JOINT UNIVERSITIES PRELIMINARY EXAMINATIONS BOARD

JUNE 2019 EXAMINATIONS

JUPEB/005E

CHEMISTRY: SCI – J153 **Time Allowed: 3 hours**

SECTION A: MULTIPLE CHOICE QUESTIONS

Answer all questions in this section.

Use the OMR answer sheet provided to answer the questions, follow the instructions on the OMR sheet.

SECTION B: ESSAY QUESTIONS

Answer FOUR questions ONLY in this section

Turn Over

SECTIONA: MULTIPLE CHOICE QUESTIONS:

Answer ALL Questions

1. Precision in measurement is _____
   A. agreement between replicate measurements
   B. closeness of measurement to the true value
   C. estimated in terms of absolute error
   D. difference between measured value and true value.

2. Which of the following is not an assumption of Bohr's model of atom?
   A. Emission spectra of atoms are continuous
   B. Electron moves in allowed orbits around the nucleus
   C. The electron does not emit energy when in the orbits
   D. Transitions between orbits are accompanied by emission or absorption of radiation

3. The following factors influence ionization energies except…
   A. shielding effect of inner electrons
   B. magnitude of the nuclear charge
   C. shape of the orbital containing the valence electron
   D. distance of outer electrons from the nucleus

4. The energy associated with the process below is called _____
   $Li_{(g)} \rightarrow Li^{+}_{(g)} + e^{-}$
   A. electron affinity
   B. ionization energy
   C. lattice energy
   D. binding energy

5. The condensed electronic configuration of Zn^{2+} (Z=30) is _____
   A. [Ar] $4s^2\ 3d^{10}$
   B. [Ar] $4s^2\ 3d^8$
   C. [Ar] $4s^1\ 3d^{10}$
   D. [Ar] $4s^0\ 3d^{10}$

6. All the following are attributes of light except
   A. It consists of perpendicular electric and magnetic fields
   B. its frequency is directly proportional to its wavelength
   C. it is both a photon and a wave
   D. its speed in vacuum is the fastest

7. Which of the following is not true of the electromagnetic spectrum?
   A. Visible light makes up a small proportion of the spectrum
   B. The wavelength of ultraviolet radiation is greater than that of the infrared radiation
   C. Gamma rays have shorter wavelength

D. Microwave are not visible

8. A base is a proton acceptor, according to _____
   A. Arrhenius concept.
   B. Bronsted Lowry concept
   C. Lewis concept
   D. Dalton's concept

9. A bottle of concentrated hydrochloric acid solution has a label reading "37.8% HCl by mass". Calculate the molarity of this solution if it has a density of 1.1917 g cm^{-3}. (H = 1.0; Cl = 35.5)
   A. 11.3 M
   B. 14.5 M
   C. 12.0 M
   D. 12.3 M

10. State the change in oxidation number of sulphur in the redox reaction below:
    $I_2 + 2S_2O_3^{2-} \longrightarrow 2I^- + S_4O_7^{2-}$
    A. -2 to -4
    B. +2 to +3
    C. -4 to -2
    D. +3 to +2

11. What is the percent carbon in the glutamic acid, $C_5H_8NO_4$?
    [C= 12.01; H=1.01; N=14.0; O=16.00]
    A. 8.22
    B. 24.3
    C. 41.1
    D. 48.2

12. Which of the following elements exhibit diagonal relationship with aluminum?
    A. beryllium
    B. silicon
    C. carbon
    D. germanium

13. Nitrogen dioxide decomposes on heating according to the following equation
    $2NO_{2(g)} \leftrightharpoons 2NO_{(g)} + O_{2(g)}$
    When 4 mol of nitrogen dioxide was put into a 1 dm^3 container and heated to a constant temperature, the equilibrium mixture contained 0.8 mol of oxygen. What is the numerical value of equilibrium constant, K_c, at the temperature of the experiment?
    A. $\frac{0.8^2 \times 0.8}{4^2}$
    B. $\frac{1.6 \times 0.8}{2.4^2}$
    C. $\frac{1.6^2 \times 0.8}{4^2}$

