Trial Exam

2013 Unit 3-4 VCE

VCE Chemistry Units 3-4

Student name _____

Question and answer book

Reading time 15 minutes

Writing time: 2 hour and 30 minutes

Structure of book

Section	Number of questions	Number of marks
A	30	30
B	13	132

You may use a data booklet and calculator.

All answers are to be printed in the space provided. If you run out of space you may use the back of the paper.

Detach the multiple-choice response sheet and write your name on the top of the sheet.

All multiple choice questions to be answered by circling the appropriate response on the multiple-choice response sheet.

At the end of the exam place the multiple-choice response sheet in the front cover of the examination booklet.
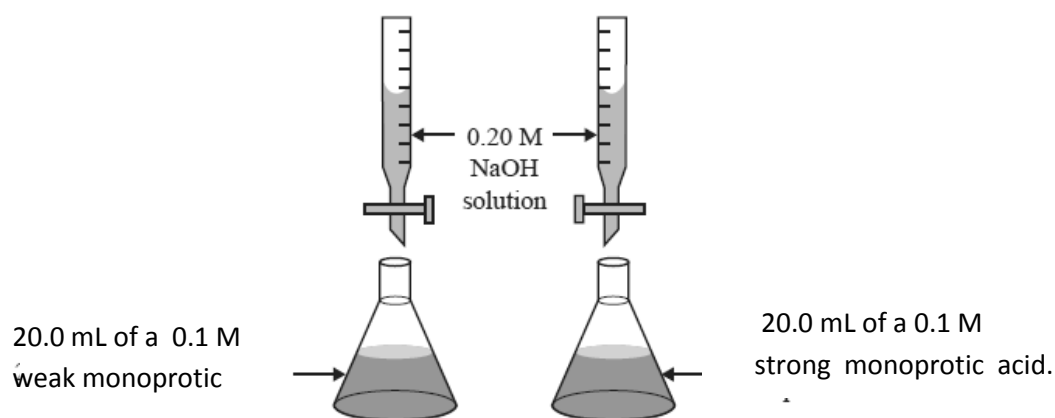
1.	A	B	C	D	**16.**	A	B	C	D
2.	A	B	C	D	**17.**	A	B	C	D
3.	A	B	C	D	**18.**	A	B	C	D
4.	A	B	C	D	**19.**	A	B	C	D
5.	A	B	C	D	**20.**	A	B	C	D
6.	A	B	C	D	**21.**	A	B	C	D
7.	A	B	C	D	**22.**	A	B	C	D
8.	A	B	C	D	**23.**	A	B	C	D
9.	A	B	C	D	**24.**	A	B	C	D
10.	A	B	C	D	**25.**	A	B	C	D
11.	A	B	C	D	**26.**	A	B	C	D
12.	A	B	C	D	**27.**	A	B	C	D
13.	A	B	C	D	**28.**	A	B	C	D
14.	A	B	C	D	**29.**	A	B	C	D
15.	A	B	C	D	**30.**	A	B	C	D

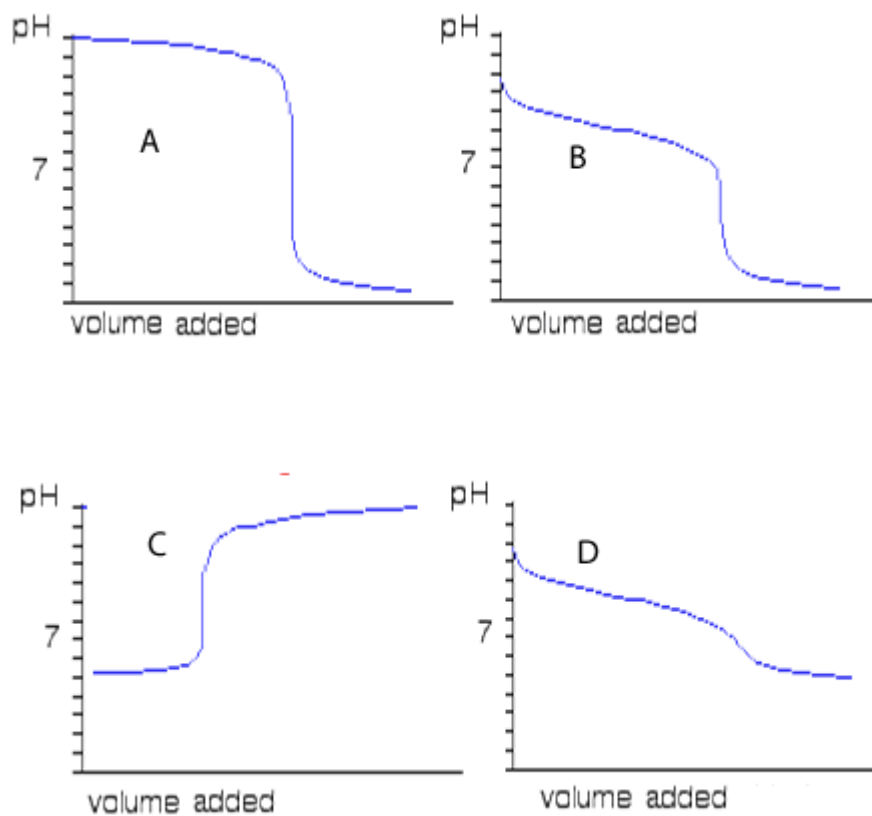Circle the correct response to each question on the answer sheet.

1) Gold metal is electroplated onto sheets of iron using a gold anode and a well-stirred solution containing Au^+ ions.
   During this process
   A. the anode increases in mass.
   B. Au^+ ions move towards the cathode.
   C. the concentration of Au^+ in the solution decreases.
   D. the concentration of Au^+ in the solution increases.

2) The passage of 0.0263 faradays of electricity through a molten chromium compound yields 4.415 g of chromium metal.
   The oxidation number of chromium in the compound is likely to be
   A. +2
   B. +3
   C. +4
   D. +6

3) Zinc metal is used as a sacrificial anode protecting an iron pipe from corrosion. A constant current of 1.8×10^{-6} A flows between the zinc and iron metals. What is the amount, in grams, of zinc metal reacting every second?
   A. 1.87×10^{-11}
   B. 1.22×10^{-9}
   C. 6.09×10^{-10}
   D. 1.22

4) An aqueous solution containing a mixture of 1.0 M NaI and 1.0 M $CaCl_2$ was electrolysed using unreactive electrodes.
   Which one of the following reactions is most likely to occur at the anode?
   A. $2H_2O(l) \rightarrow O_2(g) + 4H^+(aq) + 4e^-$
   B. $2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$
   C. $Ca^{2+}(aq) + 2e^- \rightarrow Ca(s)$
   D. $2I^-(aq) \rightarrow I_2(aq) + 2e^-$

5) Potassium metal is manufactured by electrolysis of potassium salts.
   Which of the following would be the best choice for the electrolyte and the anode in a commercial cell where the electrodes are not periodically replaced?
   A. electrolyte =KCl solution, anode = iron rod
   B. electrolyte =molten KCl, anode = iron rod
   C. electrolyte = KCl solution, anode = carbon rod
   D. electrolyte = molten KCl, anode = carbon rod

Consider the diagram shown below to answer questions 6 – 9

← 0.20 M →
NaOH
solution

20.0 mL of a 0.1 M
weak monoprotic

20.0 mL of a 0.1 M
strong monoprotic acid.

6) The amount of 0.20 M NaOH needed to reach the equivalence point of the strong monoprotic acid titration is:
   a) 10.0 mL
   b) 20.0 mL
   c) 30.0 mL
   d) Impossible to calculate with knowing the K_a value of the strong acid.

