STUDENT NUMBER Letter

Figures									
Words									

VCAB

Victorian Curriculum and Assessment Board

Victorian Certificate of Education 1993

CHEMISTRY

Common Assessment Task 1: Chemistry in a practical context

Thursday 17 June 1993: 9.00 am to 10.45 am
Reading time: 9.00 am to 9.15 am
Writing time: 9.15 am to 10.45 am
Writing time: 9.15 am to 10.45 am
Total writing time: 1 hour 30 minutes

QUESTION AND ANSWER BOOKLET

Structure of booklet

Section	*Number of questions*	*Number of questions to be answered*
A	1 (20 items)	1 (20 items)
B	6	6

Directions to students

Materials
Question and answer booklet of 19 pages, including relevant data on page 2.
Multiple-choice answer sheet.
An approved calculator may be used.

The task
Answer **all** items from Section A.
Section A items should be answered on the multiple-choice answer sheet provided.
Answer all questions from Section B.
Section B questions should be answered in this booklet in the spaces provided following each question.
There is provision for rough working throughout the booklet.
All written responses should be in English.

At the end of the task
Please ensure that you write your student number in the space provided on this booklet and your **name and student number** in the space provided on the multiple-choice answer sheet. Place the multiple-choice answer sheet inside the back cover of this booklet and hand them in.

Data

Physical Constants:

R = 8.31 J $K^{-1}mol^{-1}$

Ideal gas molar volume at STP (0°C and 1 atmosphere pressure) = 22.4 L mol^{-1}

Ionisation constant of water, K_w, at 25°C = 1×10^{-14}

SECTION A

Specific instructions for Section A

Section A, Question I consists of 20 multiple-choice items and is worth approximately 31 per cent of the marks available.

You should spend approximately 28 minutes on this section.

Choose the response that is **correct** or **best answers the question**, and mark your choice on the multiple-choice answer sheet according to the instructions on that sheet.

A correct answer scores 1, an incorrect answer scores 0. No credit will be given for an item if two or more letters are marked for that item. Marks will **not** be deducted for incorrect answers and you should attempt every item.

Question 1

Item 1

A 50 mL burette can deliver a volume of liquid with a precision of approximately plus or minus

A. 0.2mL
B. 0.02 mL
C. 0.002 mL
D. 0.002 mL

The following information refers to items 2 and 3

A commercial pest strip uses a pesticide called dimethyl dichlorovinyl phosphate (DDVP) that has a molar mass of 221. Each pest strip weighs 29.0 g and contains 18.6 per cent by mass of DDVP.

Item 2

How many mole of DDVP are there in a typical pest strip?

A. 2.44
B. 0.705
C. 0.410
D. 0.0244

Item 3

What mass of pest strip would have to be swallowed by a 10kg dog to receive a lethal amount? (Lethal amount for a dog is 30 mg of DDVP per kilogram of dog weight.)

