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VCE Chemistry 2005
Analytical Test
Unit 3

Time allowed: 50 minutes
Total marks: 40

SECTION A
Contains 12 multiple choice questions

SECTION B
4 Extended response questions

Suggested Answers to this test are given in a separate file

Student Name…….

VCE Chemistry 2005 Analytical Test Unit 3
SECTION A

MULTIPLE CHOICE ANSWER SHEET

Instructions:

For each question choose the response that is correct or best answers the question.
Circle the chosen response on this answer sheet.
Only circle **one** response for each question.

Question 1.	A	B	C	D
Question 2.	A	B	C	D
Question 3.	A	B	C	D
Question 4.	A	B	C	D
Question 5.	A	B	C	D
Question 6.	A	B	C	D
Question 7.	A	B	C	D
Question 8.	A	B	C	D
Question 9.	A	B	C	D
Question 10.	A	B	C	D
Question 11.	A	B	C	D
Question 12.	A	B	C	D

VCE Chemistry 2005 Analytical Test Unit 3
SECTION A - [12 marks, 15 minutes]

This section contains 12 multiple choice questions.
For each question choose the response that is correct or best answers the question.
Indicate your answer on the answer sheet provided.
*(Choose only **one** answer for each question.)*

Question 1
When a sample of a hydrocarbon was completely burnt in pure oxygen it produced 2.000 L of carbon dioxide at SLC and 1.836 g of water. The empirical formula for this hydrocarbon is

A. C_4H_5.
B. CH_2.
C. CH.
D. C_2H_5

Question 2
A gaseous pollutant was isolated from a city's atmosphere. A 2.78 g sample of the gas occupied 2.35 L at 18 ºC and 102 kPa. The pollutant is most likely

A. NO.
B. CO.
C. NO_2.
D. O_3.

Question 3
What volume of 0.100 M aqueous sulfuric acid solution would be required to neutralise a 20.00 mL aliquot of 0.150 M aqueous sodium hydroxide solution?

A. 15.0 mL.
B. 30.0 mL.
C. 60.0 mL.
D. 20.0 mL.

Question 4
Which one of the following chemical equations would best represent the reduction of chromium(III) ions by zinc metal?

A. $Cr^{3+}(aq) + Zn(s) \rightarrow Cr^{2+}(aq) + Zn^{+}(aq)$
B. $Cr^{3+}(aq) + Zn^{2+}(aq) \rightarrow Cr^{2+}(aq) + Zn^{3+}(aq)$
C. $2Cr^{3+}(aq) + Zn(s) \rightarrow 2Cr^{2+}(aq) + Zn^{2+}(aq)$
D. $2Cr^{3+}(aq) + Zn^{2+}(aq) \rightarrow 2Cr^{4+}(aq) + Zn$

Question 5
Which one of the following changes will **not** affect the R_f value for thin layer chromatography?

A. Allowing the solvent to travel a larger distance from then origin on the plate.
B. Using a different absorbent material on the plate.
C. Developing the plate using a more polar solvent.
D. Developing the plate using a less polar solvent.

Question 6
The titration of an aqueous solution of phosphoric acid with an aqueous solution of potassium hydroxide was carried out to an indicator end-point. A 10.00 mL aliquot 0.250 M of phosphoric acid required a titre of 12.50 mL of 0.400 M potassium hydroxide. Which one of the following chemical equations best describes the reaction for this titration?

A. $H^+(aq) + OH^-(aq) \rightleftharpoons H_2O(l)$

B. $H_3PO_4(aq) + 3KOH(aq) \rightarrow K_3PO_4(aq) + 3H_2O(l)$

C. $H_3PO_4(aq) + 2KOH(aq) \rightarrow K_2HPO_4(aq) + 2H_2O(l)$

D. $H_3PO_4(aq) + KOH(aq) \rightarrow KH_2PO_4(aq) + H_2O(l)$

Question 7
In atomic absorptions spectroscopy, AAS, the light that is analysed

A. originates from the light emitted in the flame by the atoms of the element being analysed.

B. originates from a lamp emitting light of a specific wavelength that is absorbed by the atoms of the element being analysed.

C. originates from a white light source that is absorbed by the atoms of the element being analysed.

D. originates from light that is absorbed by the atoms of the element being analysed in the flame.

Question 8
What would be the sulfate ion concentration in a solution prepared by mixing 50.0 mL of 0.100 M sodium sulfate and 25.00 mL of 0.250 M aluminium sulfate solutions?