7) When comparing the amount of 0.20 M NaOH needed to reach the equivalence point of both acid solutions it can be said that
   a) the strong acid will require a lower amount than that needed for the weak monoprotic acid.
   b) the strong acid will require a greater amount than that needed for the weak monoprotic acid
   c) the strong acid will require the same amount as that needed for the weak monoprotic acid
   d) it is impossible to calculate unless the Ka values of both acids are known

8) The pH of the solution in the flask containing the weak acid when the equivalence point is reached is most likely to be around
   a) 13.8
   b) 7.8
   c) 7.0
   d) 6.5

Use the following information to answer questions 9-10

pH

A

7

volume added

pH

B

7

volume added

pH

C

7

volume added

pH

D

7

volume added

9) Which graph represents ethanoic acid solution titrated against NaOH solution?
   a) A
   b) B
   c) C
   d) D

10) Graph B represents a titration of a sample of _____ with a standard solution of _____

   a) ammonia solution, hydrochloric acid
   b) hydrochloric acid solution, sodium hydroxide
   c) ethanoic acid solution, sodium hydroxide
   d) none of the above.

11) A mixture of solid sodium azide and potassium nitrate decomposes upon heating to produce nitrogen according to the equation below.

$$10NaN_3(s) + 2KNO_3(s) => 5Na_2O(s) + K_2O(s) + 16N_2(g)$$
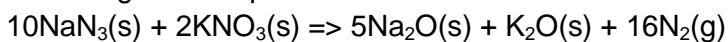
A particular air bag inflates to a volume of 45.0 L at a pressure of 105 kPa and temperature of 30.0 °C. If the molar mass of sodium azide is 65.0 g/mol calculate the mass NaN_3 present in the mixture?

a) 0.76 g
b) 86.4 g
c) 8.64 kg
d) 0.0762 kg

12) An unknown hydrocarbon with a formula mass 84 g/mol reacts with HBr to form one compound. This hydrocarbon shows 3 separate peaks in low resolution ^1H NMR spectrum and 3 separate peaks in a ^{13}C NMR spectrum. The hydrocarbon is most likely

a) hex-3-ene
b) 2,2 dimethyl but-2-ene
c) 2 methyl pent-3-ene
d) None of the above is a possible candidate for the unknown hydrocarbon.

13) Which of one of the following molecules can form a polyester?

a) $HOCH_2CH_2OH$
b) $HOOC-CH_2CH_2-COOH$
c) $CHCHCH_2OH$
d) $HOOC-CH_2CH_2OH$

14) A tripeptide is formed from alanine, cysteine and glycine. Its molecular mass is closest to

a) 269 g/mol
b) 233 g/mol
c) 249 g/mol
d) 200 g/mol

15) The structure of lysine at pH 13 is given by

a) A
b) B
c) C
d) D
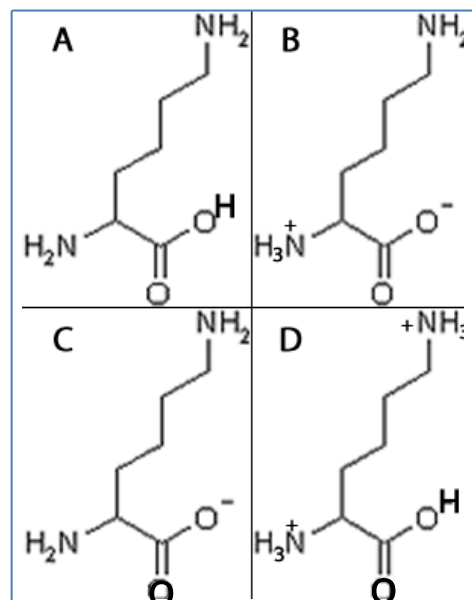
16) 9.9 grams of phosgene gas is placed in a 2.00 litre container and allowed to come to equilibrium according to the equation below. .
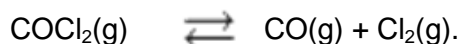
$COCl_2(g)$ ⇌ $CO(g) + Cl_2(g)$.
If at equilibrium, the concentration of Cl_2 is 0.042 M. What is the equilibrium constant at this temperature?
a) 1.00×10^{-4} M
b) 1.84×10^{-3} M
c) 2.45×10^{3} M
d) 0.221 M

Use the following information to answer questions 17-19.
1.00 mole of H_2 and 1.00 mole of I_2 gases are placed in a 1.00 L container and allowed to reach equilibrium. The equilibrium constant at this temperature for the reaction below is 49.

$H_2(g) + I_2(g)$ ⇌ $2HI(g)$ $\Delta H = $ *negative value*
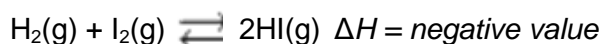
17) What is the concentration of H_2?
a) 0.875 M
b) 0.252 M
c) 0.220 M
d) 0.748 M

18) When equilibrium was reached the pressure in the vessel was increased by the addition of neon gas. Which of the following alternatives best explains how the equilibrium shifted?
a) It moved to the right in order to partly undo the increase in pressure.
b) It moved to the right to fully undo the increase in pressure and return he system back to its original pressure.
c) It moved to the left to partly undo the increase in pressure
d) There was no shift in the equilibrium.

19) After a few hours, it was observed that the equilibrium position was shifting to the left. What could possibly have caused this to happen.
a) A substance was added that reacted with HI to form a stable solid compound.
b) The volume of the vessel was slowly decreasing by an external force.
c) A slow leak has developed in the vessel thus reducing the pressure.
d) The vessel was heated.

A sample of compound X is analysed in a mass spectrometer where it is ionised to form X^+. Some X^+ further breaks apart to produce fragments Y and G^+ according to the equation below
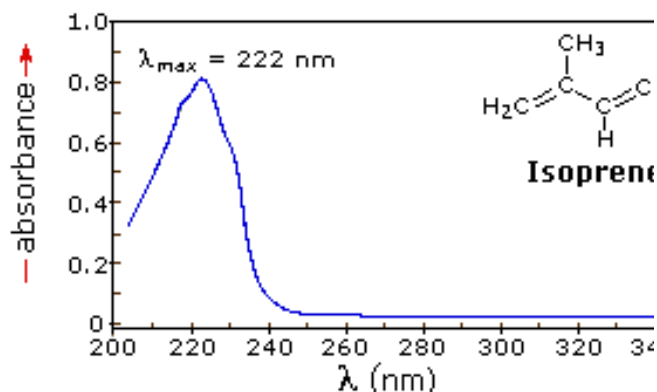
$X^+ \Rightarrow Y + G^+$

20) Which equation best outlines the initial ionisation of compound X?
   a) $X(g) + e \Rightarrow X^+(g) + 2e$
   b) $X(s) \Rightarrow X^+(s) + e$
   c) $X(g) \Rightarrow 2e + X^{2+}(g)$
   d) $X(l) + \text{heat energy} \Rightarrow 2e + X^{2+}(g)$

21) Which fragments will appear on the spectrum?
   a) X^+ only
   b) G^+ only
   c) Y, G^+ and X^+
   d) G^+ and X^+ only

22) The UV-visible spectrum of a solution of isoprene is shown on the right. Which statement below is ultimately correct?


a) The shape of the spectrum comes about due to emission of energy from excited electrons.
b) The amount of light absorbed does not depend on the wavelength of light passing through the sample.
c) The amount of light absorbed depends on the concentration of isoprene.
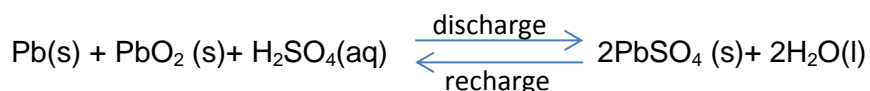d) Options C and A are correct.

