SECTION A - Multichoice

Question 6
Which species has the same shape as the NO_3^- ion?

A. SO_3 B. SO_3^{2-} C. NH_3 D. ClF_3 E. ClO_3^-

Question 7
Consider the following reaction and the associated value for $\Delta_r H^o$:

$2H_2(g) + 2Cl_2(g) \rightarrow 4HCl(g)$ $\Delta_r H^o = -92.3$ kJ mol^{-1}

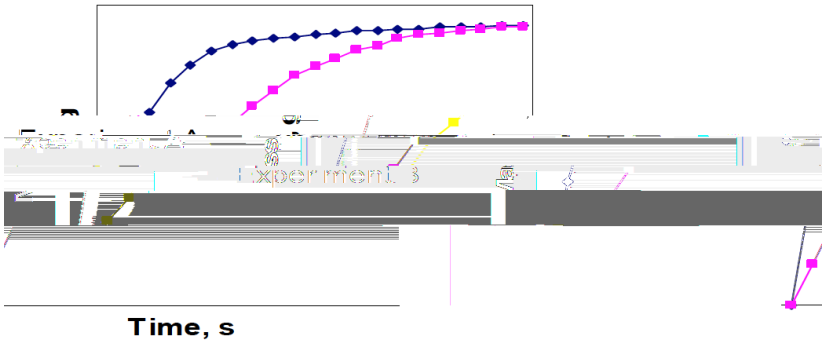
Which statement about this information is incorrect?

A. $\Delta_r H^o$ will be –92.3 kJ mol^{-1} if the HCl is produced as a liquid.
B. The four HCl bonds are stronger than the four bonds in $2H_2$ and $2Cl_2$.
C. If the equation is reversed, $\Delta_r H^o$ equals +92.3 kJ mol^{-1}.
D. 23.1 kJ of heat will be evolved when 1 mol of HCl(g) is produced.
E. The reactants are in their standard states.

Question 8
In which reaction will an increase in the volume of the container favour the formation of products?

A. $H_2(g) + I_2(g) \rightarrow 2HI(g)$
B. $4NH_3(g) + 5O_2$

Question 11
The graph below shows student data from two trials in which he studied the rate of a particular reaction, changing just one of the reaction conditions in the second trial.



Which one of the following statements MUST be INCORRECT?

A. Exactly the same amounts of reactants were used in the two experiments
B. The reaction temperature was higher in Experiment A than in Experiment B
C. The mass of one of the products was being measured in the two experiments
D. The final rate of reaction was greater in experiment A than in Experiment B
E. The initial rate of reaction was greater in Experiment A than in Experiment B

Question 12
A lemon-flavoured drink contains citric acid as the only acidic component. 10.00 mL of the drink is diluted with 15.00 mL of distilled water and titrated with NaOH solution using phenolphthalein as indicator. Under these conditions citric acid behaves as a diprotic (or dibasic) acid.

25.00 mL of 0.100 mol L^{-1} sodium hydroxide solution is used to reach the endpoint of the titration.
Which is the concentration of the citric acid in the drink?

A. 0.100 mol L^{-1}
B. 0.125 mol L^{-1}
C. 0.200 mol L^{-1}
D. 0.250 mol L^{-1}
E. 0.500 mol L^{-1}

Question 13
Lattices of ionic compounds are more stable if the ions are small and highly-charged and combined in a simple 1:1. On the basis of this information, choose the pair of ions that are likely to form crystals with the highest melting (or decomposition) temperature.

A. Li, O
B. Ag, O
C. Li, F
D. Mg, F
E. Mg, O

Question 22

Which steps in the formation of NaF(s) are exothermic?

I. $Na(g) \rightarrow Na^{+}(g) + e^{-}$

II. $F(g) + e^{-} \rightarrow F^{-}(g)$

III. $Na^{+}(g) + F^{-}(g) \rightarrow NaF(s)$

SECTION B – Long Answers

QUESTION ONE (9 marks)
A compound contains only C, H, and N.
Combustion of 0.125 g of the compound produces 0.172 g of H_2O and 0.279 g of CO_2.

a) Calculate the mass of H and C in 0.125 g of the compound. (2 marks)

1 mark each correct mass

Answer 9.56×10^{-3}mol H_2O or 0.0191 g and 6.34×10^{-3} mol CO_2 or 0.0761 g

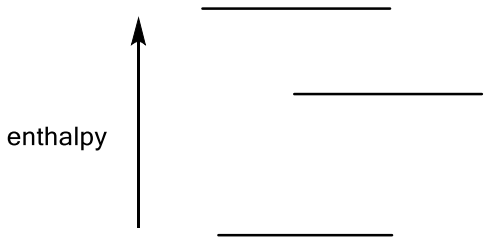
b) Show that the empirical formula of this compound is C_3

QUESTION TWO (6 marks)

a) (2 marks)The standard enthalpy change for the reaction in which one mole of CO_2 is formed from its elements is -394 kJ mol^{-1}. The standard enthalpy change for the combustion of one mole of CO is -283 kJ mol^{-1}.

