Name:	Index No.:	CT Group: 07

PIONEER JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATION 2008

CHEMISTRY   **9746/02**
Higher 2

Paper 2 Structured   **16 September 2008**

                                                                   1 hour 30 minutes

Additional Materials: Data Booklet

READ THESE INSTRUCTIONS FIRST

Write your name, CT Group and index number in the spaces at the top of this page.
Write in dark blue or black pen.

Answer **all** questions.
Write your answers in the spaces provided on the question paper.

A Data Booklet is provided.
You may use a calculator.

The number of marks is given in brackets [ ] at the end of each question or part question.

FOR EXAMINER'S USE			
Question		**Question**	
1	/ 8	5	/ 6
2	/ 5	6	/ 10
3	/ 9	7	/ 6
4	/ 6	8	/ 10
		Total	**/ 60**

This document consists of **12** printed pages.

Answer **all** questions. Write your answers in the spaces provided.

1   **(a)**   Nitrogen and phosphorus are elements of Group V in the Periodic Table.

Nitrogen exists naturally as gaseous diatomic N≡N molecules whereas phosphorus is a solid and exists as P_4 molecules comprising of P-P single bonds.

(i)   Account for the difference in their physical states in terms of structure and bonding.   [2]

(ii)   Suggest why phosphorus does **not** occur naturally as P≡P molecules.   [1]

(b)   Nitrate, NO_3^-, and phosphate, PO_4^{3-}, are oxoanions of nitrogen and phosphorus respectively.

(i)   Draw dot-and-cross diagrams to show the bonding NO_3^- and PO_4^{3-}. Hence, deduce the shapes and state the bond angles around the nitrogen and phosphorus atom.   [4]

(ii)   Explain why it is not possible for nitrogen to form an oxoanion with formula of NO_4^{3-}.   [1]

[Total: 8]

2 **(a)** Strontium fluoride, SrF_2, is sparingly soluble in water.

The solubility of strontium fluoride in water at $25^{\circ}C$ is 0.073 g dm^{-3}. Calculate the solubility product, K_{sp}, of strontium fluoride, stating the units. [2]

(b) By means of calculations, predict whether a precipitate will form when 25.0 cm^3 of 0.0100 mol dm^{-3} strontium nitrate is mixed with 20.0 cm^3 of 0.0150 mol dm^{-3} sodium fluoride. [3]

[Total: 5]

3 Ethylenediamine tetra-acetate (edta) forms hexacoordinate complexes with many divalent metal ions.

(a) On the diagram below, circle the six atoms of edta that form bonds with the metal ion. [1]
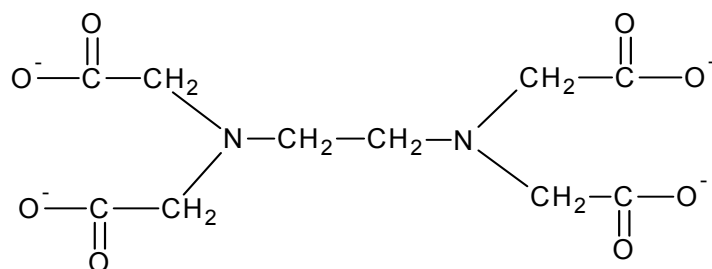
edta

(b) (i) Describe and explain what is seen when $NH_3(aq)$ is added dropwise to $CuSO_4(aq)$ until no further change is observed. [4]

(ii) When a small amount of aqueous edta is added to the resulting mixture in **(b)(i)**, the solution turns pale blue. State the type of reaction that has taken place and write an equation for the reaction. [2]

(c) Cadmium ions are poisonous; they can cause bone porosity by replacing the calcium ions in bones. One treatment for cadmium poisoning involves administering a solution of edta.

Calcium and zinc are essential for health.

