CHEMISTRY 3.4 Paper 2

Describe properties of particles and thermochemical principles

Credits: Five

INSTRUCTIONS

Answer **ALL** questions

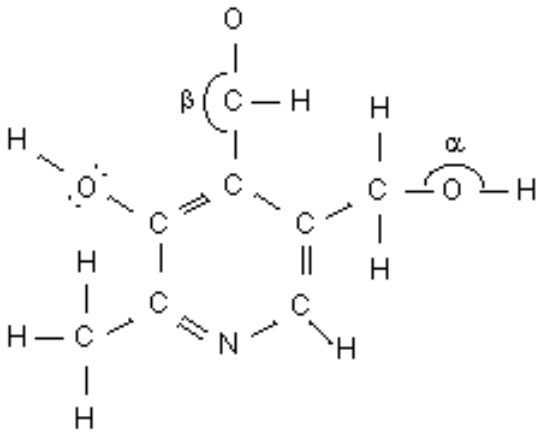
You may refer to a copy of the periodic table during this paper.

You are advised to spend 50 minutes answering this question.

Question One (Bursary 2002 Question 2: modified)

a Vitamin B6 is an organic compound whose deficiency in the human body can cause apathy, irritability and an increased susceptibility to infections. Below is an incomplete Lewis structure for Vitamin B6.

Complete the structure by adding further double bonds and lone pairs of electrons as appropriate.
A M



b Explain why the marked angles have the following approximate values. A M

$\alpha = 109°$ _____

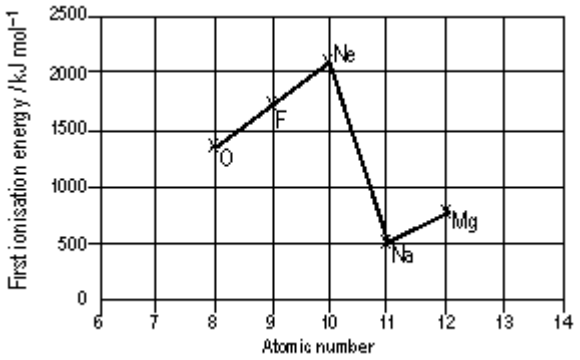
_____

$\beta = 120°$ _____

_____

Question Two (Bursary 2002 Question 3: modified)

a The graph below plots the ionisation energies of some elements from the second and third periods of the periodic table.



i Write the electron configuration for Na using s, p, d notation. A _____

ii Discuss the change in ionisation energy from Ne to Na, and from Na to Mg. A M E

_____

_____

_____

_____

iii State why the ionisation of an element is endothermic. A

_____

_____

_____

b Define the term electronegativity. A

_____

_____

c State why there is no value in data books for the electronegativity of Ne. A

_____

_____

d Explain why fluorine is more electronegative than chlorine. A M

_____

_____

e Astatine is an element below iodine in the periodic table.

i Circle the state for At_2 at room temperature. A solid liquid gas

ii Give the formula for the compound astatine would form with magnesium. A_____

iii Explain why an astatine atom is larger than an iodine atom. A M

_____

_____

Question Three (Bursary 2002 Question 6: modified)

The elements in the first series of transition elements are:

Sc Ti V Cr Mn Fe Co Ni Cu Zn

a Write the symbol of an element from the list above that matches each of the descriptions below. An element that:

i has the ground state electron configuration $[Ar]3d^5 4s^1$ A _____

ii does not form coloured compounds A _____

iii forms pale pink compounds when in the +2 oxidation state. A _____

b **i** Write the *s, p, d* electron configuration for Cu^+. A M _____

ii Discuss why copper(I) chloride is not coloured, unlike copper(II) chloride. A M E

_____

_____

_____

_____

Question Four (Bursary 2000 Question 11: modified)

a In each of the boxes below, draw a Lewis structure and state the shape of the sulfur species indicated.

SO_2	SO_3
Shape: _____	Shape: _____

A M

b Circle the non-polar molecule. SO_2 SO_3

Justify your answer. A M _____

_____

_____

c Boiling points depend on both the polarity of the molecule and the size of its electron cloud. The boiling point of sulfur dioxide, SO_2, is –10 °C while the boiling point of sulfur trioxide, SO_3, is 45 °C. Circle the factor below that is more significant in determining the relative boiling points of SO_2 and SO_3.

polarity of molecule size of electron cloud

Justify your answer. A M E _____

_____

_____

_____

_____

Question Five (Bursary 2002 Question 10: modified)

Nitrogen oxide, NO(g), can be formed during electrical storms. The equation for this reaction is

$$\tfrac{1}{2}N_2(g) + \tfrac{1}{2}O_2(g) \rightarrow \quad NO(g) \quad \Delta H° = 90 \text{ kJ mol}^{-1}$$

a Calculate the bond enthalpy of the nitrogen to oxygen bond using the bond enthalpies given. A M E

Bond	**Bond Enthalpy / kJ mol^{-1}**
N≡N	945
O=O	498

The reaction below is one that contributes to the formation of photochemical smog.

$$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g) \qquad \Delta_f H = -114.1 \text{ kJ}$$

b Calculate the quantity of heat released when 100 g of NO(g) is converted to $NO_2(g)$. A M

Question Six (Bursary 2002 Question Ten: modified)

The boiling points for the hydrogen halides and the enthalpies for the hydrogen halide bonds are given in the table below.

	Boiling Point / °C	**Bond Enthalpy / kJ mol^{-1}**
HF	20	568.0
HCl	–85	432.0
HBr	–67	366.3
HI	–35	298.3

a Discuss the trend in boiling points from HF to HI. A M E

b Explain, using information from the table, why HF is a weaker acid than the other hydrogen halides. A M

(Bursary 2002 Question 11: modified)
Octadecanoic acid, $CH_3(CH_2)_{16}COOH$ and *cis*-octadec-9-enoic acid, $CH_3(CH_2)_7CH{=}CH(CH_2)_7COOH$ have similar molar masses but octadecanoic acid (melting point 70 °C) is a solid and *cis*-octadec-9-enoic acid (melting point 13 °C) is a liquid at room temperature.

c Account for the difference in the melting points of these two compounds. A M

Nitroglycerin is a derivative of glycerol. It has the molecular formula $C_3H_5N_3O_9$.

d Calculate the standard enthalpy change for the formation of nitroglycerin. A M E
Use the data given.

$$\tfrac{1}{2}N_2(g) + O_2(g) \rightarrow NO_2(g) \qquad \Delta_f H° = 34 \text{ kJ mol}^{-1}$$

$$C(s) + O_2(g) \rightarrow CO_2(g) \qquad \Delta_f H° = -394 \text{ kJ mol}^{-1}$$

$$H_2(g) + \tfrac{1}{2}O_2(g) \rightarrow H_2O(g) \qquad \Delta_f H° = -242 \text{ kJ mol}^{-1}$$

$$4C_3H_5N_3O_9(l) + 11O_2(g) \rightarrow 10H_2O(g) + 12CO_2(g) + 12NO_2(g) \qquad \Delta_r H° = -6160 \text{ kJ mol}^{-1}$$