23) A sample of fish caught in the bay was analysed for mercury content. Whixh technique is best suited for this task?
   a) Atomic absorption spectroscopy.
   b) UV-Visible spectroscopy.
   c) ^{1}HNMR.
   d) IR spectroscopy.

24) A banned, red food dye is tested using paper chromatography. The chromatogram is shown on the right alongside a food dye found in baby food. Which comment below is true?
a) Dye particles are separated according to size and the banned food dye is present in baby food.
b) Dye particles are separated according to charge and the banned food dye is present in baby food.
c) Dye particles are separated according to colour and the banned food dye is present in baby food.
d) Dye particles are separated according to the time it takes to reach the top of the solvent front.

baby food

12.0 cm
banned food dye
8.0 cm
5.0 cm
3.3 cm
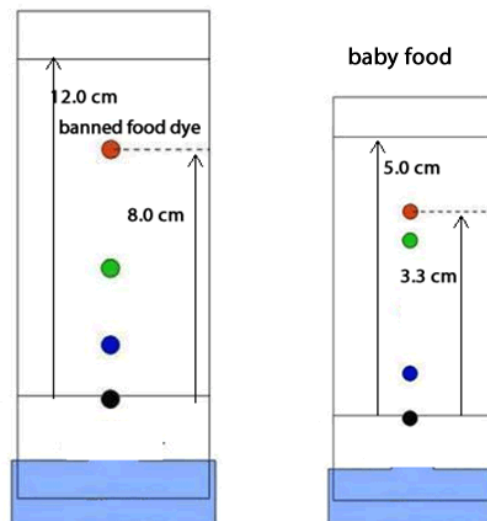
25) In a HPLC setup the column is loaded with beads covered in methyl groups while the solvent is polar. A mixture of propan-1-ol, propanoic acid, and pentan-1-ol is run through the column. Which option places the compounds from lowest to highest retention time.
a) propan-1-ol < propanoic acid < pentan-1-ol
b) propan-1-ol < pentan-1-ol < propanoic acid
c) propanoic acid < propan-1-ol < pentan-1-ol
d) pentan-1-ol < propanoic acid < propan-1-ol

26) Which one of the following analytical techniques does not involve the use or production of electrons in a high energy state.
i. AAS
ii. IR
iii. NMR
iv. Gas liquid chromatography
a) i and iii only
b) ii and iii only
c) iv, ii and I only
d) iii and iv only

27) Given the lead-acid battery reaction:

$Pb(s) + PbO_2 (s)+ H_2SO_4(aq)$ $\underset{\text{recharge}}{\overset{\text{discharge}}{\rightleftarrows}}$ $2PbSO_4 (s)+ 2H_2O(l)$

Which species is oxidized during battery discharge and recharge?
a) During discharge Pb is oxidised and during recharge PbO_2 is oxidised
b) During discharge PbO_2 is oxidised and during recharge $PbSO_4$ is oxidised
c) During discharge Pb is oxidised and during recharge $PbSO_4$ is oxidised
d) During discharge Pb is oxidised and during recharge H_2O is oxidised

The following information relates to questions 28-29
The overall reaction for the nickel-cadmium battery is given below
$$NiO_2 + Cd + 2H_2O \longrightarrow Ni(OH)_2 + Cd(OH)_2$$
The electrolyte is potassium hydroxide KOH
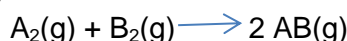
28) Which of the following reactions occur at the anode and cathode of the battery when discharging?
   a) Cathode $e + H^+ + NiO_2 \longrightarrow Ni(OH)_2$
      Anode $2H_2O + Cd \longrightarrow Cd(OH)_2 + 2H^+ + 2e$
   b) Cathode $NiO_2 + H_2O + 2e \longrightarrow Ni(OH)_2 + O^{-2}$
      Anode $2OH^- + Cd \longrightarrow Cd(OH)_2 + 2e$
   c) Cathode $2e + 2H_2O + NiO_2 \longrightarrow Ni(OH)_2 + 2OH^-$
      Anode $2OH^- + Cd \longrightarrow Cd(OH)_2 + 2e$
   d) Cathode $e + H^+ + H_2O + NiO_2 \longrightarrow Ni(OH)_2$
      Anode $Cd \longrightarrow Cd(OH)_2 + 2H^+ + 2e$

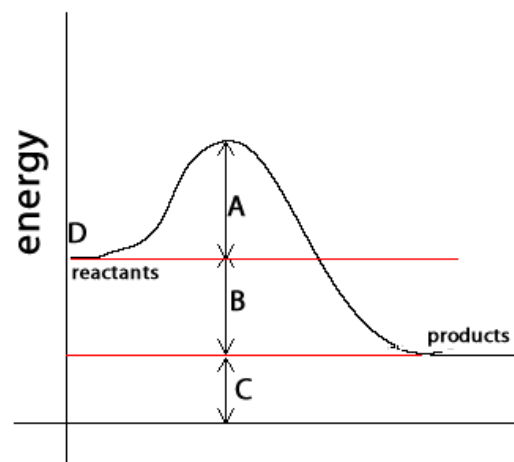29) If the battery delivers a current of 1.5 mA for 30.0 hours, what mass of Cd is used up?
   a) 1.6 grams
   b) 1.2 grams
   c) 0.094 grams
   d) 0.93 grams

30) Consider the reaction below.
   $A_2(g) + B_2(g) \longrightarrow 2\ AB(g)$
   This reaction takes place in a sealed vessel and its energy profile is shown on the right.
   The volume of the reaction vessel is suddenly halved. What factors shown on the energy profile would change?


   a) "A" would halve as the molecules have less distance to travel for a successful collision.
   b) "D" would double as the molecules have more energy and collide twice as often .
   c) "D", "B", "A" and "C" would remain unchanged
   d) "B" would halve as the energy difference between reactants and products is not that great in high pressure conditions.
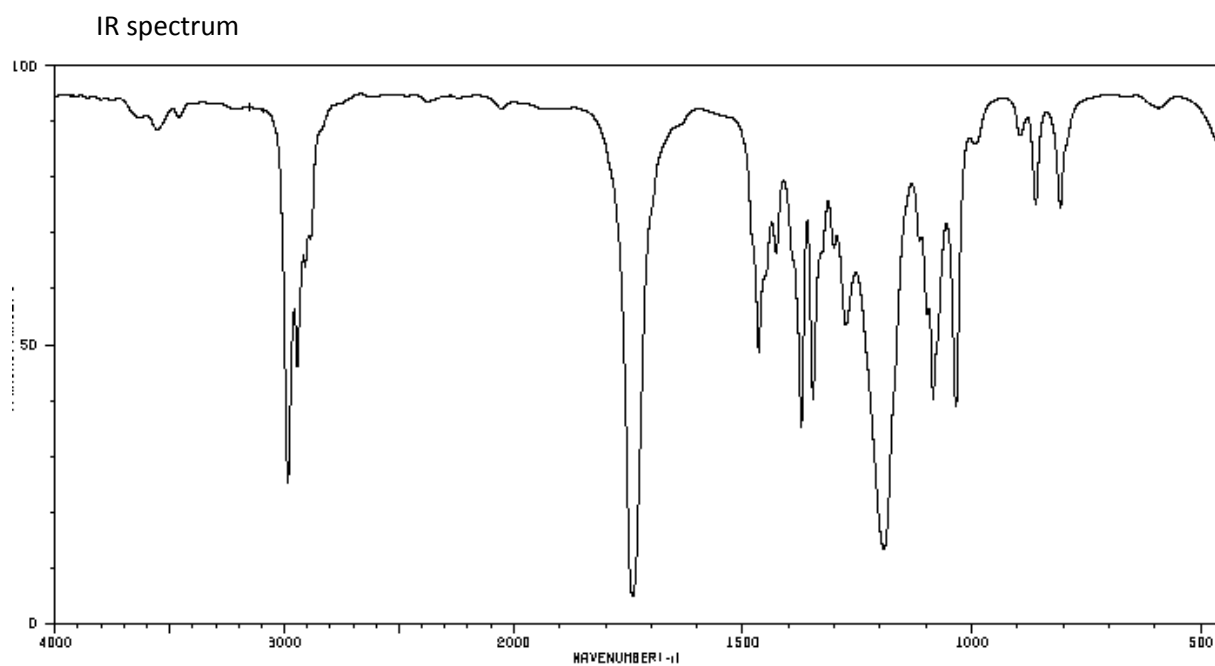
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Section B to follow.