$Ca^{2+} + edta^{4-} \rightleftharpoons [Ca(edta)]^{2-}$ $\qquad K_c = 5 \times 10^{10} \ mol^{-1} \ dm^3$

$Cd^{2+} + edta^{4-} \rightleftharpoons [Cd(edta)]^{2-}$ $\qquad K_c = 6 \times 10^{16} \ mol^{-1} \ dm^3$

$Zn^{2+} + edta^{4-} \rightleftharpoons [Zn(edta)]^{2-}$ $\qquad K_c = 3 \times 10^{16} \ mol^{-1} \ dm^3$

(i) Comment on the use of edta as a treatment for cadmium poisoning in the light of the data provided. [1]

**(ii)** Suggest a problem that might arise during the treatment. [1]

[Total: 9]

4 **(a)** **(i)** The decomposition of hydrogen peroxide proceeds in two steps as shown below:

$$H_2O_2 \rightarrow H_2O + O \qquad \text{slow}$$
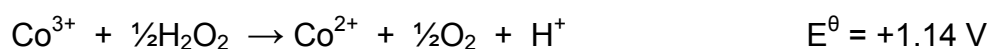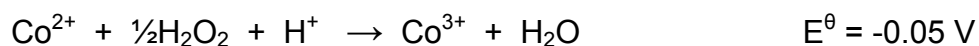
$$O + H_2O_2 \rightarrow H_2O + O_2 \qquad \text{fast}$$
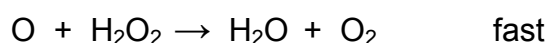
Write the rate equation for this reaction. [1]

(ii) Using your answer to **(a)(i)** and the axes provided, sketch the graphs of rate against $[H_2O_2]$ and $[H_2O_2]$ against time to show the order of reaction clearly. [2]

rate

$[H_2O_2]$

$[H_2O_2]$

time
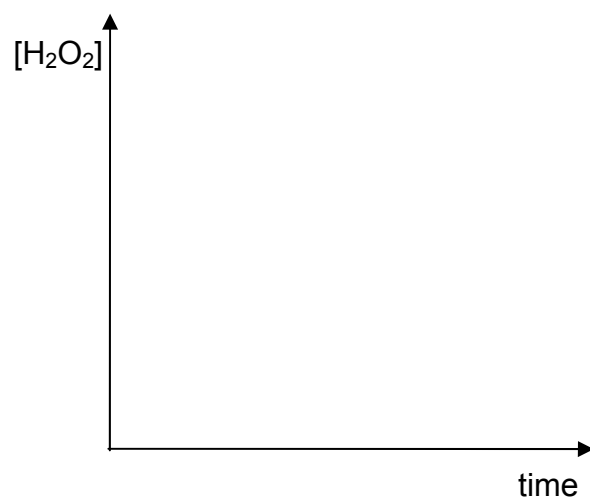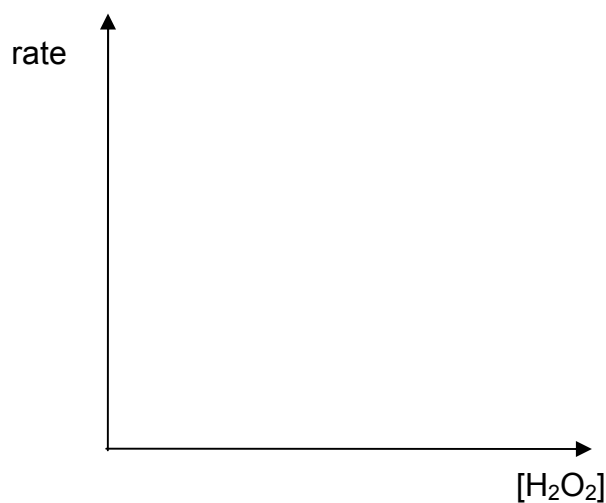
(b) Aqueous hydrogen peroxide is fairly stable but, when a mixture of cobalt(II) salt and tartaric acid, HOOCCH(OH)CH(OH)COOH, is added to hydrogen peroxide, oxygen is vigorously evolved.

$$Co^{2+} + \tfrac{1}{2}H_2O_2 + H^+ \rightarrow Co^{3+} + H_2O \qquad\qquad E^\theta = -0.05 \text{ V}$$

$$Co^{3+} + \tfrac{1}{2}H_2O_2 \rightarrow Co^{2+} + \tfrac{1}{2}O_2 + H^+ \qquad\qquad E^\theta = +1.14 \text{ V}$$

