Section A: Multiple Choice: (1 mark each)
Write your answers on the multiple choice grid on page 3

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

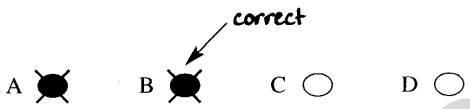
Sample: 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

A ○ B ● C ○ D ○

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A ● B ⊗ C ○ D ○

If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word **correct** and drawing an arrow as follows.



1. As the pH of a solution increases, phenolphthalein changes from colourless to dark pink in the pH range 8.6 to 10.0. By what factor does the hydrogen ion concentration of the solution change over this range?

   (A) the hydrogen ion concentration increases by a factor of 1.5
   (B) the hydrogen ion concentration decreases by a factor of 25
   (C) the hydrogen concentration increases by a factor of 25
   (D) the hydrogen concentration decreases by a factor of 1.5

2. What is the pH of a solution containing a mixture of 25.0 mL of 0.25 mol L^{-1} HNO_3 and 20.0 mL of 0.35 mol L^{-1} HCl ?

   (A) 0.3
   (B) 0.5
   (C) 1.8
   (D) 2.2

3. Which statement best represents Lavoisier's definition of an acid?

   (A).Acids contain oxygen.
   (B). Acids are proton donors.
   (C) Acids contain replaceable hydrogen.
   (D).Acids ionise in solution to form hydrogen ions.

4. Which of the following is a use for manufactured esters?

(A) fats
(B) food colouring
(C) detergents
(D) food flavouring

5. The pH of 0.001 mol L^{-1} solutions of Na_2O, CaO, SiO_2 and SO_2 are tested. Which would have the lowest pH?

(A) CaO
(B) Na_2O
(C) SO_2
(D) SiO_2

6. Several factors can disturb a system at equilibrium.
Which of the following changes will always shift the equilibrium to the right?

(A) change the concentration of the product(s)
(B) increase the concentration of one of the reactants
(C) cooling the equilibrium mixture
(D) changing the pressure of the reaction vessel

Section A. Multiple Choice Answer Grid

1.	A O	B O	C O	D O
2.	A O	B O	C O	D O
3.	A O	B O	C O	D O
4.	A O	B O	C O	D O
5.	A O	B O	C O	D O
6.	A O	B O	C O	D O

Section B: Short Answer Questions **MARKS**

Question 7 (7 marks)

Acid rain is one of the major ecological problems in the world today and the main culprits are sulfur dioxide and nitrogen oxides from industrial processes.

(a) Identify an industrial process which produces sulfur dioxide **or** nitrogen oxides and construct a chemical equation showing the formation of sulfur dioxide **or** an oxide of nitrogen. **2**

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(b) Construct a chemical equation showing sulfur dioxide or an oxide of nitrogen forming acid rain. **1**

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(c) Identify two harmful aspects of acid rain. **2**

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MARKS

(d) A large industrial plant produces 750,000 litres of sulfur dioxide per day.
The pollutant gas is neutralised with calcium hydroxide…

$$SO_2(g) + Ca(OH)_2(aq) \rightarrow CaSO_3(aq) + H_2O(l)$$

Calculate the mass of calcium hydroxide required to neutralise the sulfur dioxide at 100 kPa and 25^0C. **2**

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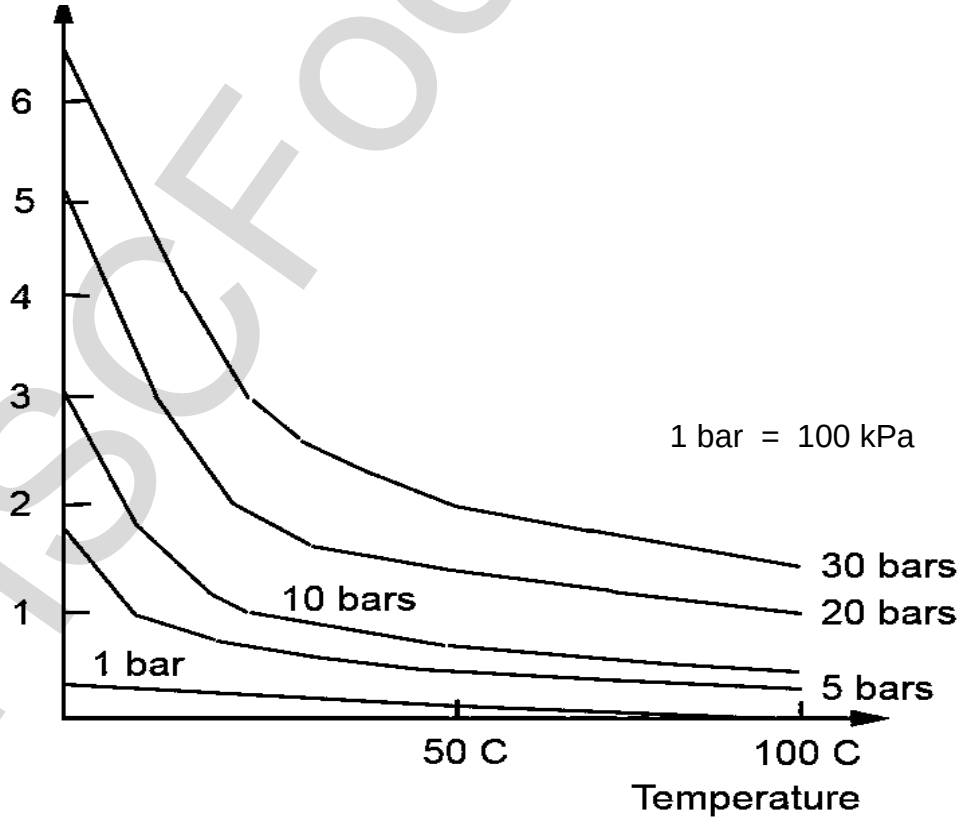
Question 8 (4 marks)

Carbon dioxide dissolves in water according to the equilibrium…

$$CO_2(g) + H_2O(l) \rightleftharpoons H_2CO_3(aq) \quad \Delta H = -20.3 \text{ kJ mol}^{-1}$$

The graph shows the solubility of carbon dioxide under changing conditions…



Question 8 continues next page (page 5)

MARKS

Identify the trends in the solubility of CO_2 and explain them based upon Le Châtelier's principle. **4**

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Question 9 (4 marks)

Industrial chemistry processes have enabled scientists to develop replacements for natural products.