D. $\frac{1.6^2 \times 0.8}{2.4^2}$

14. In which of the following reactions is the change in entropy positive?
    A. $2Ag^{+}_{(aq)} + Zn_{(s)} \rightleftharpoons Zn^{2+}_{(aq)} + 2Ag_{(s)}$
    B. $2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$
    C. $2HF_{(g)} \rightleftharpoons H_{2(g)} + F_{2(g)}$
    D. $H_2O_{(s)} \rightleftharpoons H_2O_{(l)}$

15. A system in which only energy is transferred between the system and the surrounding is…
    A. open system.
    B. closed system.
    C. isolated system.
    D. adiabatic.

16. Which of these orbitals is the most stable?
    A. 3d
    B. 4p
    C. 5p
    D. 5d

17. Identify the species A in the radioactive reaction represented by the equation below: $C^{234}_{90}Th + A \rightarrow {}^{238}_{92}U$
    A. ${}^{0}_{1}n$
    B. ${}^{1}_{0}e$
    C. ${}^{1}_{1}\gamma$
    D. ${}^{4}_{2}He$

18. Arrange the following elements in order of decreasing reducing power Na, Rb, K, Cs
    A. Cs>K>Rb>Na
    B. Na>K>Cs>Rb
    C. Cs>Rb>K> Na
    D. Cs<K<Na<Rb

19. Hydride of the halogens with the highest stability to heat is…
    A. HCl
    B. HBr
    C. HF
    D. HI

20. Hydrocarbons which react with ammonical copper(I)chloride solution conform to the general molecular formula C
    A. C_nH_n
    B. C_nH_{2n}

C. C_nH_{2n+2}
D. C_nH_{2n-2}.

21. In the coordination compounds, $[Co(NH_3)_6]\ [FeCl_4]_x$, if the primary valences of Co and Fe are both +3, what is x?
    A. 2
    B. 1
    C. 3
    D. 5

22. Which of the following is TRUE about sodium chloride in the solid state?
    A. its ions are linked by metallic bonds
    B. it exists as aggregate of ions
    C. it conducts electricity
    D. it exists as discrete molecules

23. A method of preventing corrosion that involves coating steel with zinc metal is called ___
    A. painting
    B. enameling
    C. electroplating
    D. galvanizing

24. Which type of radioactive decay produces a daughter nucleus with a higher atomic number?
    A. α
    B. $\beta-$
    C. γ
    D. β^+

25. For a reaction that is second order with respect to a reactant, A, how many times does the rate increase as [A] increases by a factor of 2?
    A. 1 time
    B. 2 times
    C. 3 times
    D. 4 times

26. What is the number of atoms present in 21.6 g of Ag?
    [Ag =108 $gmol^{-1}$, N_A=6.023 x $10^{23}{}_{mol^{-}}$]
    A. 0.2 x 10^{24}
    B. 1.204 x 10^{23}
    C. 6.02 x 10^{22}
    D. 1.08 x 10^{23}

27. Transition metal atoms without unpaired electrons are said to be _____
    A. diamagnetic
    B. paramagnetic

C. ferromagnetic
D. anti-ferromagnetic

28. Strontium is an element in Group 2 of the Periodic Table. Which of the following statements about strontium is NOT correct?
    A. Its first ionization energy is lower than that of calcium.
    B. Its atomic radius smaller than magnesium.
    C. It has two electrons in its outermost energy level.
    D. It forms a chloride with the formula $SrCl_2$

29. Why is the melting point of diamond much-higher than that of graphite?
    A. diamond consists of covalent bonds extending in all directions.
    B. the structural layers of graphite are too far apart.
    C. diamond has a higher density than graphite.
    D. graphite is partially soluble in water.

