1. Canola oil is used in cooking. During the cooking process some of the triolein undergoes hydrolysis. One sample of canola oil was tested after use in cooking and found to have a pH of 5.5.
   1. Calculate the concentration, in mol L–1 , of H+ in this sample.

[H+] = 10-5.5

[H+] = 3.2x10-6 molL-1

(2 marks)

1. The concentration of amine chloride salts in a 50 L sample of water from another metal pipe is 5 ppm. Calculate the mass, in grams, of amine chloride salts in this sample.

5 / 1000 = 0.005 gL-1

m = CV

m = 0.005 x 50

m = 0.25 g

(2 marks)

1. Volumetric analysis is used for the quantitative determination of PbCO3 in mineral ores. A 3.15 g sample of an ore was analysed to determine the percentage of PbCO3 present, using the following procedure:

Step 1 An excess of 0.6293 mol L–1 HNO3(aq) was added to the sample. The equation for this reaction is shown below:

2HNO3(aq) + PbCO3(s) -> Pb(NO3)2(aq) + H2O(l) + CO2(g)

Step 2 When the reaction was complete, the unreacted HNO3 was titrated with 0.1423 mol L–1 NaOH(aq). The equation for the titration reaction is shown below:

HNO3(aq) + NaOH(aq) -> NaNO3(aq) + H2O(l)

1. State one observation that would indicate that the reaction in Step 1 was complete.

\_\_\_effervescence (bubbles) stopped\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(1 mark)

1. *Credit will be given for the correct use of significant figures in answers to part (b*). 4sf until part vi (1 mark)
   1. The volume of HNO3 added in Step 1 was 25.00 mL. Calculate the number of moles of HNO3 added to the sample.

n = CV

n = 0.6293 x 0.02500

n = 0.01573 mol (4sf)

(2 marks)

* 1. The volume of NaOH required was 23.67 mL. Calculate the number of moles of NaOH that reacted with the HNO3 in Step 2.

n(NaOH) = CV

n(NaOH) = 0.1423 x 0.02367

n(NaOH) = 0.003368 mol (4sf)

(2 marks)

* 1. Calculate the number of moles of unreacted HNO3 that remained after Step 1.

n(HNO3 unreacted) = n(NaOH)

n(HNO3 unreacted) = 0.003368 mol

(1 mark)

* 1. Hence, calculate the number of moles of HNO3 that reacted during Step 1.

n(HNO3 reacted) = n(HNO3 total) - n(HNO3 unreacted)

n(HNO3 reacted) = 0.01573 – 0.003368

n(HNO3 reacted) = 0.01236 mol (4sf)

(1 mark)

* 1. Calculate the number of moles of PbCO3 in the ore sample.

n(PbCO3) = 0.5 x 0.01236

n(PbCO3) = 0.006182 mol (4sf)

(2 marks)

* 1. Calculate the percentage, by mass, of PbCO3 in the ore sample.

m(PbCO3) = nM

m(PbCO3) = 0.006182 x (207.2 + 12.01 + 16x3)

m(PbCO3) = 1.652 g

C(PbCO3) = 1.652 / 3.15 x 100

C(PbCO3) = 52.4 % w/w (3sf)

(3 marks)

* 1. The ore analysed also contained CaCO3. State and explain the effect of CaCO3 on the calculated percentage of PbCO3 in the ore sample.

\_\_\_CaCO3 would react with nitric acid in a similar way. Any CaCO3 in the sample would increase the amount of nitric acid reacted and hence would indicate a higher calculated percentage of PbCO3 than actually present.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(3 marks) TOTAL: 16 marks

1. An ore sample containing bismuth was analysed using atomic absorption spectroscopy (AAS).

Standard solutions of bismuth were used to calibrate the spectrometer and the following data were recorded:

**Bismuth concentration (ppm) Absorbance**

0.0 0.00

5.0 0.25

10.0 0.56

15.0 0.81

20.0 1.08

1. Using the data in the table on the page opposite, plot a calibration line

(5 marks)

1. State the characteristic of a calibration graph that provides information about the precision of the results obtained.

Data points lie on the trendline\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (1 mark)

1. The absorbance of the sample containing bismuth was found to be 0.51.

Determine the concentration, in ppm, of bismuth in the sample.

\_\_\_\_\_\_9.4 ppm\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (1 mark)

1. Explain why other trace elements in the sample containing bismuth will not interfere with the AAS analysis of bismuth.

Each element has a characteristic absorbance due to its specific electron configuration. As a bismuth lamp would be used, only bismuth would absorb at that frequency, meaning that traces of other elements would not affect the absorbance and hence the concentration calculated would also be unaffected. (3 marks)

1. *Credit will be given for the correct use of significant figures in answers to part (c)*. (1 mark)
2. A sample of white wine was treated to ensure all of the sulfur present was in the form of SO2. The

SO2 concentration was then determined by titration. In one titration procedure, white wine was pipetted into a conical flask and titrated with an iodine solution.

(i) State which one of the following should have been used to rinse the conical flask immediately

before use: iodine solution, white wine, or distilled water.

\_\_\_\_\_\_distilled water (controlling moles)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (1 mark)

(ii) In one 20.0 mL sample of white wine, the SO2 concentration was calculated to be 4.76 x10–3 mol L–1.