1. An organic compound is analysed and found to contain the following percentage composition by mass.58.8% C, 9.8% H, 31.4% O.

The relevant spectra are shown below.
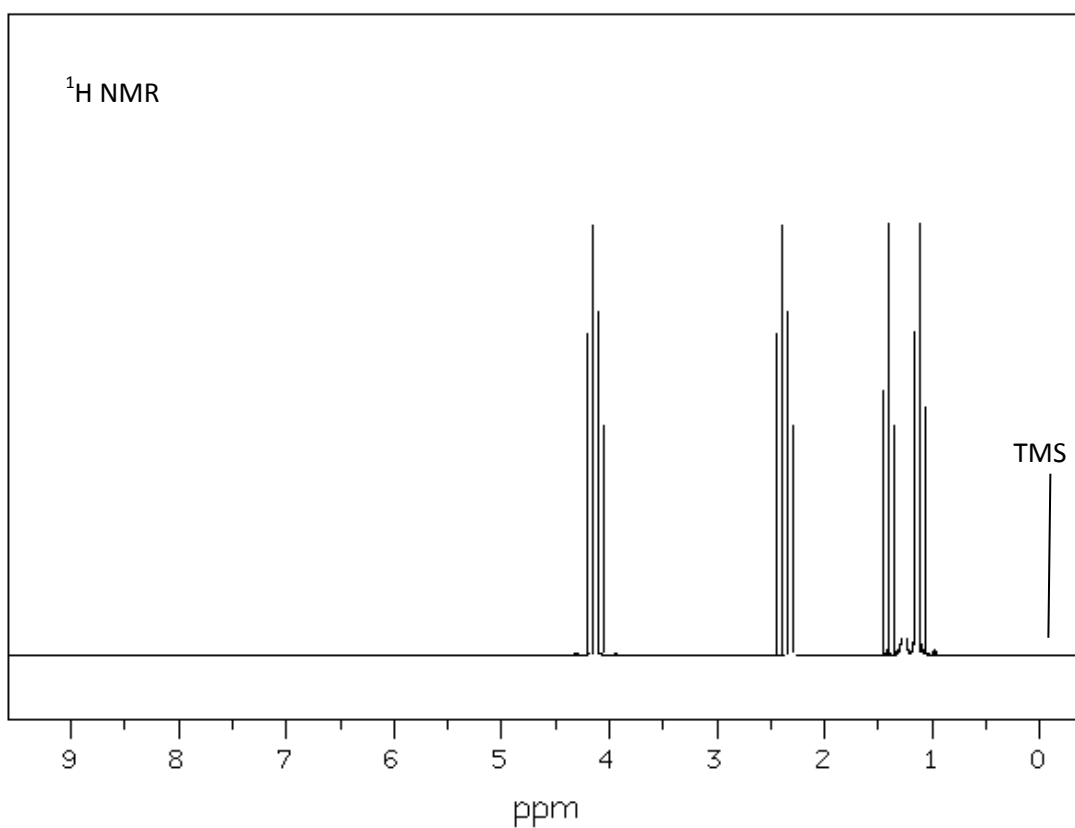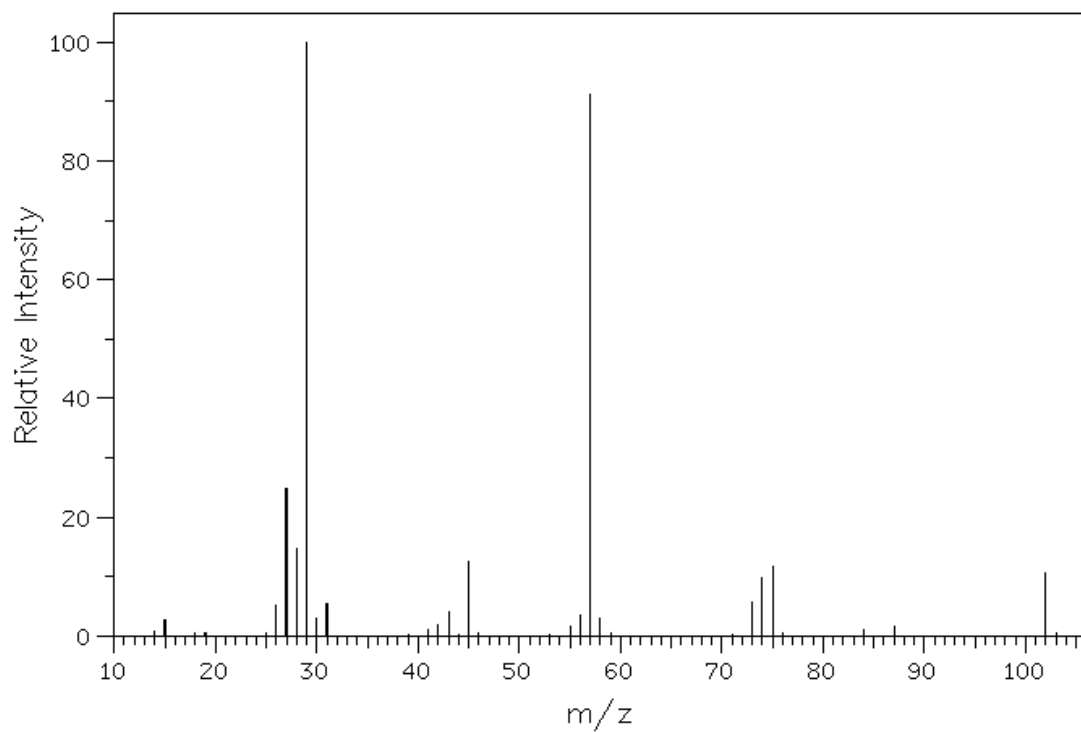
IR spectrum

a) Calculate the empirical formula of the compound.

2 marks

b) What is the molecular formula of the compound?

1 mark

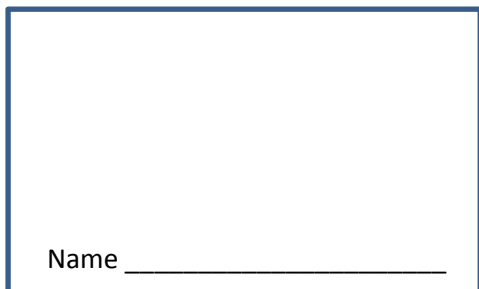c) What information can be deduced from the IR spectrum at 1250 cm⁻ and at 1750 cm⁻ ?

1   mark

4

e) What is the significance of a singlet at 2.0 ppm on ^{1}H NMR

1 mark

f) Draw the structural formula and name the compound in b) above.

Name _____

2 marks

g) What are the names of two possible raw materials for the production of this compound?

i)

ii)

2   marks

h) What type of reaction forms this compound?