30. The oxidation state of Au in $K[Au(OH)_4]$ is _____
    A. +1
    B. +2
    C. +3
    D. +4

31. Which of the following is NOT true of a catalyst?
    A. Catalysts will decrease the activation energy of the reaction.
    B. Catalysts will be influenced by the pH of the substance.
    C. Catalysts do not change the thermodynamics of the reaction.
    D. Catalysts cause a change in the equilibrium constant of the reaction.

32. Which of the following will always produce a spontaneous reaction?
    A. Positive ΔH and a positive ΔS
    B. Positive ΔH and a negative ΔS
    C. Negative ΔH and a positive ΔS
    D. Negative ΔH and a negative ΔS

33. In the electrolysis of brine (concentrated NaCl) using mercury as the cathode, the components produced and resulting solution are _____ , _____ and _____ respectively.
    A. H_2, Cl_2 and basic
    B. Na, O_2 and neutral
    C. H_2, O_2 and basic
    D. Na, Cl_2 and neutral

34. The IUPAC name of $K_2[PtCl_6]$ is …
    A. Potassium hexachloroplatinate (II)
    B. Potassium hexachloroplatinate (IV)
    C. Platinun hexachloropotassiate (I)
    D. Potassium hexachloroplatinum (II)

35. Given that the standard enthalpy changes of formation of $TiO_2(s)$ and $CO(g)$ are –940 kJ mol^{-1} and –110 kJ mol^{-1} respectively. What is the standard enthalpy change (kJ/mol) of the reaction?
$TiO_2(s) + 2C(s) \rightarrow Ti(s) + 2CO(g)$.
    A. -830
    B. -720
    C. +720
    D. +830

36. The reaction $C_{12}H_{20}O_{10} + 2H_2O \rightarrow 2C_6H_{12}O_6$ represents _____
    A. polymerization of glucose
    B. hydrolysis of carbohydrate
    C. fermentation of sugar
    D. dehydration of starch

37. The shape and bond angle of the sp^2 hybridized orbital are _____
    A. tetrahedral & 109.5°
    B. trigonal & 120°
    C. trigonal & 180°
    D. linear & 180°

38. Calculate the volume of oxygen evolved at 285K and 0.91 x 10^5 Nm^{-2} when a current of 2.5A is passed through acidified water for 1.5mins. [Molar volume of a gas is 22.4dm^3; standard pressure = 1.01 x 10^5 Nm^{-2}; 1Faraday = 96500C].
    A. 12.34 cm^3
    B. 23.12 cm^3
    C. 15.13 cm^3
    D. 9.13 cm^3

39. Which of the following group of compounds forms a layer of silver when reacted with silver trioxonitrate (V) in the presence of excess ammonia?
    A. Alkanols
    B. Alkanals
    C. Alkanones
    D. Alkanoic acids

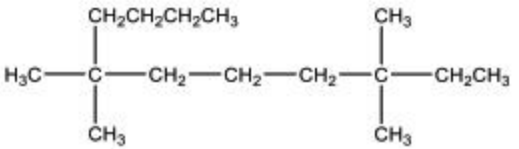
40. Which of the following compounds is NOT a functional group isomer of CH_2OHCH_2CHO? AN
    A. $CH_2=COHCH_2OH$
    B. CH_3OCH_2CHO
    C. $CH_3CHOHCHO$
    D. CH_3COCH_2OH

41. Which of the following is the final product from the reaction of ethyne with hydrogen bromide?
    A. $CH_3 - CHBr_2$
    B. $CH_2Br - CH_2Br$
    C. $CH_3 - CH_3$
    D. $CH_2 = CHBr$

42. The IUPAC name for $CH_3CH_2CH_2CHClCH_3$ is _____
    A. 2-Chloropentane
    B. 2-Chloropropane
    C. 4-Chlorohexane
    D. 4-Chloropentane.