Calculate the volume of 0.0120 mol L–1 iodine solution that would have reacted in this titration, given that the equation for the reaction is:



n(wine) = CV

n(wine) = 4.76 x 10-3 x 0.02

n(wine) = 9.52 x 10-5 mol

n(I2) = n(wine)

n(I2) = 9.52 x 10-5 mol

V(I2) = n / C

V(I2) = 9.52 x 10-5 / 0.0120

V(I2) = 0.00793 L (3sf)

(4 marks)

(iii) Determine whether the SO2 concentration of 4.76 x10–3 mol L–1 in this sample was lower than the Australian legal limit of 250 mg L–1 for wine.

4.76 x 10-3 x (32.06 + 16x2) = 0.305 gL-1

0.305 gL-1 = 305 mgL-1

Yes this is above the Australian legal limit

(3 marks)

1. Lindane has been used in mosquito control, and is therefore present in the environment. It has been estimated that the daily human intake is approximately 14 ng per kilogram of body weight.

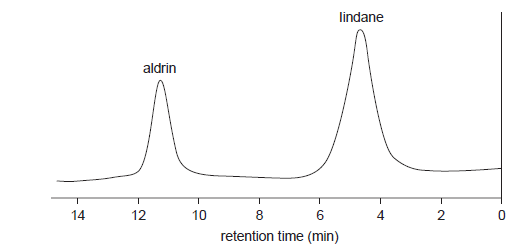
Calculate in μg the daily intake of lindane for a 70 kg person.

* 1. The presence of lindane and other pesticides can be detected using chromatography.

1. Explain the principles of chromatography.

\_\_\_\_\_Chromotography relies on the different relative attraction different substances have for a mobile and stationary phase. The relative attraction each substance has for each phase depends on the relative polarities of the substances present. As each substance will have a different attraction for each phase, each will move a different distance in a given time with the mobile phase. As they move different distances, these substances can be separated.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (4 marks)

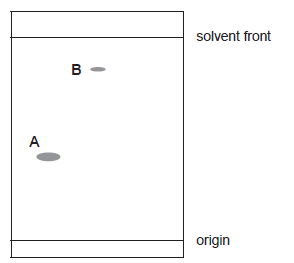
1. An analysis for the pesticides lindane and aldrin was undertaken using gas chromatography in which the column used was packed with a non-polar form of silica. The following chromatogram was obtained:
2. State the retention time for lindane.

\_\_\_\_\_\_4.5 min\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (1 mark)

1. State whether aldrin is more polar or less polar than lindane.

\_\_\_\_aldrin is less polar than lindane\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (1 mark)

1. Thin-layer chromatography using a polar stationary phase was used to identify the two vanilloids vanillin and eugenol. The diagram below shows the chromatogram produced:



1. Calculate the *R*F value for **B**.

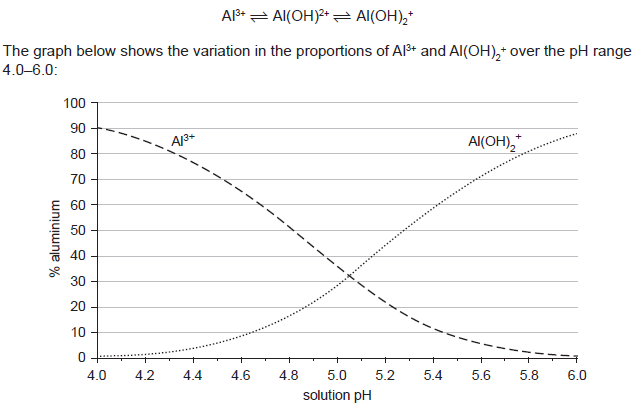
(use a ruler)

Rf = 3/3.5

Rf = 0.86

1. Aluminium is the most common metal in the Earth’s crust.
   1. Aluminium toxicity to plants affects some wheat-growing regions of Australia. In the pH range

4.0–6.0 aluminium is present in soil as three species in equilibrium:



* 1. State what happens to the percentage of aluminium present as Al(OH)2 as pH increases

from 4.0 to 6.0.

\_\_Concentration of Al(OH)2+ increases as the pH increases\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (1 mark)

* 1. Using the graph above, determine the pH when 65% of the aluminium is present as Al3+.

\_\_\_\_\_\_\_4.6\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (1 mark)

* 1. The graph does not show the percentage of aluminium present as Al(OH)2+ across the pH

range 4.0–6.0. Using the graph above, determine the percentage of aluminium present as Al(OH)2+ at pH 5.5. Show your working.

Al3+ + Al(OH)2+ + Al(OH)2+ = 100%

Al3+ = 9%

Al(OH)2+ = 65%

100 – 65 – 9 = 26%

* 1. A wheat farmer found that the total concentration of aluminium in a soil was 43 μmol L–1.
     1. Using the graph on the page opposite, determine the concentration, in μmol L–1, of Al3+ in this soil if it has a pH of 4.2.

Al3+ = 85% of 43 μmol L–1

Al3+ = 0.85 x 43

Al3+ = 37 μmol L–1

(2 marks)