A. 0.30 g
B. 1.6 g
C. 3.0×10^2 g
D. 1.6×10^2 g

Working space

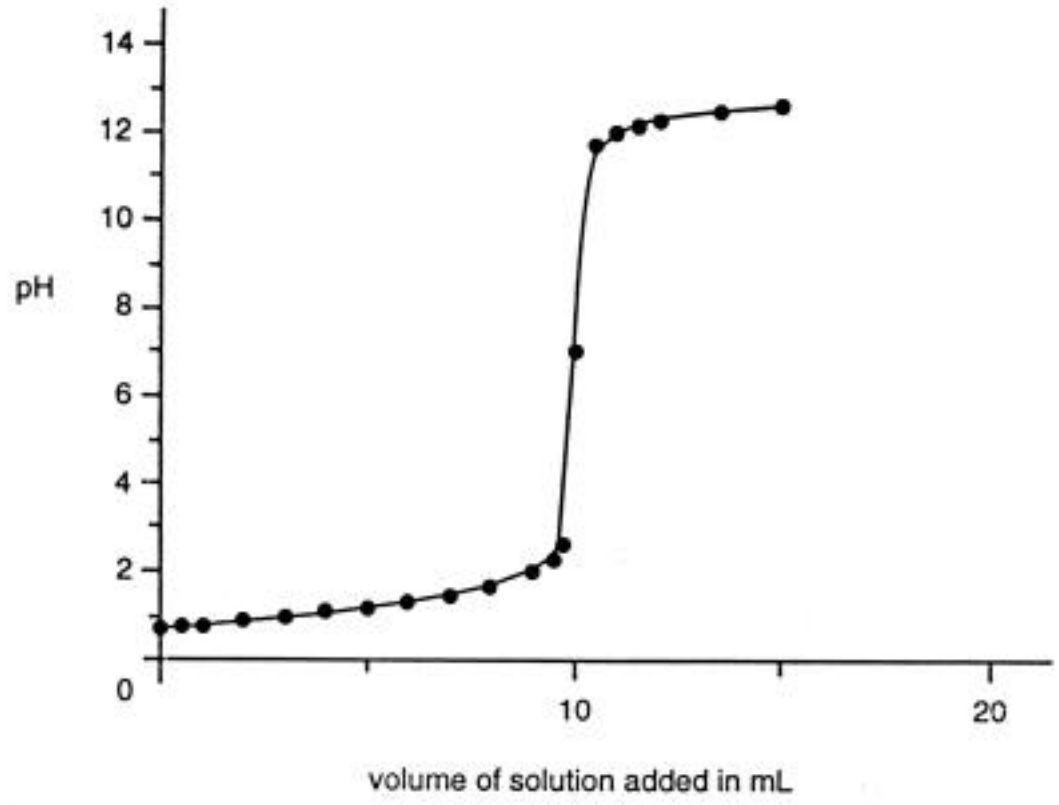
Item 4
What is the hydrogen ion concentration in an aqueous solution of HCI of pH 3?
A. 3.0M
B. 0.3M
C. 0.003 M
D. 0.001 M

Item 5
You are given 1 L of a 10^{-3} M solution of aqueous HCl. This solution is diluted to a volume of 100 L. The pH of the resulting solution is
A. 1
B. 3
C. 5
D. 7

Item 6
The hydroxide ion concentration in an aqueous solution of pH 9 at 25°C is
A. 10^{-3} M
B. 10^{-5} M
C. 10^{-7} M
D 10^{-9} M

Item 7

When one solution is added to another. the variation of pH with volume of solution added is shown below.



You will get a graph of this shape if you add
A. an acid to an acidic solution.
B. an acid to a basic solution.
C. a base to an acidic solution.
D. a base to a basic solution.

Working space

Item 8

A commercial preparation called 'Waterprufer' is sprayed on ski boots to make them waterproof. This substance is likely to work because it makes a

A. hydrophilic surface that stops water from wetting the surface of the boots.
B. hydrophobic surface that stops water from wetting the surface of the boots.
C. hydrophilic surface that allows water to wet the surface of the boots.
D. hydrophobic surface that allows water to wet the surface of the boots.

Item 9

The mass of poly(ethylene) that could be produced from 250 L of gaseous ethylene (relative molecular mass of ethylene = 28) at 20.0°C and 1000 kPa is

A. 4.21×10^7 g
B. 2.87×10^6 g
C. 4.21×10^4 g
D. 7.87×10^3 g

The following information refers to items 10 and 11

The drug, aspirin, is a weak acid that is slightly ionised in aqueous solution according to the following equation

$$\underset{\text{aspirin}}{C_9H_8O_4(aq)} + H_2O(l) \rightleftharpoons C_9H_7O_4^-(aq) + H_3O^+(aq)$$

Item 10

If sodium hydroxide is added to an aqueous solution of aspirin

A. $[C_9H_7O_4^-]$ will increase.
B. $[H_3O^+]$ will increase.
C. $[C_9H_8O_4]$ will increase.
D. $[OH^-]$ will decrease.

Item 11

When sulfuric acid is added to an aqueous solution of aspirin

A. the product $[H_3O^+]\,[OH^-]$ will increase.
B. $[H_3O^+]$ will decrease.
C. $[C_9H_7O_4^-]$ will increase.
D. $[C_9H_8O_4]$ will increase.