For each of the reactions above, complete the diagram by writing the reactants of the balanced equation for the reaction on one line and the product on a different line.
Show all states.

2 marks all lines correct ç
½ mark 1 line correct but 1.5 marks total if correct species but not balanced
if totally reversed (top to bottom) give 1 mark



b) (2 marks)Use the information above to calculate the enthalpy change for formation of one mole of CO from its elements. Show how you arrived at your answer.

2 marks including correct unit and negative sign -

d) (2 marks) Iron is prepared from Fe_2O_3 by reaction with CO as shown in the equation given below.

$Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(s) + 3CO_2(g)$ $\quad {}_rH^o = -22$ kJ mol^{-1}

Calculate *H* for the reaction that produces 100 g iron.

1 mark for correct moles Fe
1 mark final answer ç accept either kJ or kJ mol^{-1}

QUESTION THREE (10 marks)

Part A (5 marks)
This question is concerned with solutions of the reactants and the product of the reaction given below:

$$NH_3(aq) + HNO_3(aq) \rightarrow NH_4NO_3(aq)$$

a) As shown below, H_3O^+ and OH^- are present in all of these solutions. Complete the table by firstly giving, for each solution, formulae for any other species (molecules or ions excluding H_2O) that are present. These species may arise either by dissolving or by reaction with water. Then identify species which fit descriptions given in the column at the left.

½ mark each correct box plus ½ for part (b)

b) Circle the solute in the solution with the lowest conductivity. NH_3 HNO_3 NH_4NO_3

Part B (5 marks)
Write net equations for the reaction of each of the combinations of reactants below. Use appropriate ionic and molecular formulae, omitting any ions or molecules that do not take part in the reaction. You need not balance the equations. All reactions occur in aqueous solution unless otherwise indicated.

1 mark each eqn correct.
1/2 mark if $Zn(OH)_2$

QUESTION FOUR (9 marks)

Part A (5 marks)
Consider two flasks in which the reaction system below is at equilibrium. CO_2 is added to one flask. The temperature of the other flask is increased. In both cases the mixture is allowed to stand until equilibrium is restored.

$$CH_4(g) + 2O_2(g) \quad CO_2(g) + 2H_2O(g) \qquad {}_rH° = -802.3 \text{ kJ mol}^{-1}$$

Compare the final equilibrium concentration with that prior to the change being applied.
Describe the direction of change (if any) in the concentrations of species and in K_c (the equilibrium constant) by writing

QUESTION FIVE (8 marks)

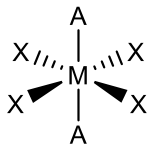
Compound A ($C_5H_{12}O$) reacts with $SOCl_2$ to form compound B ($C_5H_{11}Cl$) which, on heating with alcoholic KOH, forms two alkenes (C_5H_{10}), compounds C and D. Neither of compounds D and E can exist as *cis-trans* isomers. Addition of HCl to compound C forms compound E, an isomer of B, as the major product, while addition of HCl to compound D gives B.

a) Deduce the structures and names of compounds A to E.

Space for working

Part A (4 marks)
The octahedral compound MX_6 has X in six equivalent positions.

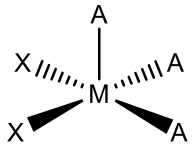
a) Sketch the two possible isomers for the octahedral compound MA_2X_4 in which two groups are different from the other four. (2 marks)

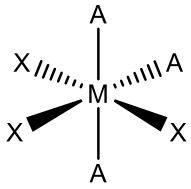


M

1 mark each structure

b) Sketch the two possible isomers for the octahedral compound MA_3X_3 in which three groups are different from the other three. (2marks) *ANS in one the three are mutally cis; in the other one pair is trans*





1 mark each structure

Part B (4 marks)
A salt of vanadium(V) contains vanadium in the +5 oxidation state.

A one litre solution contains 2.55 g of vanadium as a

PERIODIC TABLE OF THE ELEMENTS

18

1

H

1 2 1.0