THE UNITED REPUBLIC OF TANZANIA
NATIONAL EXAMINATIONS COUNCIL
ADVANCED CERTIFICATE OF SECONDARY EDUCATION
EXAMINATION

132/1

CHEMISTRY 1
(For Both School and Private Candidates)

Time: 2:30 Hours   **Thursday, 14th February, 2013 p.m.**
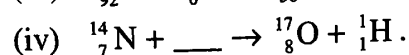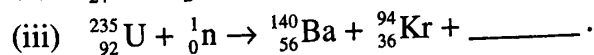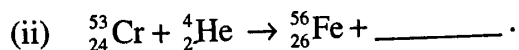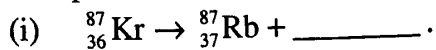

Instructions

1. This paper consists of **fourteen (14)** questions in sections A, B and C.

2. Answer **four (4)** questions from section A and **three (3)** questions from each of sections B and C.

3. Each question carries **ten (10)** marks.

4. Mathematical tables and non-programmable calculators may be used.

5. Cellular phones are **not** allowed in the examination room.

6. Write your **Examination Number** on every page of your answer booklet(s).

7. For calculations you may use the following constants:
   - Rydberg constant $R_H = 1.09678 \times 10^7 \, m^{-1}$
   - Gas constant, $R = 8.31 \, Jmol^{-1} \, K^{-1}$ or $0.082 \, atm \, mol^{-1} \, K^-$
   - GMV = $22.4 \, dm^3$
   - 1 litre = $1 dm^3 = 1000 \, cm^3$
   - Standard temperature = 273 K
   - Standard pressure = 760 mmHg
   - Planck constant, $h = 6.63 \times 10^{-34} \, Js$
   - Velocity of light, $c = 3.0 \times 10^8 \, m/s$
   - Atomic masses: H = 1,   C = 12,   O = 16,   Na = 23,   S = 32,
     Cl = 35.5,   Ca = 40.

Answer **four (4)** questions from this section.

1. (a) Differentiate nuclear reaction from chemical reaction. **(2 marks)**

    (b) Complete the following nuclear equations:

    (i) $^{87}_{36}Kr \rightarrow ^{87}_{37}Rb + \underline{\hspace{2cm}}$.

    (ii) $^{53}_{24}Cr + ^{4}_{2}He \rightarrow ^{56}_{26}Fe + \underline{\hspace{2cm}}$.

    (iii) $^{235}_{92}U + ^{1}_{0}n \rightarrow ^{140}_{56}Ba + ^{94}_{36}Kr + \underline{\hspace{2cm}}$.

    (iv) $^{14}_{7}N + \underline{\hspace{1cm}} \rightarrow ^{17}_{8}O + ^{1}_{1}H$.

    (4 marks)

    (c) The following figure shows the mass spectrum of lead. The highest peaks and the mass numbers of the isotopes are shown. Calculate the average atomic mass of lead.
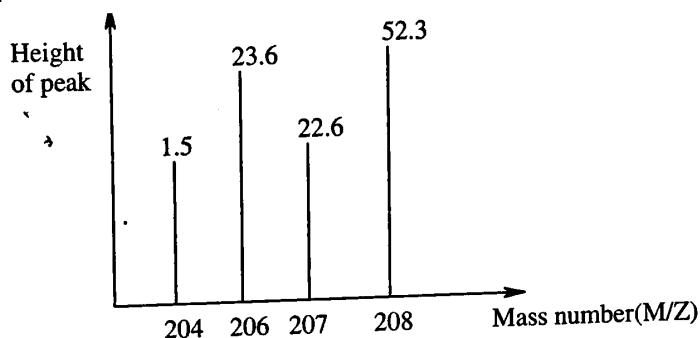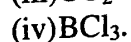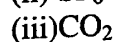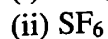

    (4 marks)

2. (a) Lyman discovered a series of spectral lines for hydrogen in the ultra-violet region of the electromagnetic spectrum. What value must n_1 have for this series? Give a reason for your answer. **(2 marks)**

    (b) Calculate the energy of a line in the Lyman series with $n_1 = 1$ and $n_2 = \infty$. **(4 marks)**

    (c) An experimental iodine laser emits light of wavelength 1.315 μm. Calculate the frequency of this light and the energy per photon. **(4 marks)**

3. (a) Predict the hybridization of the following:
    (i) PCl_5
    (ii) SF_6
    (iii) CO_2
    (iv) BCl_3.

    (6 marks)

    (b) Arrange the following substances in order of increasing melting points:
    CO_2, H_2O, CO, H_2 and Ar.

    (1 mark)

    (c) Use VSEPR theory to predict the molecular geometry of the species PCl_3, NH_3 and PCl_5.

    (3 marks)

4. (a) State two characteristics of compounds which are suitable for steam distillation.

    (2 marks)

    (b) An aromatic compound Z was steam distilled at 98.6 °C and 1 atmospheric pressure. The distillate was found to contain 25.5 grams of water and 7.4 grams of aromatic compound Z.