Item 12

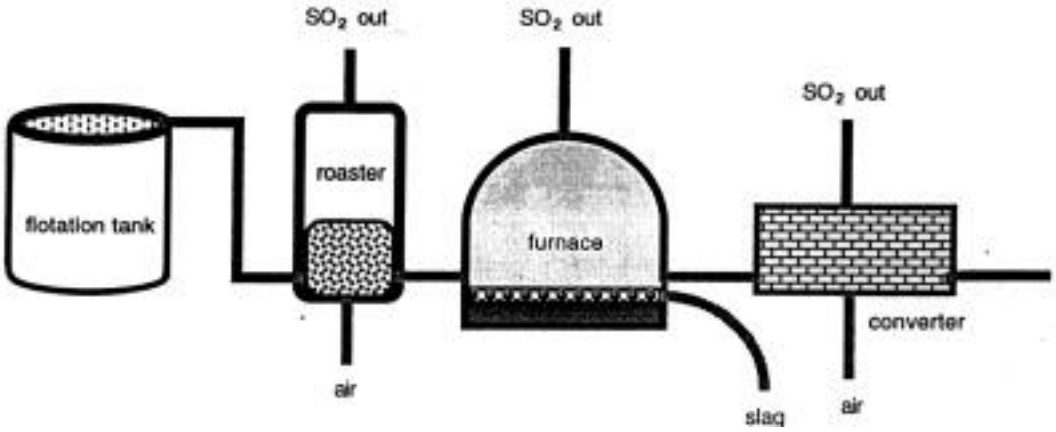
The hydrolysis of a fat in the presence of the enzyme lipase may be represented by the following equation.

$$\text{fat + water} \xrightleftharpoons{\text{lipase}} \text{glycerol + fatty acid}$$

Which one of the following statements is **not** true?

A. Lipase is a protein.
B. Lipase binds more strongly to the fat than to either the glycerol or the fatty acid.
C. In the presence of lipase the position of equilibrium for this reaction is shifted to the right.
D. In the presence of lipase the forward reaction and back reaction both proceed at a greater rate.

This figure shows a flow diagram for the industrial production of copper from its ore. The information it contains refers to items 13 to 16



Item 13

The concentration of the copper-containing mineral is carried out with a flotation process using a surface-active agent. The best way to describe how the surface-active agent causes the copper-rich mineral particles to float to the top is

A. the hydrophilic end of the surface-active molecules attaches to the mineral particles while the hydrophobic end attaches to an air bubble.
B. the hydrophilic end of the surface-active agent remains in the water, while the hydrophobic end attaches to the waste material thus holding the waste material in solution.
C. the hydrophobic end of the surface-active molecules attaches to the mineral particles, while the hydrophilic end attaches to an air bubble.
D. the hydrophobic end the surface-active agent remains in the water, while the hydrophilic end attaches to the waste material. This causes it to hold the waste material in solution.

Item 14

Identify which one of the following equations best describes the production of slag.

A. $CuFeS_2(s) + 4O_2(g) \rightarrow Cu_2S(1) + 2FeO(l) + 3SO_2(g)$
B. $FeO(l) + SiO_2(s) \rightarrow FeSiO_3(l)$
C. $Cu_2S(l) + O_2(g) \rightarrow 2Cu(l) + SO_2(g)$
D. $2Cu_2O(l) + Cu_2S(l) \rightarrow 6Cu(l) + SO_2(g)$

Item 15

Identify which one of the following equations best describes the 'roasting' process.

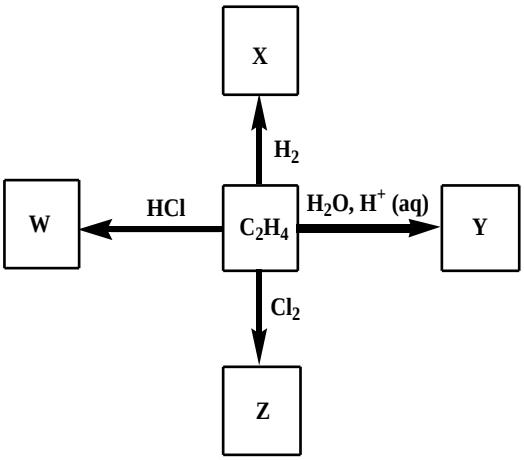
A. $2CuFeS2(s) + 4O_2(g) \rightarrow Cu_2S(1) + 2FeO(1) + 3SO_2(g)$
B. $FeO(I) + SiO_2(s) \rightarrow FeSiO_3(l)$
C. $Cu_2S(1) + O_2(g) \rightarrow 2Cu(l) + SO_2(g)$
D. $2Cu_2O(1) + Cu_2S(l) \rightarrow 6Cu(l) + SO_2(g)$

Item 16

Identify which one of the following equations best describes the process occurring in the converter.