(i) State the role of cobalt(II) in this reaction. What property of cobalt makes it suitable for this function? [2]

**(ii)** Suggest a role for the tartaric acid in the reaction. [1]

[Total: 6]

5 For each of the following pairs of compounds, describe a simple chemical test which would enable you to distinguish between them. Describe the observations and write equations for the reactions involved. [6]

(a)

NHCOCH$_2$CH$_3$ CH$_3$ CH$_3$ and   CONHCH$_2$CH$_3$ CH$_3$ CH$_3$

(b)

 and
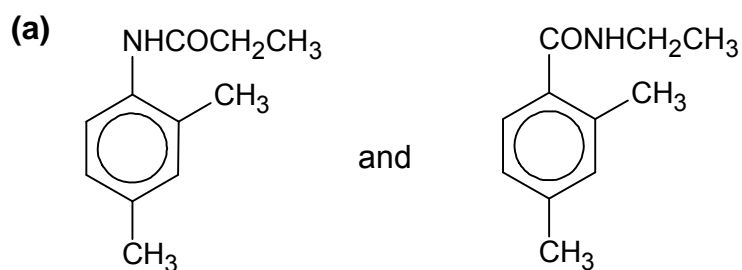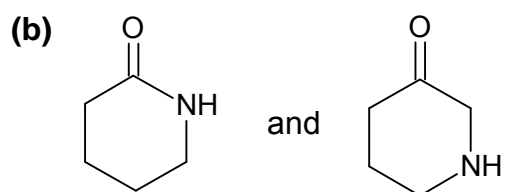
[Total: 6]

6 (a) Consider the following reaction scheme, starting from 2-phenylethanol.
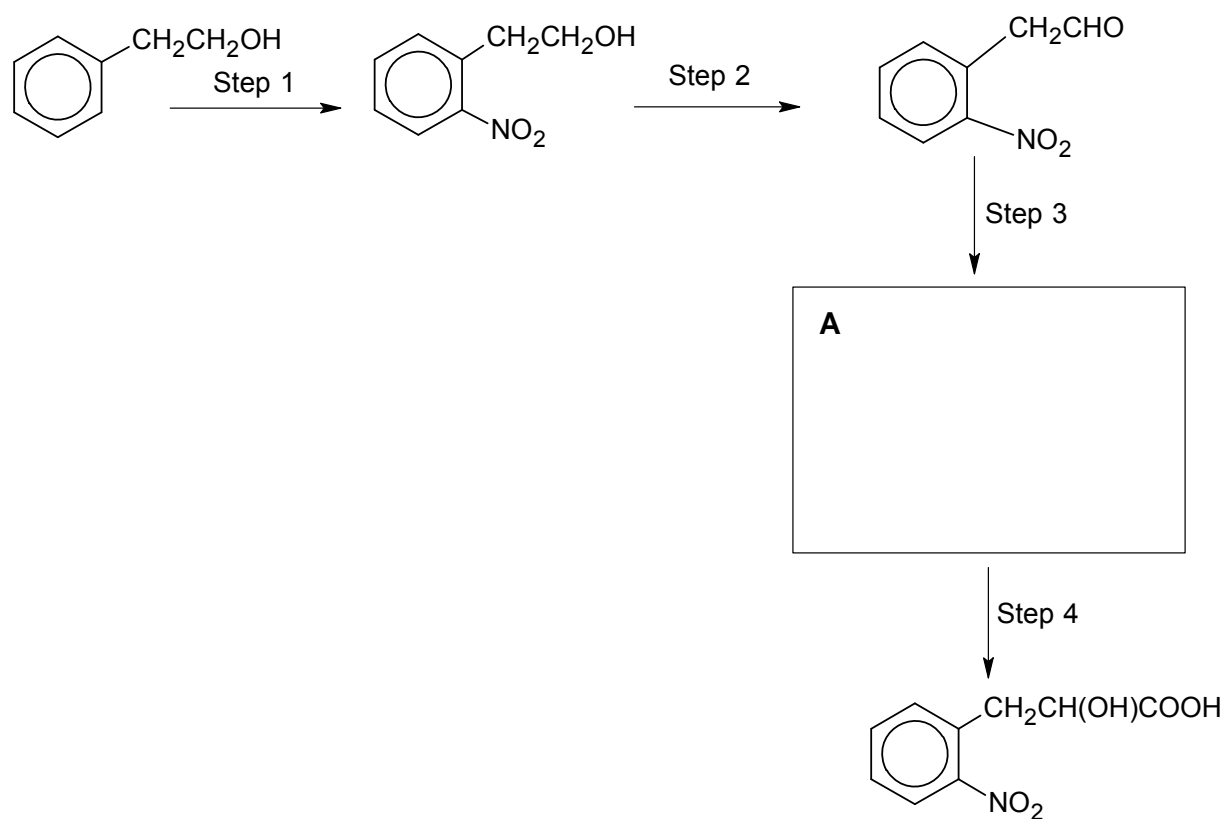
(i) Draw the structure of **A** in the box provided. [1]