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Given that the saturated vapour pressure of water at 98.6 °C is 720 mmHg, calculate the relative molecular mass of the aromatic compound. **(4 marks)**

(c) Benzene (C_6H_6) and toluene form a nearly ideal solution. At 313 K the vapour pressure of pure benzene is 150 mmHg and of pure toluene is 50 mmHg. Calculate the vapour pressure of a mixture of these two liquids containing equal masses at the given temperature. **(4 marks)**

5. (a) Define the following:
    (i) Molar volume of a gas at stp. **(2 marks)**
    (ii) Dalton's law of partial pressures.

(b). Two gas burettes, one containing 10 cm³ of sulphur dioxide (SO_2) and the other containing 30 cm³ of hydrogen sulphide (H_2S) both at 1 atmosphere and at 0 °C are initially separated by a stop cork. The stop cork is then opened and the two gases are allowed to mix according to the reaction $SO_{2(g)} + 2H_2S_{(g)} \rightarrow 3S_{(s)} + 2H_2O_{(l)}$. Calculate the final pressure (in atmospheres) after the reaction has ended and the apparatus has regained its temperature of 0 °C. (Assume liquid water does not exert pressure). **(8 marks)**

6. (a) Distinguish between the following:
    (i) Reaction quotient and equilibrium constant.
    (ii) Chemical equilibrium and physical equilibrium. **(2 marks)**

(b) (i) The K_c value for the reaction $2NO_{(g)} + Cl_{2(g)} \rightleftharpoons 2NOCl_{(g)}$ is 4.6 x 10⁴ dm³mol⁻¹ at 298 Kelvin. Calculate the K_p value for this equilibrium.
    (ii) Calculate the K_p value for the equilibrium $2NOCl_{(g)} \rightleftharpoons 2NO_{(g)} + Cl_{2(g)}$ at 298 Kelvin. **(4 marks)**

(c) For the equilibrium reaction $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$, derive K_p and K_c relationship if the pressure of the mixture is P_T and volume is V_T. **(4 marks)**

SECTION B (30 marks)

Answer **three (3)** questions from this section.

7. (a) Three elements; F, G and H have atomic numbers 17, 18 and 19 respectively.
    (i) Write electronic configuration of each element.
    (ii) What type of ion each element is expected to form?
    (iii) In which group and period would each element be placed? **(6 marks)**

(b) Study the following hypothetical elements in a periodic table and then answer questions that follow.

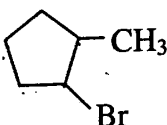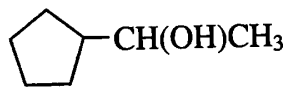| GROUP/ PERIOD	I	II	III	IV	V	VI	VII	0
2	A	B	C	D	E	F	G	H)
3	I	J	K	L	M	N	O	P)

Using letters indicated in the table, identify the following:
(i) The element which is the most electronegative.
(ii) A pair of elements that is likely to form the strongest electrovalent bond.
(iii) Two elements which are likely to have strongest reducing properties.
(iv) Two elements which form neither negative nor positive ions. **(4 marks)**

8. (a) With reference to Modern periodic table, briefly explain the following:
     (i) Diagonal relationship.
     (ii) Anomalous behaviour. **(4 marks)**

  (b) Explain how the hydrides of period 3 elements react with water. **(4 marks)**

  (c) The following are some oxides of elements of period 3: Na_2O, Al_2O_3, P_2O5, SiO_2 and MgO.
    Arrange them in the order of
     (i) increasing in basic characters
     (ii) decreasing in ionic characters. **(2 marks)**

9. (a) (i) What is the difference between the first and the second ionisation energies of electron?
     (ii) The first and the second ionisation energies for the sodium atom are 493 kJ and 4560 kJ respectively. Account for such a big difference between the two ionisation energies. **(6 marks)**

  (b) By using chemical reactions, show how sodium reacts with the following:
     (i) ethanol
     (ii) ammonia
     (iii) oxygen
     (iv) water. **(4 marks)**

10. (a) State the law of mass action. **(2 marks)**

  (b) One mole of PCl_5 was introduced into a closed vessel at a certain temperature. By the time equilibrium was established, it was found that PCl_5 was 10% dissociated and the total pressure in the vessel was 4 atmospheres. Calculate
     (i) K_p value at the temperature of the experiment
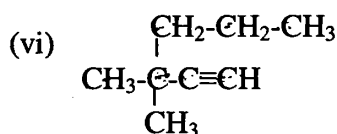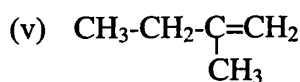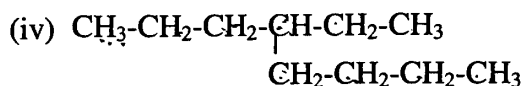   (ii) the total pressure at which PCl_5 was 20% dissociated. **(8 marks)**
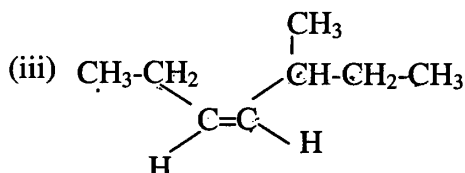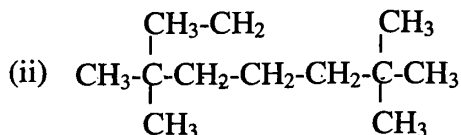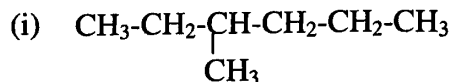
SECTION C (30 marks)

Answer **three (3)** questions from this section.