A. $2CuFeS_2(s) + 4O_2(g) \rightarrow Cu_2S(l) + 2FeO(l) + 3SO_2(g)$
B. $FeO(l) + SiO_2(s) \rightarrow FeSiO_3(l)$
C. $Cu_2S(l) + O_2(g) \rightarrow 2Cu(l) + SO_2(g)$
D. $2Cu_2O(l) + Cu_2S(l) \rightarrow 6Cu(l) + SO_2(g)$

The following information refers to items 17 to 20 which deal with reactions of the compound



Item 17

Substance W would be

A. CH_3CI

B. CH_2Cl_2

C. CH_3CH_2Cl

D. $C_2H_4CI_2$

Item 18

Substance X would be

A acetylene

B. ethylene

C. methane

D. ethane

Item 19

Substance Y would be

A. CH_3OH

B. CH_3CH_2OH

C. $C_2H_4(OH)_2$

D. CH_3COOH

Item 20

Substance Z would be

A. CH_3Cl

B. CH_2Cl_2

C. CH_3CH_2Cl

D. $C_2H_4Cl_2$

END OF SECTION A

SECTION B

Specific instructions for Section B

Section B consists of six short-answer questions (questions 2 to 7 inclusive). You must answer all these questions. The section is worth 45 marks or approximately 69 per cent of the total. You should spend approximately 62 minutes on this section.

The marks allotted to each question and suggested times are indicated at the end of the question.

Questions should be answered in the spaces provided in this booklet.

To obtain full credit for your responses you should

- give simplified answers with an appropriate number of significant figures to all numerical questions; unsimplified answers will not be given full credit.
- show all working in your answers to numerical questions. No credit can be given for an incorrect answer unless it is accompanied by details of the working.
- make sure chemical equations are balanced and that the formulas for individual substances include an indication of state, { for example $H_2(g)$; NaCl(s) }

Question 2

a. At 25°C, liquid octane (a liquid hydrocarbon) has a surface tension of 0.021 N m^{-1} while water has a surface tension of 0.072 N m - . Briefly explain what is meant by the term 'surface tension' and give a brief explanation for the **difference** between the surface tensions of the two liquids.

b. You are given a sample of an oil to be used in a medical procedure. The oil is to be used in the form of an emulsion in water. Briefly describe the chemical nature of a substance that might be chosen as the emulsifier and hence explain the nature of an emulsion.

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c. What is a simple laboratory method you could use to tell the difference between an oil-in-water emulsion and a water-in-oil emulsion?

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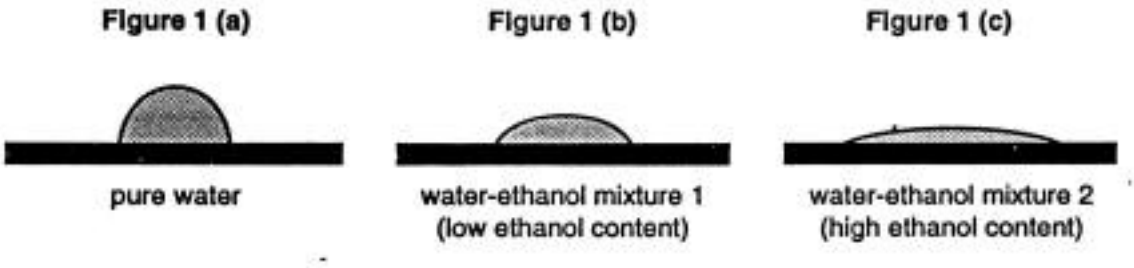
4 + 2 + 2 = 8 marks

(suggested time: 11 minutes)

Working space

Question 3

When a drop of water is placed in the palm of a person 's hand it takes a shape like that shown in figure I (a) below. If the same experiment is repeated with mixtures of water and ethanol, the drops appears as shown in figures 1(b) and 1(c).



a. What property of the liquid is responsible for the changes in drop shape as the proportion of ethanol in the mixture is increased?

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_____

b. Describe how the change in drop shape shown in the above experiment could be used as the basis of an experimental method for determining the proportion of ethanol in various mixtures of water and ethanol.

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1 + 3 = 4 marks

(suggested time: 5 minutes)

Question 4

Methanol can be prepared industrially by the reaction of carbon monoxide and hydrogen with a suitable catalyst according to the equation

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g); \qquad \Delta H = -90 \text{ kJ mol}^{-1}$$

a. Write an equation for the equilibrium constant, K_c, for this reaction.

b. At 150°C the equilibrium constant, K_c, has a value of 2.2 M^{-2}. In a particular reaction mixture at this temperature, in a vessel of volume 5.0 L, the amount of each gas was found to be

$n(CO) = 1.5 \times 10^{-3}$ mol; $n(H_2) = 2.0 \times 10^{-3}$ mol; $n(CH_3OH) = 2.4 \times 10^{-8}$mol

i. Use these numbers to show that, in the reaction mixture which is described above, the reaction is **not** at equilibrium.