A. 0.150 M
B. 0.233 M
C. 0.317 M
D. 0.467 M

Question 9
When calcium carbonate is heated it decomposes according to the chemical equation,

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$

A 1.839 g sample of a mixture of calcium carbonate and calcium oxide was heated and a mass loss of 0.572 g was recorded. What was the percentage by mass (% w/w) of calcium oxide in the original sample?

A. 70.7 %
B. 31.1 %
C. 68.9 %
D. 29.3 %

Question 10
In a reduction-oxidation reaction

A. the oxidation number of the oxidant decreases by the same amount as the oxidation number of the reductant increases.

B. the oxidation number of the oxidant decreases and the oxidation number of the reductant increases.

C. the oxidation number of the oxidant increases and the oxidation number of the reductant decreases.

D. the oxidation number of the oxidant increases by the same amount as the oxidation number of the reductant decreases.

Question 11
An artist wanted to know if a paint contained copper compounds. Which of the following techniques would be most suited to answering the artist's request?

A. UV-Visible spectrophotometry.
B. Paper chromatography.
C. High performance liquid chromatography (HPLC).
D. Flame test.

Question 12
Which of the following procedures would need to be followed to prepare a 0.100 M aqueous sodium carbonate standard solution?

A. Dissolve 2.650 g of anhydrous sodium carbonate in distilled water so that the total volume of the solution was 250.0 mL
B. Dissolve 2.65 g of sodium carbonate in 250.00 mL of distilled water.
C. Dissolve 7.1500 g of sodium carbonate decahydrate in 250.00 mL of distilled water.
D. Dissolve 7.150 g of sodium carbonate decahydrate in distilled water so that the total volume of the solution was 250.0 mL

End of Section A

SECTION B - [28 marks, 35 minutes]

This section contains four questions, numbered 1 to 4.
All questions should be answered in the spaces provided.
The mark allocation and approximate time that should be spent on each question are given.

Question 1 - [7 marks, 9 minutes]

A 12.387 g sample of garnierite, a mineral containing nickel, was analysed for its nickel content by digesting it in concentrated acid and then diluting the resultant solution with distilled water to 200.0 mL in a volumetric flask. A 50.00 mL sample of this solution then had dimethylglyoxime reagent added to it to precipitate the compound $Ni(C_4H_7O_2N_2)_2$. The precipitate was thoroughly washed with water and dried at 110 °C to constant mass. The mass of dried precipitate was found to be 2.869 g.

a. Calculate the mass of nickel in the 50.00 mL sample used to obtain the precipitate.

2 marks

b. Calculate the percentage by mass (% w/w) of nickel in the mineral sample.

2 marks

c. Give one reason why it is a better procedure to dry the precipitate to constant mass, rather than to dry it for a specific time.

1 mark

d. When a sample of the precipitate was dried at a much higher temperature, the calculated nickel content was lower than when the above procedure was followed. Give one possible explanation for this observation.

1 mark

e. What instrumental analytical technique could be used in place of the above gravimetric procedure?

1 mark

Question 2 - [9 marks, 11 minutes]

Potassium iodate, KIO_3, is often used as a primary standard for titrations that require iodine, as it will react with excess iodide ions in weakly acidic solutions to form iodine in solution as described by the chemical equation,

$$IO_3^-(aq) + 5I^-(aq) + 6H^+(aq) \rightarrow 3I_2(aq) + 3H_2O(l)$$

a. A solution of iodine was prepared by adding excess potassium iodide to 2.500 mL of 2.000×10^{-3} M potassium iodate solution.
Calculate the number of mole of iodine that would be formed in this solution.

2 marks

b. An aqueous solution of sodium thiosulfate, $Na_2S_2O_3$, was standardised using this solution. The chemical equation for this reaction is

$$I_2(aq) + 2S_2O_3^{2-}(aq) \rightarrow 2I^-(aq) + S_4O_6^{2-}(aq)$$

The solution formed in a. above required 10.53 mL of sodium thiosulfate solution.

i. Calculate the number of mole of thiosulfate that reacted with the iodine.

ii. Calculate the concentration of the sodium thiosulfate solution.

