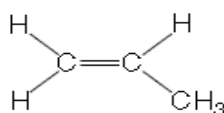
[4 marks]

### CHM 004

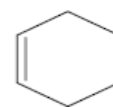
2. Crude oil is the principal source of hydrocarbons. The following are examples of such hydrocarbons.



ethane



propene



cyclohexene

- (a). Give the structural formulae of the organic products in the following reactions.

(i) The reaction of ethane with bromine in the presence of U.V. light. [1 mark]

(ii) The reaction of HBr with butene. [1 mark]

(iii) The reaction of cyclohexene with hydrogen bromide. [1 mark]

- (b). Write equations for the following reactions.

(i) The complete combustion of propane. [1 mark]

(ii) The action of steam on propene in the presence of a catalyst. [1 mark]

(iii) The reaction of cyclohexene with hydrogen in the presence of a catalyst. [1 mark]

- (c). Write a structural formula for each of the following and indicate whether it is primary, secondary or tertiary.

- (i) 3 – pentanol (ii) 2,2 - dimethyl -1- propanol (iii) 1 - methyl cyclopentanol(iv) 2 - methyl -2- propanol [4 marks]

### **CHM 001**

3. (a). Explain the following terms:

- (i) Precision
- (ii) Accuracy.

**(4marks)**

(b). The concentration of Nickel in Nigerian coin was determined with visible spectrophotometer, and the following results (%) were obtained: 3.65, 4.11, 3.59, 7.51, 3.95, 3.87, 4.06, 1.48, 3.60, 3.76 and 3.99. if the true concentration (%) of nickel in coin as determined by atomic absorption and inductively coupled plasma atomic emission spectrophotometer was 3.92.

Use the above data to determine:

- (i) Absolute error
- (ii) Percentage relative error
- (iii) Average error

**(6 marks)**

### **CHM 003**

4. (a). Name the strongest type of intermolecular force between hydrogen fluoride molecules and draw a diagram to illustrate how two molecules of HF are attracted to each other.

In your diagram show all lone pairs of electrons and any partial charges. Explain the origin of these charges.

Suggest why this strong intermolecular force is not present between HI molecules.

**[3 marks]**

(b). Crystals of sodium chloride and of diamond both have giant structures. Their melting points are 1074 K and 3827 K, respectively. State the type of structure present in each case and explain why the melting point of diamond is so high.

**[3 marks]**

(c). Write a Lewis structure and identify the octet-rule exception for (i)  $\text{SClF}_5$  (ii)  $\text{BFCl}_2$

**[4 marks]**

### **CHM 002**

5. (a). State Gay-Lussac's law **[2 marks]**

(b). State Aufbau's principle and Hund's rule of maximum multiplicity. **[2 marks]**

(c). what do you understand by a Bronsted acid? **[1 mark]**

(d). briefly explain the term "Inert Pair Effect" **[2 marks]**.

(e). Compare and contrast the following properties of the transition elements with that of S and P- block elements. (i) Colour (ii) Atomic / ionic radius (iii) oxidation states. **[3 marks]**

### **CHM 003**

6. (a). Write an equation for the synthesis of hydrogen gas by the reaction of methane with steam. **[1 mark]**
- (b). Compare the physical and chemical properties of the hydrides of; Na, C, N and S **[3 marks]**
- (c). Explain using equation why rain falling in unpolluted air is acidic with a pH of about 5.6. **[2 marks]**
- (d). Acid rain has a pH value less than 5.6. Explain using equation how the burning of coal can contribute to acid rain formation. **[2 marks]**
- (e). What are the consequences of global warming on the environment? **[2 marks]**

### **CHM 004**

7. An organic compound X contains 40% carbon, 53.3% oxygen and 6.7% hydrogen. The vapor density of X is 30. The organic compound reacted with sodium hydrogen trioxocarbonate (IV) and a colorless gas was given off which turned lime water milky. On boiling under reflux, the mixture of X and ethanol, a sweet smelling liquid Y was formed.
- (a). Determine the (i) empirical and (ii) molecular formula of X. **[4 marks]**
- (b). What is the name of the colourless gas given off? **[1 mark]**
- (c). Give the formula of the functional group present in X. **[1 mark]**
- (d). Deduce the structure of the compound X **[1 mark]**
- (e). Name the reaction which took place between X and ethanol, and write an equation for the reaction between X and ethanol. **[3 marks]**

### **CHM 002**

8. (a). State three (3) major factors, which affect the discharge of ions at the electrodes during electrolysis. **[3 marks]**
- (b). Explain why a tin-plated iron container corrodes faster than a galvanized iron container with reference to the electrochemical series. **[2 marks]**
- (c). 528g of a trivalent metal is deposited when a current of 1.56A is passed through a solution of its salt for 1hour; calculate the relative atomic mass of the metal. Hence identify the metal. (1F = 96500C) **[2 marks]**
- (d). State any three (3) common applications of electrolysis. **[3 marks]**