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ii. How would the concentration of CO change as the system moves towards equilibrium? Briefly explain your answer.

_____

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c. Explain how you would tell from the data given how the equilibrium constant would change as the temperature was raised.

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1+3+1+2 = 7 marks
(suggested time: 10 minutes)

Question 5

Your employer asks you to check that the concentration of ammonia (NH_3) in a bottle of 'U BUTE' cloudy ammonia is no less than 2.0 M. You decide to dilute a 25.00 mL sample of the cloudy ammonia with water to a volume of exactly 250.00 mL You then plan to titrate a 20.00 mL sample of the diluted solution with a standard solution of hydrochloric acid so that the volume of the standard HCl used (the titre) will be approximately 20 mL.

a. Sketch a flow chart showing the procedure you should use.

b. Write a chemical equation for the reaction between ammonia and hydrochloric acid.

_____

c. If the ammonia concentration in the original 25.00 mL sample was approximately 2 M, approximately how many mole of ammonia would there be in the diluted 250.00 ml sample of ammonia?

_____

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_____

_____

d. Approximately how many mole of HCl would be used in one titration?

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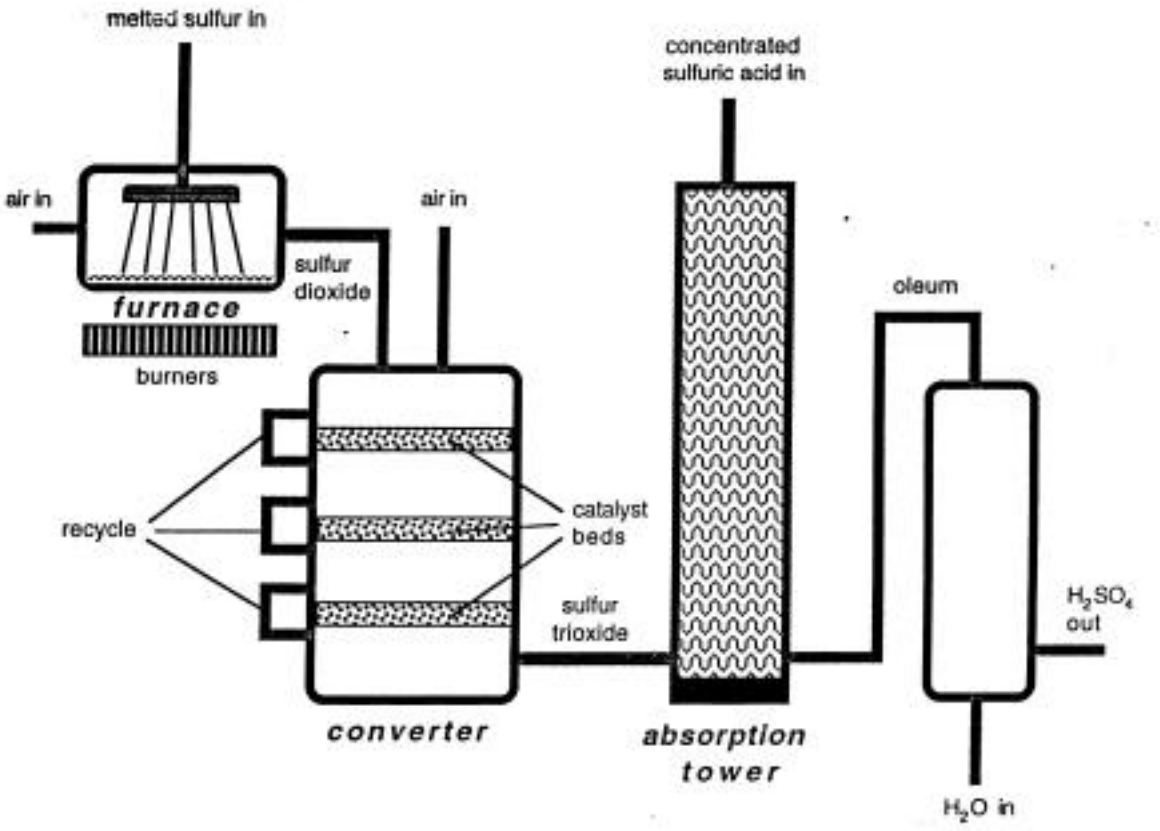
e. What would be the approximate concentration of the standard HCl solution?

f. Briefly describe two safety precautions that should be observed when carrying out these titrations.

g. Give a reason why the original cloudy ammonia solution should be diluted before attempting a titration.