43. In Benedicts test, a positive test is indicated by a colour change from _____
    A. brick red to blue
    B. brown to purple
    C. blue to Red
    D. purple colour change

44. The IUPAC name for the compound below is _____



    A. 5,5,9,9-tetramethylundecane
    B. 3,3,7,7-tetramethylundecane
    C. 2,6,6-trimethyl-2-n-butyloctane
    D. 3,3,7-trimethyl-7-n-butyloctane

45. Given below are sets of homologous series, identify the set that contains a carbonyl group:
    A. alkanes, alkenes, alkynes
    B. alcohols, carboxylic acids, ethers
    C. aldehydes, ketones, amines
    D. carboxylic acids, aldehydes, ketones

46. There is free rotation about the carbons of ethane but not that of ethene. This is due to the fact that _____
    A. the carbons in ethane are round.
    B. there are only four hydrogen atoms in ethane.
    C. the carbon in ethane are smaller than those of ethene
    D. the carbons in ethene are linked by double bonds

47. $H_3C\text{-}Br \longrightarrow CH_3^+ + Br^-$

The above equation shows _____

A. Substitution reaction
B. Homolytic fission
C. Heterolytic fission
D. Electrophilic reaction

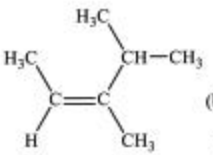
48. Which group of compounds produce yellow crystals of CHI_3 in the presence of I_2/NaOH?

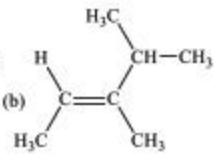
A. Alkane
B. Alkanone
C. Carboxylic acid
D. Ester

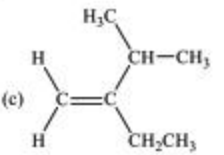
49. Identify P in the reaction $C_2H_5MgBr + P \xrightarrow{H_2O/H^+} C_2H_5C(OH)(CH_3)C_3H_7$

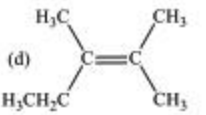
A. C_3H_7CHO
B. C_3H_7COCl
C. $C_3H_7COCH_3$
D. $C_2H_5COC_2H_5$

50. What is the major product of the following reaction?

(a) 

(b) 

(c) 

(d) 

SECTION B: ESSAY QUESTIONS

Answer FOUR Questions in all; Not more than ONE Question from each Course

CHM 001

1(a) (i) State three Bohr's postulates of hydrogen atom (1½ marks)

(ii) Calculate the wavelength (nm) of the spectral line of hydrogen atom for which $n_1 = 3$ and $n_2 = 6$. ($R = 1.09678 \times 10^7\ m^{-1}$) (2marks)

(b) State the type of chemical bonds in each of the following:

(i) Na_2O

(ii) $BeCl_2$

(iii) F_3BNH_3

(iv) CO_2

(v) NH_4^+

(vi) NaCl (3 marks)

(c) The isotopic masses of two isotopes are 34.969 and 36.9689 amu respectively. Estimate the relative atomic mass of the element if the percentage abundance of the heavier isotope is 24.47%. (2 marks)

(d) (i) Write the electronic configuration of strontium $_{38}Sr$.

(ii) What block does it belong? (1½ marks)

2. (a) (i) Define the term ionization energy. (1 mark)

(ii) State two factors that affect ionization energy of an atom. (1 mark)

(b) 500 mg of iron (II) complex ferrous bisglycinate hydrochloride was dissolved in dilute H_2SO_4 and titrated with 0.0200 $mol.dm^{-3}$ $KMnO_4$. 18.10 cm^3 of $KMnO_4$ solution were required to reach the end point.

The equation for the titration reaction is as follows:

$$5Fe^{2+} + MnO_4^- + 8H^+ \rightarrow 5Fe^{2+} + Mn^{2+} + 4H_2O$$

Calculate the

i. number of moles of Fe^{2+} in the capsule,

ii. mass of iron in the capsule

iii. molar mass of the iron (II) complex, assuming 1 mole of the complex contains 1 mole of iron. (Fe = 55.9 g mol^{-1}). (3½ marks)

(c) Identify each of the following reactions as precipitation, neutralization, decomposition or combination.