1 mark

i) What is the relevance of the peak at 0 on the ^{1}H NMR spectrum labelled TMS

1 mark

7

2. Given the following two molecular compounds
 $(CH_3)_2CHCOOCH(CH_3)_2$ and $CH_3CH_2COOCH(CH_3)_2$
Outline the similarities and differences between the IR, ^1H NMR and ^{13}C NMR spectra of each molecule by completing the table below.

The table for ethanol is filled in for you.

Compound	IR spectrum	^1H NMR	^{13}C NMR
$CH_3CH_2COOCH(CH_3)_2$			
$(CH_3)_2CHCOOCH(CH_3)_2$			
Ethanol	Strong absorption at: 2850-3300 (due to C-H) 3200-3550 (due to O-H)	Three sets of peaks. A singlet representing the OH A quartet representing the CH_2 A triplet representing the CH_3	Two single peaks

6 marks

3. The percentage of iron (Fe^{3+}) in steel wool is determined by reacting a known amount of steel wool with excess sulphuric acid producing soluble iron(III)sulphate. A 1.20g piece of steel wool is dissolved in 30.0 mL of 1.00M sulphuric acid, H_2SO_4. The excess sulphuric acid is determined by titration with a 0.050M NaOH solution. 27.0 mL of sodium hydroxide is required to neutralise the acid.

a) Write a balanced chemical equation for the reaction between sodium hydroxide and sulphuric acid.
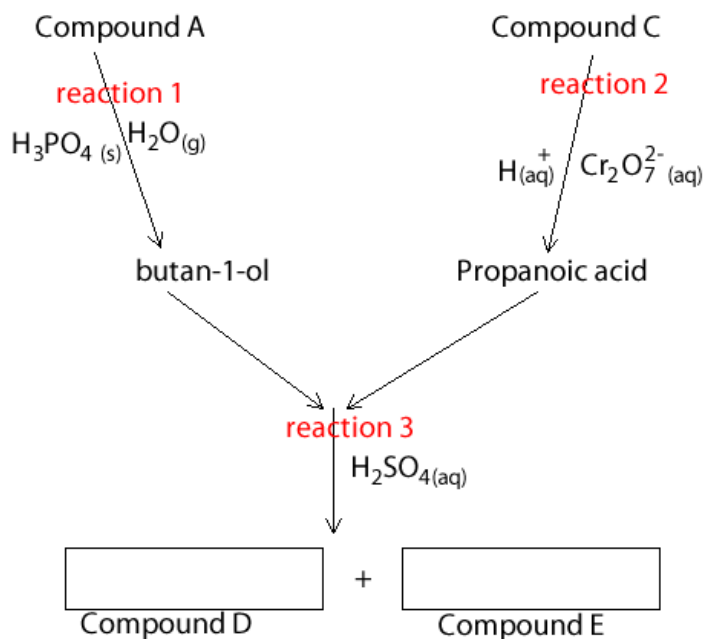
2 marks

b) Calculate the amount, in mol, of sulphuric acid that reacted with the sample of steel wool.

2 marks

c) Determine the percentage, by mass, of iron in the steel wool.

2 marks

12

4. Below is the reaction pathway of two compounds A and C

Compound A   Compound C

reaction 1   reaction 2

$H_3PO_{4 (s)}$ $H_2O_{(g)}$

$H^+_{(aq)}$ $Cr_2O^{2-}_{7 (aq)}$

butan-1-ol   Propanoic acid

reaction 3

$H_2SO_{4 (aq)}$

[Compound D]   +   [Compound E]

a) Give the systematic name for compound A

1 mark

b) What type of reaction is

i) reaction 1 _____

ii) reaction 2 _____

iii) reaction 3 _____

3 marks

c) Identify compounds
  i) D _____

  ii) E _____

2 marks

d) Draw the structure of the heavier compound that results from reaction 3, showing all bonds.
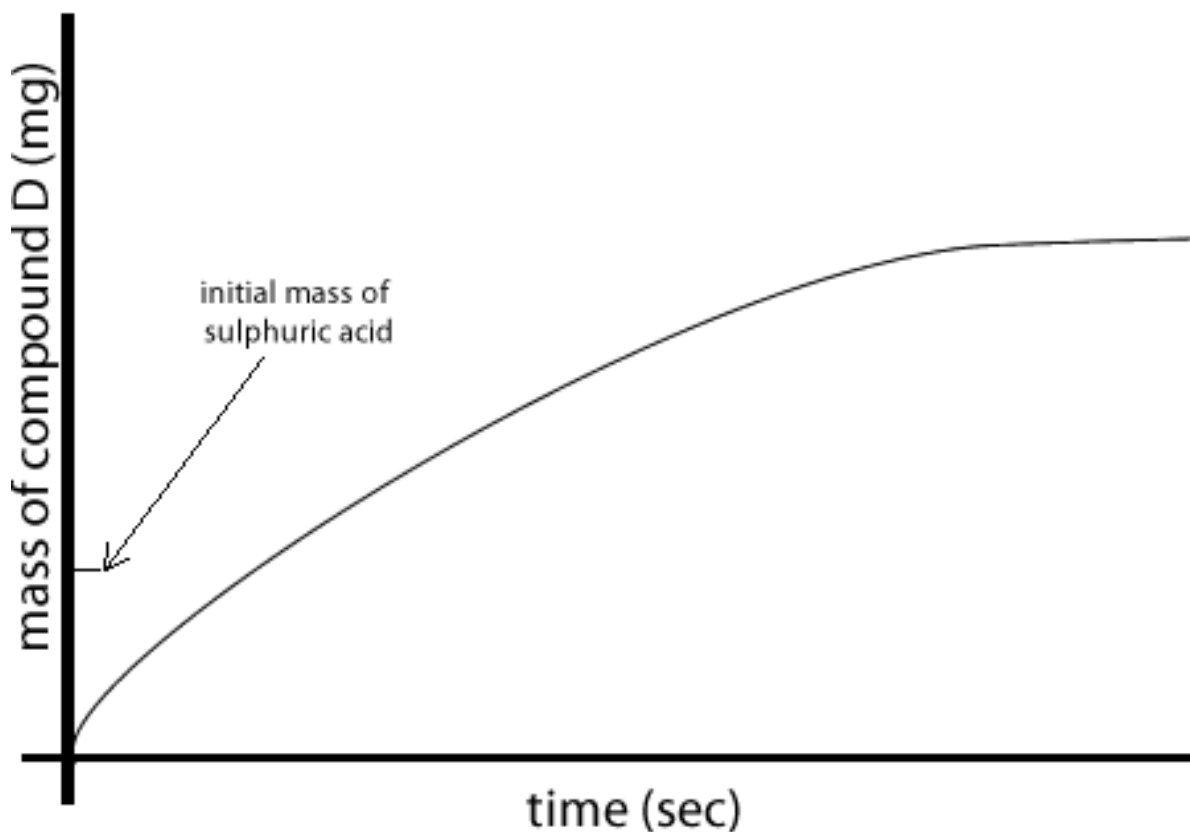

1 mark

e) The IR spectrum of the compound in question d) above contains 3 peaks of high absorption. Give the range in wave number (cm⁻) where each peak is likely to be found and the bond that it represents.

Bond	Absorption range (cm⁻)

3 marks

10

f) Below is a graph showing the mass of compound D formed over time in the absence of H_2SO_4. On the axes below draw the expected mass vs time graph **with** the H_2SO_4 present, assuming no change in the conditions under which the current graph was drawn. Give an explanation


mass of compound D (mg)

initial mass of
sulphuric acid

time (sec)

2 marks

g) On the same graph draw how the mass of H_2SO_4 changes over the course of the reaction.