$2 \times 1 = 2$ marks

c. Vitamin C, ascorbic acid, $C_6H_8O_6$, is oxidised by iodine as described by the chemical equation,

$$C_6H_8O_6(aq) + I_2(aq) \rightarrow C_6H_6O_6(aq) + 2I^-(aq) + 2H^+(aq)$$

A 2.500 mL sample of a fruit drink was allowed to react with the solution formed in a. above, and the excess iodine was then titrated with the sodium thiosulfate solution standardised in b. above. The titration required 7.514 mL of sodium thiosulfate solution.

i. Calculate the number of mole of thiosulfate added in the titration.

ii. Calculate the number of mole of iodine that was in excess after the reaction with the vitamin C.

iii. Calculate the number of mole of iodine that reacted with the vitamin C.

iv. Calculate the mass in milligram, mg, of vitamin C in the sample

v. Express the concentration of vitamin C in the fruit drink in mg/100 mL.

5 × 1 = 5 marks

Question 3 - [5 marks, 6 minutes]

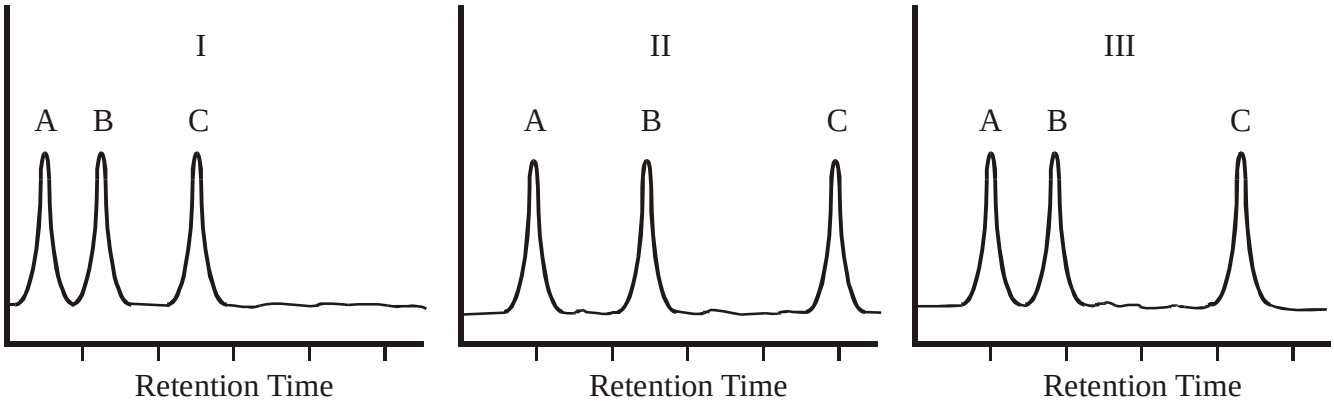
a. Draw a labelled diagram to show the key components in a high performance liquid chromatograph, HPLC.

2 marks

b. Give one example for the use of HPLC as an analytical tool.

1 mark

c. The diagrams below show the high performance liquid chromatograms for a mixture containing equal amounts of [A] ethanol, C_2H_5OH, [B] propanol, C_3H_7OH and [C] glycerol, $CH_2(OH)CH(OH)CH_2(OH)$, obtained from three different instruments.



i. What would be one factor that could explain the difference between chromatogram I and II?

ii. What would be one factor that could explain the difference between chromatogram I and III?

2 × 1 = 2 marks

Question 4 - [7 marks, 9 minutes]
A chemist analysing soft drinks used a spectrophotometric technique to determine their phosphate ion, $PO_4^{3-}(aq)$, content. A suitable reagent was added to standard solutions and the absorbances measured using red light with a wavelength of 830 nm. The data for the absorbances of the standard solutions are contained in the table below.

Concentration (ppm $PO_4^{3-}(aq)$)	**Absorbance**
2.0	0.26
4.0	0.51
6.0	0.77
8.0	1.02
10.0	1.27

a. What is the colour of the material in solution being analysed?

1 mark

b. On the grid below construct the calibration curve from the above data.

2 marks

c. A sample of soft drink was allowed to degas over a 24 hour period. A 5.00 mL sample of this was then added to a 100.0 mL volumetric flask and diluted to the mark with distilled water. 1.00 mL samples of this diluted sample were treated with the reagent added to the standard solutions and then diluted with distilled water until the total volume was 5.00 mL. The average absorbance for the samples was 0.56.
Use the calibration curve to determine:

i. The concentration of phosphate ions in the measured sample.

ii. The concentration of phosphate ions in the original soft drink.

iii. The mass of phosphate ions that would need to be printed on the information panel for a 375 mL can of soft drink.

1 + 2 + 1 = 4 marks

End of task