(i) $Ba(OH)_{2(aq)} + 2HI_{(aq)} \rightarrow BaI_{2(aq)} + 2H_2O_{(l)}$

(ii) $2Al_{(s)} + 3Cl_{2(g)} \rightarrow 2AlCl_{3(s)}$

(iii) $Pd(NO_3)_{2(aq)} + H_2S_{(g)} \rightarrow PdS_{(s)} + 2HNO_{3(aq)}$

(iv) $Cu(NO_3)_{2(aq)} \rightarrow CuO_{(s)} + NO_{2(g)} + \frac{1}{2}O_{2(g)}$

(v). $FeCl_{2(aq)} + 2NaOH_{(aq)} \rightarrow Fe(OH)_{2(s)} + 2NaCl_{(aq)}$ (2½ marks)

(d) The following results were obtained from a replicate analysis of blood sample for its lead content: 0.752, 0.756, 0.752, 0.769 ppm lead. Explain the precision of the results. (2 marks)

CHM 002

3(a) (i) State the two factors that affect the solubility of a solid in a liquid (1 mark)

(ii) A saturated solution of AgCl was found to have a concentration of 1.3×10^{-5} mol/dm^3. What is the solubility product of AgCl? (1½ marks)

(b) Define the term (i) entropy (ii) enthalpy. (2 marks)

(c) The equation for the reaction between sulphur trioxide and CuO is:

$CuO_{(S)} + SO_{3(g)} \rightarrow CuSO_{4(S)}$

Given the following data,

	ΔH° (kJ/mol)	S° (J/Kmol)
SO_3	-157	42.63
CuO	-395.2	256.2
$CuSO_4$	-771.36	109

(i) Calculate the standard free energy for this reaction at 37°C

(ii) Comment on the spontaneity of the reaction based on the value in (i) (3 marks)

(d) If the same volume of NH_3 and an unknown gas X effuse at a rate of 2.25 cm^3 s^{-1} and 1.40 cm^{3}s^{-1} respectively under the same experimental conditions, what is molecular mass (M_r) for X? Suggest a possible identity for X. [N=14, H=1.00] (2½ marks)

4(a) Calculate ΔH for the reaction; $4HI + O_2 \longrightarrow 2I_2 + 2H_2O$, given the following:

(i) $H_2 + I_2 \longrightarrow 2HI \quad \Delta H = +52$ kJ

(ii) $2H_2 + O_2 \longrightarrow 2H_2O \quad \Delta H = -480$ kJ (3 marks)

(b) Determine the equilibrium constant for the following reaction at 45°C

$$Sn^{2+}_{(aq)} + Cu^{2+}_{(aq)} \rightleftharpoons Sn^{4+}_{(aq)} + Cu_{(s)}$$

Given that:

$E^{\theta}\ Cu^{2+}/Cu = +0.337V$,

$E^{\theta}\ Sn^{4+}/Sn^{2+} = +0.5V$

$R = 8.314\ J\ mol^{-1}\ K^{-1}$ (3½ marks)

(c) State three factors that affect the rate of a chemical reaction (1½ marks)

(d) Consider the reaction represented by the equation below:

$$CH_3COOH_{(l)} + C_2H_5OH_{(l)} \rightleftharpoons CH_3COOC_2H_{5(l)} + H_2O_{(l)}$$

Explain the effect on the position of equilibrium of addition of:

(i) $CH_3COOC_2H_{5(l)}$

(ii) $C_2H_5OH_{(l)}$ (2 marks)

CHM 003

5(a) (i) Define the term allotropy (1 mark)

(ii) Name two allotropes each of carbon and tin (2 marks)

(iii) What is the difference between the type of allotropy exhibited by carbon and tin (1 mark)

(b) Give reason(s) for the following observations (3 marks)

(i) Fluorine exhibits only -1 oxidation state while other members of the group exhibit -1 as well as other oxidation states.