1 mark

3

5. A sample of shark meat was analysed for lead content. 5.12 grams of meat was crushed and dissolved completely in 100.00 mL of a concentrated NaOH solution. A 50.0 mL sample of the 100.00 mL fish solution was placed in a 500 mL volumetric flask and made up to the mark with distilled water. A 40.0 mL sample was taken from the volumetric flask and diluted to 100.0 mL with distilled water. A 20.00 mL sample of this diluted solution was then taken and analysed using atomic absorption spectroscopy and an absorbance reading of 0.48 was recorded.

Calibration curve
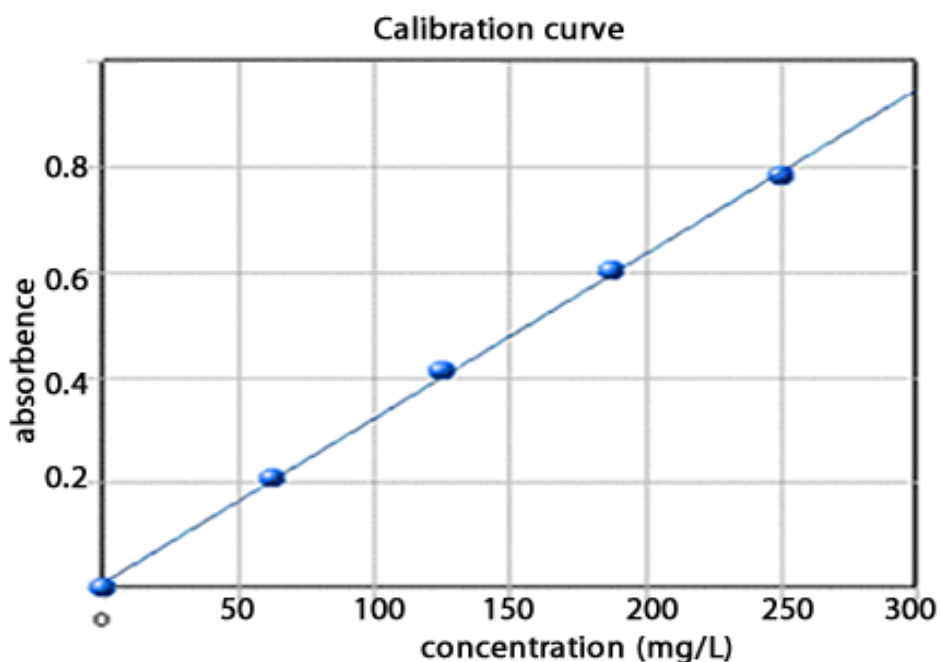
a) What is the concentration of lead of the 20.00 mL solution tested?

1 mark

b) What is the concentration of lead in the original sample of fish meat in ppm?

3 marks

c) In AAS, light is shone through the solution. Discuss which subatomic particles are involved and how they interact with the light.
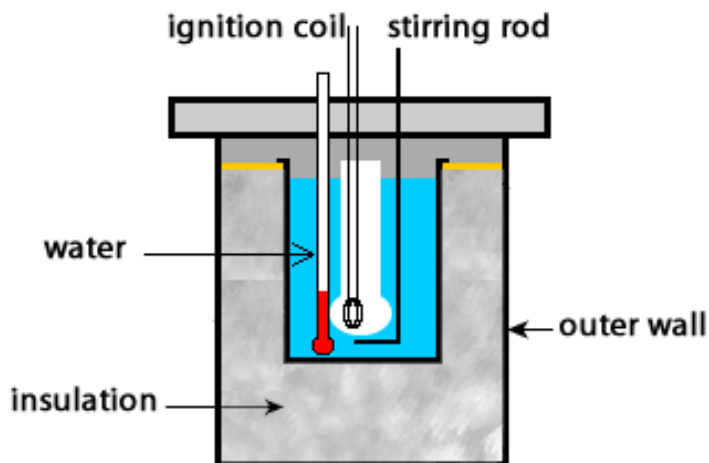
2 marks

d) Explain how this light is generated and why it is important to use a precise wavelength of light.

2 marks

8

6. A bomb calorimeter, shown below, is used to determine, **experimentally**, the ΔH of the reaction below. 11.6 grams of butane are burnt in excess oxygen to raise the temperature of the water by 2.18 °C

$$2C_4H_{10}(l) + 13O_2(g) => 8CO_2(g) + 10H_2O(g) \quad \Delta H = ?$$

The calorimeter was first calibrated by burning 6.840 g of liquid pentane in excess oxygen. The temperature of the water in the calorimeter increases from 25.0 to 26.5.

a) Calculate the calibration factor of the calorimeter?

2 marks

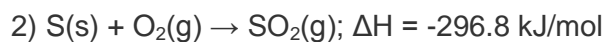b) Why must a calorimeter be calibrated before use?

1 mark

c) Calculate the enthalpy change of the reaction below
$2C_4H_{10}(l) + 13O_2(g) => 8CO_2(g) + 10H_2O(g)$

2 marks

5

d) How do you account for the molar heat of butane being lower than the value in the data sheet?

1 mark

e) 1) $C(s) + O_2(g) \rightarrow CO_2(g)$; ΔH = -393.5 kJ/mol

   2) $S(s) + O_2(g) \rightarrow SO_2(g)$; ΔH = -296.8 kJ/mol

   3) $C(s) + 2\ S(s) \rightarrow CS_2(l)$; ΔH = 87.9 kJ/mol

   Given the thermochemical equations above calculate the value of the ΔH for the reaction

$$CS_2(l) + 2\ O_2(g) \rightarrow CO_2(g) + 2\ SO_2(g)\ \Delta H =$$

2 marks

f) A camper has 0.360 grams of propane left in his bottle and needs to boil 50.0 mL of water for tea.

   i)   Write a balanced equation for the combustion of propane

1 mark

   ii)   Assuming that the cooking utensil used is 60% efficient in transferring heat energy into the water, calculate the maximum temperature that the 50.0 mL of water will reach if its initial temperature is 18 $^\circ$C.

3 marks

7

7. A iron kettle is to be copper plated using an electrolytic cell, as shown below. A total surface area of 55.8 cm^2 is to be copper plated to a depth of 2.00 mm.
Density of copper metal is 8.933 g/cm^3.

Copper Plating
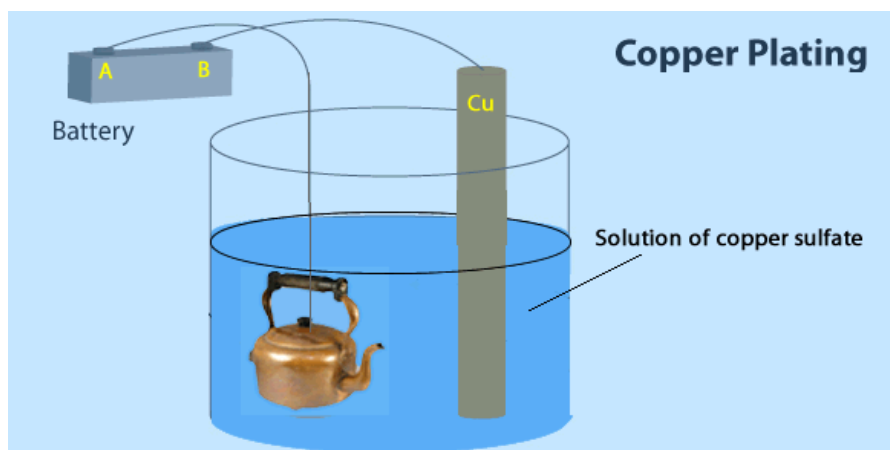
a) Write the equation for the reaction occurring at the:
   i) anode _____