3+1 + 1 + 1 + 1 + 2 + 1 = 10 marks
(suggested time: 14 minutes

Question 6
This figure shows a flow diagram of the industrial production of sulfuric acid.



a. Write down chemical equations for the following processes that occur during the industrial production of sulfuric acid

i. in the furnace.

_____

_____

ii. in the converter.

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iii in the absorption tower.

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iv. in the production of sulfuric acid from oleum.

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b. The chemical process in the converter takes place in the presence of a catalyst.

i. Explain briefly what the catalyst does.

_____

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ii. Name a suitable catalyst.

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iii. Explain the reason for the recycling process in the converter.

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c. Give a brief explanation of the factors that help determine the exact conditions of temperature and pressure chosen for the reaction occurring in the converter.

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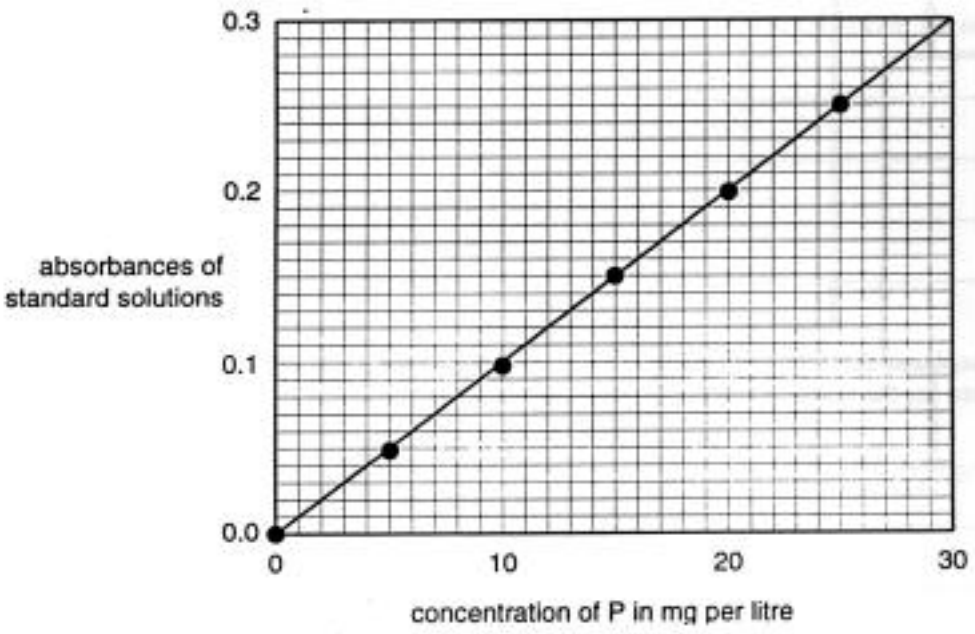
4+4+4 = 12 marks
(suggested time: 17 minutes)

Question 7

Many commercial detergents contain phosphorus in the form of sodium polyphosphate. The amount of phosphorus in a sample of detergent can be determined colorimetrically. 0.500 g of a sample of a solid detergent is dissolved in water and the solution made up to 500 mL. 20.0 mL samples of this solution are mixed with 2.00 mL of a standard molybdate solution. A blue colour develops that gives an absorbance reading of 0.130 in a simple colorimeter.

Five standard solutions of sodium polyphosphate were similarly treated with the standard molybdate solution and their absorbances are shown below. The graph shows the measured absorbance as a function of the *mass of phosphorus* (P) per litre in the standard polyphosphate solutions.



a. What is the concentration in mg per litre of phosphorus (as P) in the solution?

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_____

b. What is the percentage by mass of phosphorus (P) in the detergent?

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c. Explain why it was necessary to make up a set of standard solutions of sodium polyphosphate.

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1+ 2 + 1 = 4 marks

(suggested time: 5 minutes)

END OF QUESTION AND ANSWER BOOKLET