Year 12 Chemistry Test **NAME**_____

Topic 1: Monitoring the Environment **Total marks: 73**

1. Carbon dioxide is a significant component in Earth's atmosphere.

   (a) Describe how carbon dioxide helps to maintain a steady temperature in the Earth's atmosphere.

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   _____
   _____
   _____
   _____
   _____ (3)

   (b) Explain one harmful consequence that anthropogenic increases in carbon dioxide are predicted to have for the human population.

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   _____
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   _____
   _____ (3)

   (c) State and explain, using at least one equation, the effect of these increases in carbon dioxide on populations of marine organisms.

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   _____
   _____
   _____
   _____
   _____ (3)

   (d) Calculate the pH of seawater with a hydrogen ion concentration of 2.0×10^{-8} mol L^{-1}.

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   _____
   _____
   _____
   _____ (2)

2. Oxides of nitrogen are produced in natural processes and human sources such as car engines.

(a) State one human source of oxides of nitrogen other than car engines.

_____ (1)

(b) Write an equation for the production of NO in the engines of cars.

(2)

(c) State why the high temperature in the engines of cars allows this reaction to occur.

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_____

_____ (2)

(d) NO is a primary pollutant.
State the meaning of the term 'pollutant'.

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_____ (1)

(e) Describe how catalytic converters reduce the quantities of nitrogen oxides generated by cars.

_____

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_____ (2)

(f) Some plants release NO into the atmosphere when they decompose.

- Explain how the concentration of ozone in the atmosphere could be increased by an increase in the number of these plants in a given area. Include at least one equation.
- Give reasons why an increase in ozone concentration in the atmosphere is undesirable.

(6)

3. A groups of chemicals called halons were used in fire extinguishers in the aviation industry even though they were known to be greenhouse gases. In 2013, a group of aviation experts began an investigation to consider and recommend less harmful chemicals to replace halons. The group documented information from chemical production industries, chemical engineers, materials scientists, research institutes, regulatory agencies, and other organisations. An appropriate replacement chemical was finally selected after consideration of more than 30 different criteria related to firefighting performance, physical properties, environmental impacts, health and safety, and production requirements.

With reference to the science as a human endeavour key concept of 'Communication and Collaboration', explain how this investigation could benefit society.

(4)

4. Credit will be given for the correct use of significant figures in part (a).

(a) The following procedure is used to determine the concentration of hydrogen peroxide:

Step 1 Dilute 25.00 mL of the commercial hydrogen peroxide solution to 250.0 mL with water.

Step 2 Pipette 20.00 mL of this dilute hydrogen peroxide solution into a conical flask and acidify.

Step 3 Titrate with permanganate solution that has a concentration of 0.02123 mol L^{-1}. The equation for the reaction is shown below:

$$5H_2O_2 + 2MnO_4^- + 6H^+ \rightarrow 2Mn^{2+} + 8H_2O + 5O_2$$

In one titration, a titre of 27.63 mL was required to completely react with the dilute hydrogen peroxide solution.

(i) Calculate the number of moles of MnO_4^- that reacted in the titration.

(3)

(ii) Calculate the number of moles of hydrogen peroxide in the 20.00 mL of dilute solution.

(3)

(iii) Calculate the concentration, in mol L^{-1}, of hydrogen peroxide in the commercial hydrogen peroxide solution.

(4)

(iv) Calculate the concentration, in %w/v, of the commercial hydrogen peroxide solution.

(3)

(b) State and explain whether the conical flask should be rinsed with distilled water or with the dilute hydrogen peroxide solution immediately before titration.

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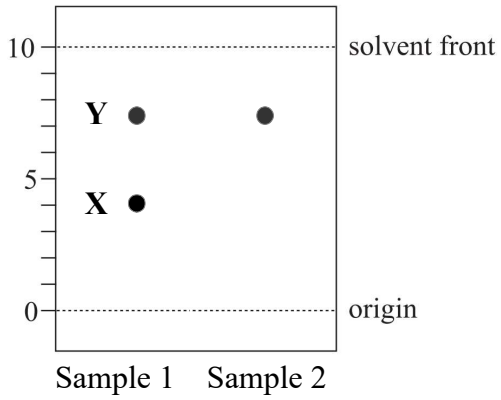
_____

_____ (2)

(c) State whether the titre value would be greater if the burette was rinsed with distilled water or permanganate solution immediately before the titration.

_____ (1)

5. Samples from some experiment were analysed by thin layer chromatography, using a polar stationary phase and a non-polar mobile phase. The chromatogram obtained is shown in the diagram below:



(a) Calculate the R_f value of component **X**.

(2)

(b) Identify which, of component **X** and component **Y**, is the more polar compound and explain your answer.

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_____

_____ (3)

6. Biological molecules such as hemoglobin and cytochrome C can be separated using ion-exchange chromatography.

In one experiment, a mixture of hemoglobin and cytochrome C is washed through an ion-exchange column with a pH 8.1 solution. After a period of time, the hemoglobin has been collected but the cytochrome C remains in the column.

(a) Calculate the hydrogen ion concentration of a pH 8.1 solution.

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_____ (2)

(b) In this experiment, an ion-exchange resin with a negative surface charge was used.