11. (a) Complete the following equations for reactions of the alkanes:
     (i) $(CH_3)_3CCH(CH_3)_2 + O_2 \xrightarrow{\text{ignite}}$.
     (ii) $CH_3CH_2CH_2CH_3 + Cl_2 \xrightarrow{\text{light}}$.
     (iii) $(CH_3)_2CHCH_3 + Br_2 \xrightarrow{\text{light}}$. **(3 marks)**

  (b) Write any three structural isomers of alkylcyclohexane of molecular formula C_6H_{12}. **(3 marks)**

  (c) Write equations for the preparation of alkenes from the following starting materials, indicate the conditions required and if there is more than one product, indicate which one is major.
     (i) $CH_3CH_2CH_2CH_2Br$ (ii) $(CH_3)_2CHC(OH)(CH_3)_2$

     (iii)   (iv) **(4 marks)**

12. (a) Write the structure of the functional groups of the following sets of compounds:
   (i) alkanes
   (ii) alkenes
   (iii) alkynes
   (iv) alcohols
   (v) ketones
   (vi) aldehydes
   (vii) carboxylic acid
   (viii) tertiary amines.
   (4 marks)

   (b) Give the IUPAC names of the following compounds:
   (i) $CH_3\text{-}CH_2\text{-}CH\text{-}CH_2\text{-}CH_2\text{-}CH_3$
        $|$
        CH_3

   (ii) $CH_3\text{-}CH_2$ CH_3
         $|$ $|$
     $CH_3\text{-}C\text{-}CH_2\text{-}CH_2\text{-}CH_2\text{-}C\text{-}CH_3$
       $|$ $|$
      CH_3 CH_3

   (iii) CH_3
          $|$
    $CH_3\text{-}CH_2$ $CH\text{-}CH_2\text{-}CH_3$
        $\backslash$ $/$
         $C\text{=}C$
       $/$ $\backslash$ H
       H

   (iv) $CH_3\text{-}CH_2\text{-}CH_2\text{-}CH\text{-}CH_2\text{-}CH_3$
           $|$
         $CH_2\text{-}CH_2\text{-}CH_2\text{-}CH_3$

   (v) $CH_3\text{-}CH_2\text{-}C\text{=}CH_2$
         $|$
        CH_3

   (vi) $CH_2\text{-}CH_2\text{-}CH_3$
       $|$
    $CH_3\text{-}C\text{-}C\text{≡}CH$
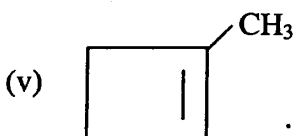 $|$
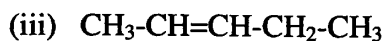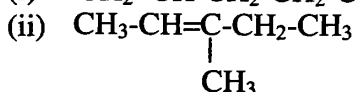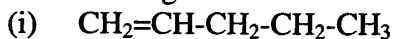 CH_3
                 (6 marks)

13. With support of chemical reactions, show how the following compounds can be prepared from ethanol as source of carbon atoms:
   (a) Benzene   **(5 marks)**
   (b) Ethyl benzene.   **(5 marks)**

14. (a) Write the structure of the major products for the reaction of gaseous hydrogen bromide with the following:
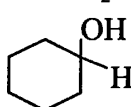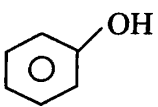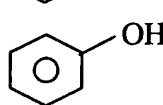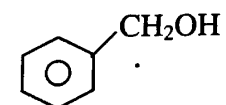   (i) $CH_2\text{=}CH\text{-}CH_2\text{-}CH_2\text{-}CH_3$
   (ii) $CH_3\text{-}CH\text{=}C\text{-}CH_2\text{-}CH_3$
          $|$
         CH_3

   (iii) $CH_3\text{-}CH\text{=}CH\text{-}CH_2\text{-}CH_3$

   (iv)

   (v) CH_3
                (5 marks)

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(b)   Explain how you can distinguish the following compounds:
   (i) $CH_3CH_2CH_2CH_3$ and $CH_2CHCH_2CH_3$.
   (ii) $CH_3CHCHCH_3$ and CH_3CCCH_3.
   (iii) $CHCCH_2CH_2CH_3$ and CH_3CCCH_3.

   (iv)   ![cyclohexanol structure with OH and H] and ![phenol-type structure with OH]

   (v)   ![structure with OH] and ![structure with CH₂OH]   **(5 marks)**