(a) Complete the table… **2**

Natural product (non-fossil fuel)	*Replacement material*

(b) Discuss issues associated with shrinking world resources of the natural product you have identified. **2**

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Question 10 …….(10 marks)

(a) Use structural formulae to draw the reaction between 1-butanol and ethanoic acid. Show the conditions necessary for reaction and name all organic products. **4**

(b) Outline the advantages of using reflux to prepare an ester. **2**

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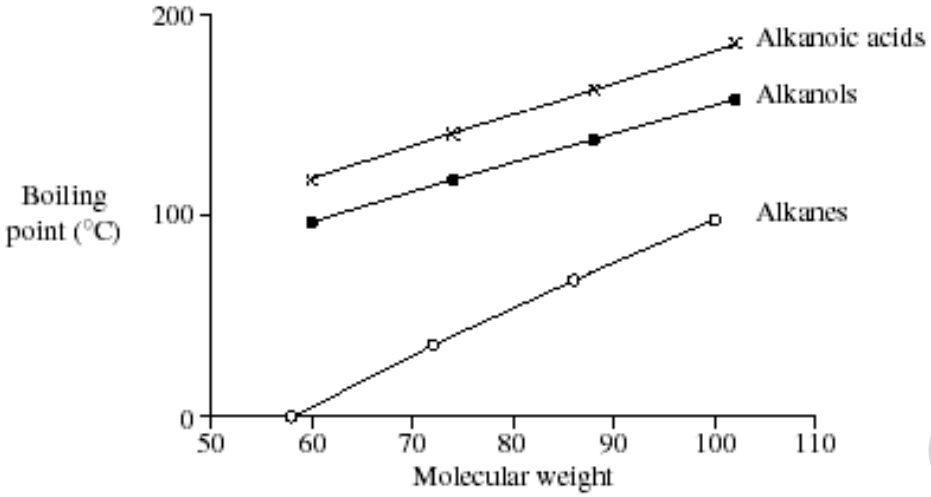
Question 10 continues next page (page 7)

(c) Explain trends in boiling points shown in the graph. **4**



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Question 11 .(4 marks)

Nuclear energy provides new elements. Some of these are transuranic elements

(a) What are transuranic elements? **1**

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(b) Identify one example of a transuranic element and describe how it is produced. **2**

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(c) Identify one method of detecting nuclear radiation. **1**

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MARKS

Question 12 (2 marks)

In each of the following reactions, which reactant is the acid? What is its conjugate base? Complete the table below **2**

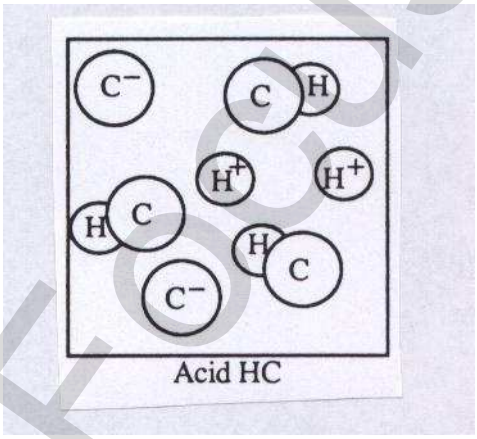
(a) $NH_4^+(aq) + HCOO^-(aq) \rightleftharpoons NH_3(g) + HCOOH(aq)$

(b) $CO_3^{2-}(aq) + HCN(aq) \rightleftharpoons HCO_3^-(aq) + CN^-$

Equation	Acid	Conjugate base
(a)		
(b)		

Question 13 (7 marks)

The diagram below represents the number and type of chemical species (other than water molecules) present in a certain volume of an acidic solution, 'Acid HC'.



Acid HC

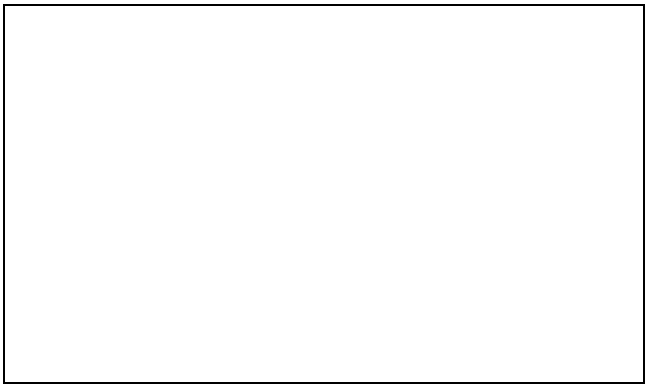
(a) Draw separate diagrams of Acid HA and Acid HB assuming all acids are in the same volume as above and represent the chemical species in a similar way to the diagram above.

(i) Acid HA is a weaker acid and more concentrated than Acid HC **2**

Question 13 continues next page

Continuation of Question 13

(ii)Acid HB is stronger but the same concentration as Acid HC. **2**



(b) Describe the difference between Acid HB and Acid HC in terms of an equilibrium between the intact molecules and its ions. **2**

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End of Test