Explain, in terms of the relative charges of hemoglobin and cytochrome C, why the hemoglobin has been collected but the cytochrome C is still in the column.

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_____ (3)

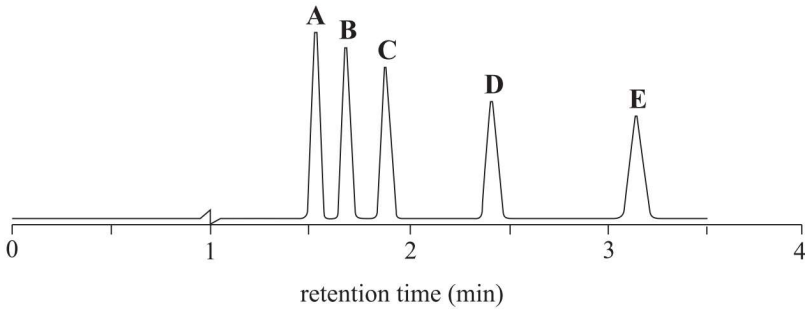
(c) In another experiment, the same mixture is washed through the ion-exchange column using the same resin but a solution of pH 10.5. At this pH, hemoglobin is negatively charged and cytochrome C is neutral.

State whether the separation will be more effective or less effective than at pH 8.1.

_____ (1)

7. Gas chromatography can be used to check the identity of the components of perfume.

(a) The retention times of some of the components of a perfume can be determined from the following chromatogram:

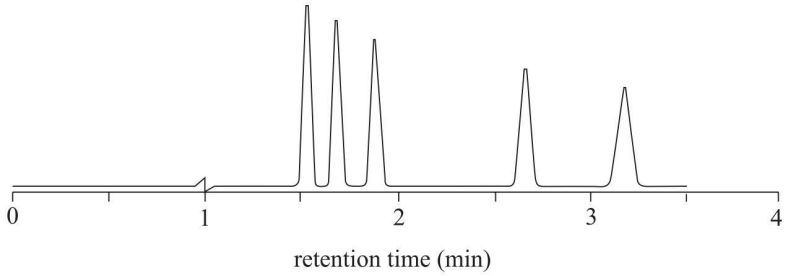


Chromatogram 1

Determine the retention time, in minutes, of component **D**.

_____ (1)

(b) The chromatogram of an imitation perfume, obtained under the same conditions as for the original perfume in Chromatogram 1, is shown below:



Chromatogram 2

State and explain how these two chromatograms indicate the difference between the imitation perfume and the original perfume.

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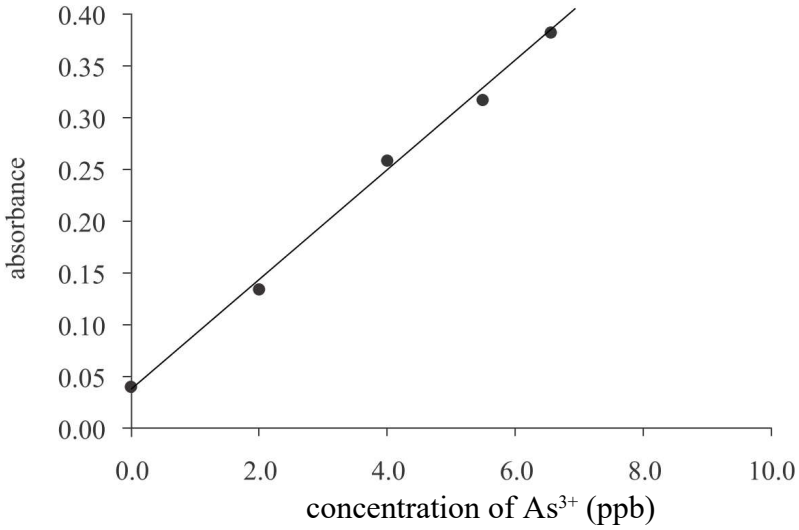
_____ (3)

8. The soil in a particular area was suspected to be contaminated with arsenic.

Absorption spectroscopy was used to test the level of arsenic in a sample of the soil.

The following calibration graph was prepared using standard solutions of As^{3+}.



(a) The sample of soil, of mass 0.45 g, was dissolved in acid, filtered, and then made up to 10.0 mL. The absorbance of the resultant solution was measured and the concentration of As^{3+} was found to be 3.5 ppb.

(i) Using the calibration graph, determine the measured absorbance of the solution.

_____ (1)

(ii) Calculate the mass, in μg, of arsenic in the 10.0 mL of solution.

(2)

(iii) Hence determine the concentration, in ppb, of arsenic in the sample of soil.

(2)

(b) The solution also contained sulfuric acid from the dissolving step.

Explain why the presence of sulfuric acid in the solution during the absorption spectroscopy would not have affected the results of the analysis.

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_____ (3)

(c) Identify one feature of the calibration graph that indicates the presence of a systematic error.

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_____ (1)

(d) Another sample of soil was suspected to contain calcium ions. The sample was dissolved in water and sprayed into a flame, where it emitted light.

(i) One calcium ion in the flame had an electron configuration of $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5\ 4s^1$.

Explain why this calcium ion emitted light.

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_____ (2)

(ii) Using subshell notation, write the electron configuration of the calcium ion after it had emitted light.

_____ (1)