   ii) cathode _____

2 marks

b) What is the polarity of terminal:
   i) A _____   ii) B ____

1 mark

c) How long, in hours, should a current of 1.80 A flow. Express the answer to the right number of significant figures?
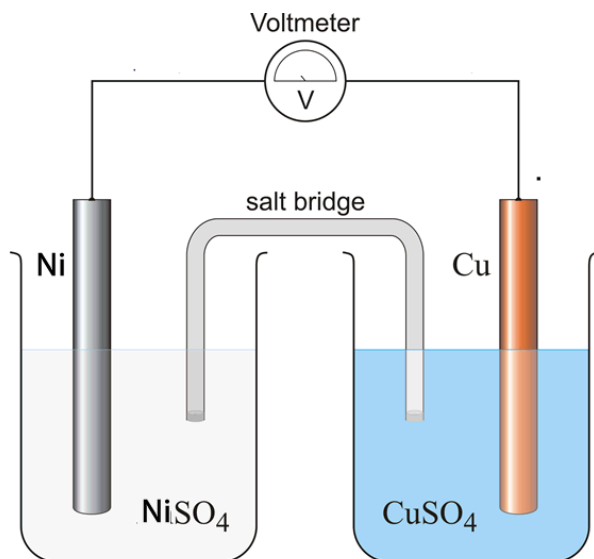
3 marks

d) i) What will happen to the concentration of Cu^{2+} ions in the solution?

1 mark

   ii) Give an explanation

1 mark

8

8. Consider the galvanic cell shown below.

a) On the diagram above indicate the following
   i) direction of electron flow
   ii) direction of negative ion movement
   iii) the anode
   iv) the cathode
   v) polarity of each electrode
   vi) the EMF of the cell

   3 marks

b) Give the half-cell equation occurring at the
   i) anode

   ii) cathode

   2 marks

c) The copper half-cell contains 100.0 mL of a 0.100 M $CuSO_4$ solution. A small current of 2.02×10^{-3} A is produced and allowed to run for 48 hours. What is the concentration of the $CuSO_4$ solution, in mol per litre, after the 48 hour discharge?

   2 marks

7

9. At a given temperature a 3.44 g sample of phosphorus pentachloride (208.5 gmol⁻) is placed in a 2.34 litre vessel where it decomposes according to the equation below.

$$PCl_5 \text{ (g)} <--> PCl_3 \text{ (g)} + Cl_2 \text{ (g)}$$

The decomposition reaction is allowed to come to equilibrium. It was found that the equilibrium mixture contained 1.03 grams of chlorine gas.

a) What percentage of the original PCl_5 decomposed?

2 marks

b) Calculate the equilibrium constant for this reaction at the temperature the reaction took place.

2 marks

c) Consider the reactions given below which are at equilibrium. Predict the outcomes after the stated change by filling the table below. Circle the correct response.

| Reaction at equilibrium	Change	Equilibrium constant	Equilibrium position
$2H_2(g) + O_2(g) \rightleftharpoons 2\,H_2O(g)\ \Delta H_m = - \text{kJ mol}^{-1}$	Volume of the reaction vessel is halved	Increase Decrease Unchanged	Shifts to the left Shifts to the right No change
$CH_4(g) + 2O_2(g) \rightleftharpoons CO_2(g) + 2H_2O(g)\ \Delta H_m = - \text{kJ mol}^{-1}$	Temperature is increased	Increase Decrease Unchanged	Shifts to the left Shifts to the right No change
$2A(aq) + B(aq) \rightleftharpoons C(aq) + 2D(aq)\ \Delta H_m = + \text{kJ mol}^{-1}$	Volume is doubled by the addition of distilled water	Increase Decrease Unchanged	Shifts to the left Shifts to the right No change
$2A(aq) + B(aq) \rightleftharpoons C(aq) + 2D(aq)\ \Delta H_m = + \text{kJ mol}^{-1}$	Volume is doubled by the addition of distilled water	Increase Decrease Unchanged	Increase Decrease Unchanged

3 marks

7

d) Consider the reaction shown below. An acidified solution of chromate ions (CrO_4^{2-}) is allowed to come to equilibrium according to the equation shown below.

$$2CrO_4^{2-}{}_{(aq)} + 2H^+{}_{(aq)} \rightleftharpoons Cr_2O_7^{2-}{}_{(aq)} + H_2O_{(l)} \quad \Delta H = positive$$
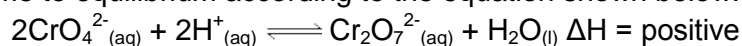
Chromate ions are yellow while dichromate ions appear red in solution.
The graph below shows the concentration of each species over time.
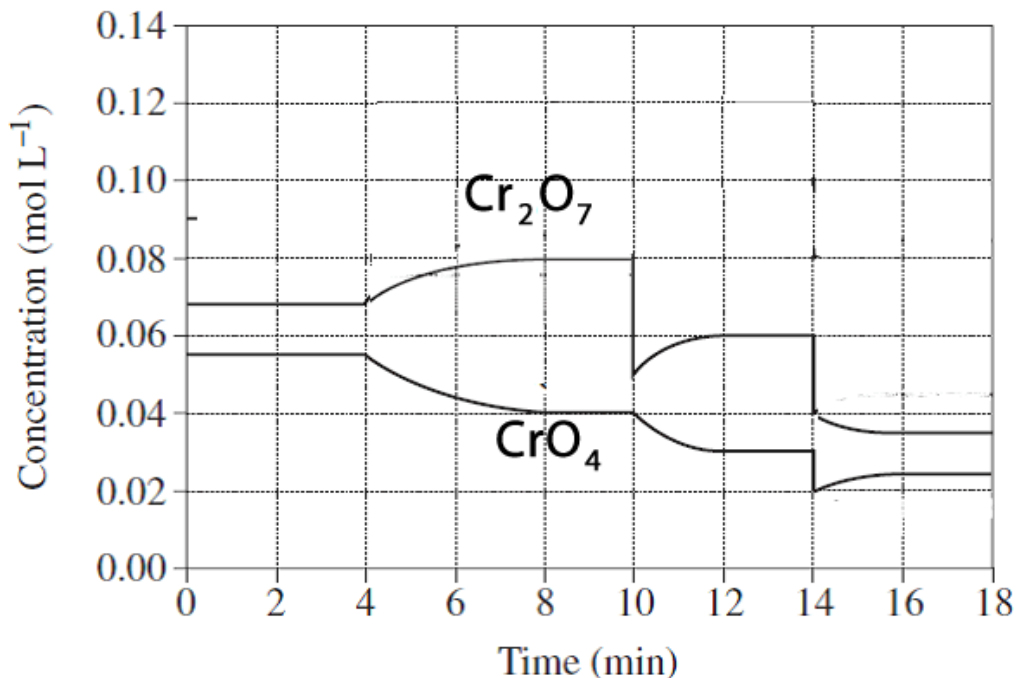
i. What two events could have happened at 4 minutes to shift the equilibrium as indicated in the graph?