(ii) State reagents and conditions for Steps 1 – 4.   [4]

Step 1	
Step 2	
Step 3	
Step 4	

(b) State the types of reactions occurring in Steps 3 and 4.   [2]
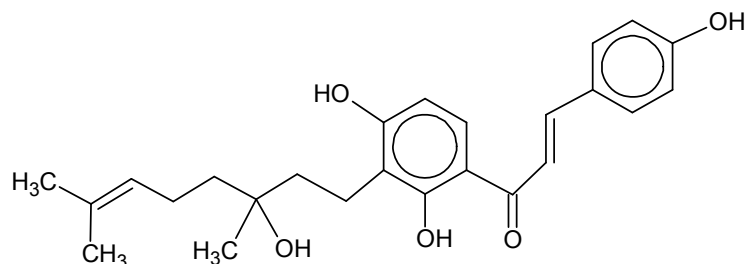
Step 3 : _____

Step 4 : _____

(c) Describe the mechanism of Step 1.   [3]

[Total: 10]

7 *Xanthoangelol J* is a member of the chalcone family, isolated from the stem of *Angelica Keiskei.* It is found to have antitumour and antimetastatic activities.


Xanthoangelol J

(a) State **four** functional groups, other than phenyl group, present in *Xanthoangelol J.*   [2]

(b) Describe what you would expect to observe when *Xanthoangelol J* reacts with the following reagents. In each case, draw the structural formula of the organic product formed.   [4]

   (i)   aqueous bromine

   (ii) cold, alkaline potassium manganate(VII).

[Total: 6]

8 The use of medicine in the treatment of illnesses was revolutionised in the 19th century and beyond due to rapid advancements in chemistry, in terms of research work, laboratory techniques and equipment.

An example of an important drug that has gained world-wide recognition for its medicinal properties is Ponstan. Ponstan capsules contain the active ingredient mefenamic acid, which is a type of medicine called a non-steroidal anti-inflammatory drug (NSAID). NSAIDs are used to relieve pain and inflammation.

The structure and some data of mefenamic acid are given below.
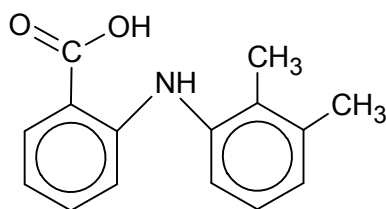
mefenamic acid

Formula : $C_{15}H_{15}NO_2$
Melting point : 230°C
Boiling point : 399°C
Density : 1.203 g cm^{-3}
Protein binding : 90%
Bioavailability : 90%
pK$_a$: 4.2
Solubility in water : 20 mg dm^{-3}
Enthalpy of vaporisation : 68.5 kJ mol^{-1}
Overdose : 740 mg kg^{-1}
Route of administration : oral
Excretion : renal and fecal
Adverse effects : drowsiness, dizziness, skin rashes, diarrhoea

(a) To alleviate a case of migraine, a patient was prescribed with a dose of the drug which includes two Ponstan capsules. Calculate the number of moles of mefenamic acid in the dose, given that each capsule contains 50 mg of mefenamic acid. [2]

(b) The patient took a dose of Ponstan at 8 am in the morning. The mefenamic acid took an hour to pass through the alimentary canal before being absorbed into the bloodstream.