(ii) Hydrogen chloride is a stronger acid than hydrogen fluoride.

(iii) Beryllium does not react with water, even on heating

(c) Using suitable reaction equations outline three methods of laboratory syntheses of H_2 from suitable metals. (1½ marks)

(d) State three properties of transition elements (1½ marks)

6 (a) The molecular formulae of coordination compounds A and B are:

A = $[Cr(NH_3)_4Cl_2]Br$ B = $[Cr(NH_3)_4(Br)(Cl)]Cl$

(i) Give the IUPAC name of the compounds A and B (2 marks)

(ii) State the oxidation number of the metal ion in both compounds (1 mark)

(iii) Which of these compounds would give a white precipitate with silver nitrate solution.

(½ mark)

(b) Using a statement and appropriate equation(s) where necessary, distinguish between synthesis gas and water gas. (2 marks)

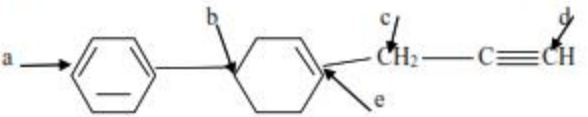
(c) Using reaction equations only, show how Li, Na and K react when heated in excess oxygen. (1½ marks)

(d) Describe using chemical equations where applicable, how is aluminium extracted from its ore? (3 marks)

CHM 004

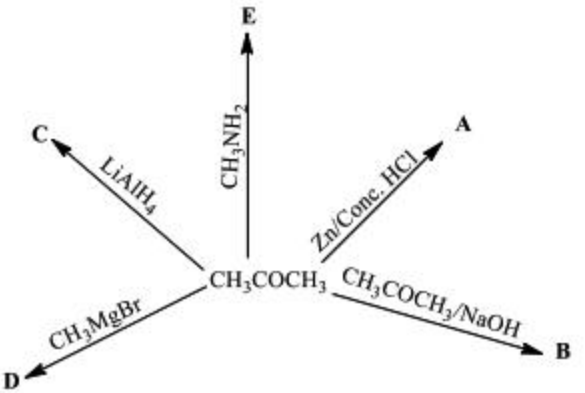
7a. (i) Define the term hybridization. (1 mark)

(ii) Indicate the hybridization of the carbon atom labelled (a) – (e) in the structure below



(2½ marks)

(b) The scheme below represents the various reactions of propanone. Give the formula of each product represented by letters A to E (2½ marks)



(c) Draw the structure of the following compounds. (3 marks)

(i) 2-bromo-3-chloro-4,4-dimethylpentanal.

(ii) Butane-1,2,3-triol.

(iii) 2,4,6-tribromophenol.

(d) A compound K, [$C_7H_{16}O$] is an alcohol which is oxidized by Chromic acid to yield compound L [$C_7H_{14}O$]. L forms crystalline 2,4-Dintrophenylhydrazine compound and gives iodoform when treated with iodine-alkali but does not form a red precipitate with Fehling's reagent. With the given data, write possible structures for compounds K and L. (1 mark)

8 (a) (i) Define biotechnology. (1 mark)

(ii) List two advantages in the use of biotechnology. (1 mark)

(b) Explain the following terms:

(i) Inductive effect
(ii) Electromeric effect
(iii) homolytic cleavage (1½ marks)

(c) Classify each of the following carbohydrates as Monosaccharides, Disaccharides, or Polysaccharides

(I) Cellulose (II) Fructose (III) Glucose
(IV) Maltose (V) Sucrose (2½ marks)

(d) (i) Write the structures of all the isomeric alcohols with molecular formula $C_4H_{10}O$ (1½ marks).

(ii) Classify them as primary, secondary and tertiary alcohols (1½ marks)

(iii) Arrange the alcohols according to their increasing boiling points (1 mark)