The graph below shows the variation in the amount of mefenamic acid in the patient's blood with time.

Use the graph to determine the half-life of mefenamic acid in the patient's blood, showing the workings clearly. [2]
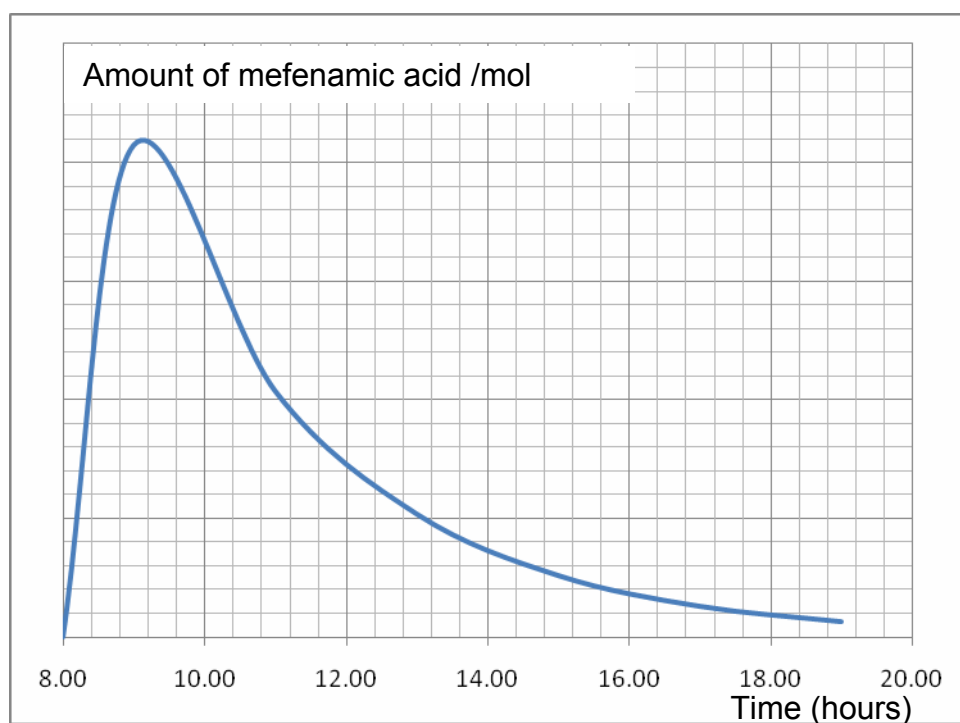
(c) **(i)** Calculate the solubility, in mol dm^{-3}, of mefenamic acid. [1]

(ii) Account for the low solubility of mefenamic acid in water. [2]

(iii) To overcome the problem of low solubility, mefenamic acid is converted to sodium mefenamate. Suggest suitable reagent and condition for the conversion. [1]

sodium mefenamate
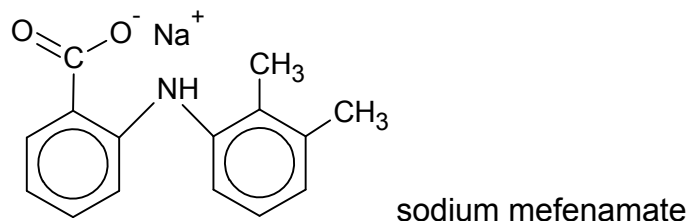
Reagent and condition: _____

(d) Unlike drugs that are administered through intravenous injections, those that are administered via the oral route will not be totally assimilated and utilised effectively by the body. The *bioavailability* of a medicine is a measure of the extent of the drug that reaches the systemic circulation and is available at the sites of action to release its therapeutic effects.

The term *overdose* describes the ingestion of a drug in quantities greater than are recommended or generally practised, which is considered harmful and dangerous as it results in detrimental impact on health.

For a patient with a mass of 65 kg, calculate the maximum mass of mefenamic acid he can ingest before he gets "overdosed", taking into consideration its "bioavailability". [2]

[Total: 10]

END OF PAPER