2 marks

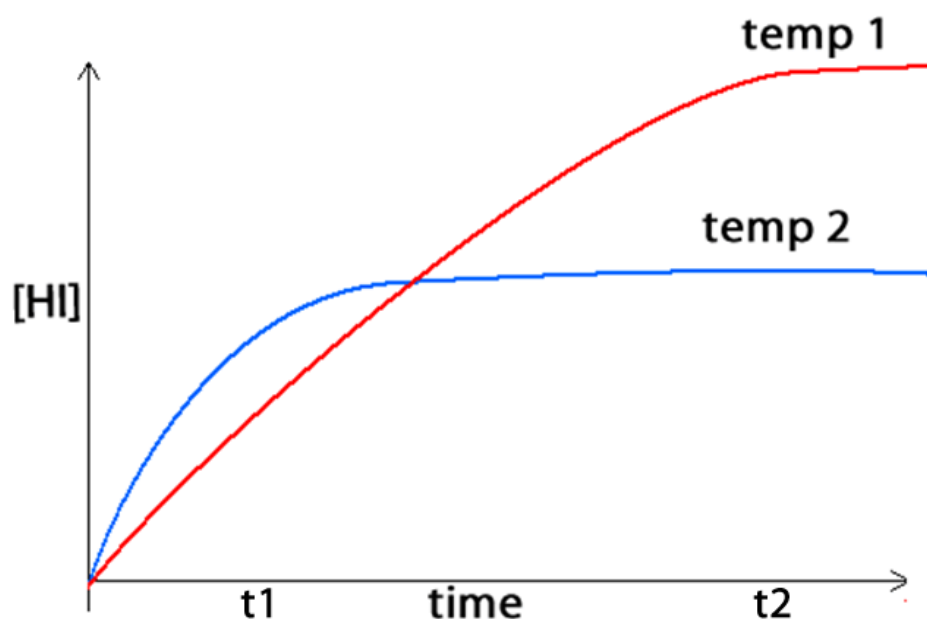ii. Assuming the temperature of the solution remained unchanged what possible happened at 14 minutes?

1 mark

iii. What event resulted in the equilibrium shift shown at the 10 minute mark?

1 mark

iv. At the 16 minute mark a catalyst was added. Describe how the equilibrium responds..

1 mark

5

e) Into a 2 litre sealed vessel was placed 2.0 mol of H_2 gas and 2.0 mol of I_2 gas and allowed to reach equilibrium. The graph of HI concentration is shown above at two different temperatures.

    i.   Which temperature is the greatest? Give an explanation

1 mark

   ii.   Decide whether the reaction is exothermic or endothermic and give a reason.

1 mark

    iii.   "At t2 the forward reaction has stopped."
          Is this comment true or false? _____
          Give a clear explanation as to why.

1 mark

    iv.   Draw the graph of [HI] at a temperature higher than both temp-1 and temp-2.

1 mark

4

10. A molten carbonate fuel is just one example of an alkali fuel cells. This fuel cell operates at temperatures above 600 ^{o}C. A shown below it uses carbon dioxide, hydrogen and oxygen as inputs.

MOLTEN CARBONATE FUEL CELL
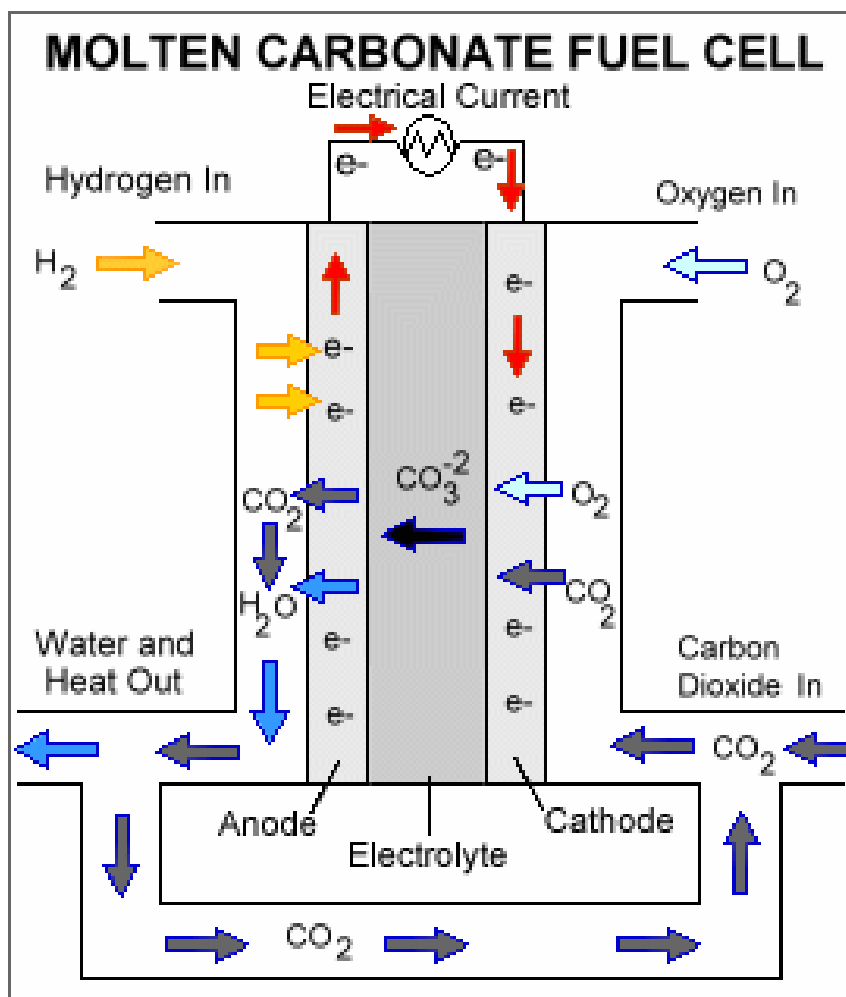
a) Give the half equation that occurs at the anode (no states necessary)

1 mark

b) Give the half equation that occurs at the cathode (no states necessary)

1 mark

c) Molten carbonate fuel cells do not produce green-house gases and are therefore more environmentally friendly than fossil fuels, however, carbon dioxide is produced at the anode. Explain.

1 mark

d) Consider the galvanic cell, shown in question 8. Name three differences between the electrodes of that galvanic cell and this fuel cell.

2 marks

5

e) Apart from the electrodes, when considering the operation of a galvanic cell and a fuel cell what are two differences between them?.

2 marks

f) It is suggested that this cell can be coupled onto conventional fossil fuel power generators to make them more environmentally friendly. Explain how this would make them environmentally friendly?

1 mark

g) Ethanol is said to be an alternative fuel source that is carbon neutral. What is meant by the term carbon neutral?

1 mark

h) Give the balanced chemical equations, states not required, of the process by which CO_2 is taken out of the atmosphere and stored in the biomass of plants. Explain why this is a redox reaction.

2 marks

i) Give the balanced chemical equation for reaction that converts glucose to ethanol during fermentation and explain why it is an redox reaction.
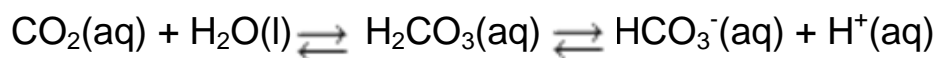
2 marks

j) Cars capable of running on hydrogen fuel cells are been developed.
   i. Discuss two advantages of hydrogen fuel over fossil fuel.

2 marks

   ii. Discuss two disadvantages of using hydrogen as a fuel source.

2 marks

12

11. Bicarbonate buffering is an important chemical system in the human body. Like all buffering systems, it tends to maintain a relatively constant blood pH. This system is represented by the equation below. Carbon dioxide (CO_2) reacts with water to form carbonic acid (H_2CO_3). Carbonic acid then dissociates to form hydrogen carbonate (HCO_3^-) ions.

$$CO_2(aq) + H_2O(l) \rightleftharpoons H_2CO_3(aq) \rightleftharpoons HCO_3^-(aq) + H^+(aq)$$

a) A 0.667 mol of H_2CO_3 is placed in a 4.00 litre vessel filled with water and allowed to reach equilibrium at an unknown temperature. Given the acidity constant K_a of H_2CO_3 at this temperature is 4.40 X 10^{-5} fined the pH of the solution.

2 marks

b) In calculating the pH of the solution in question a) above, what assumption/s did you make and why?

1 mark

c) Suppose a solution of pH 6.7 is required at the same temperature as in a) above. To a 2.00 litre solution of 0.100 M H_2CO_3 what amount in grams of sodium hydrogen carbonate should be added?
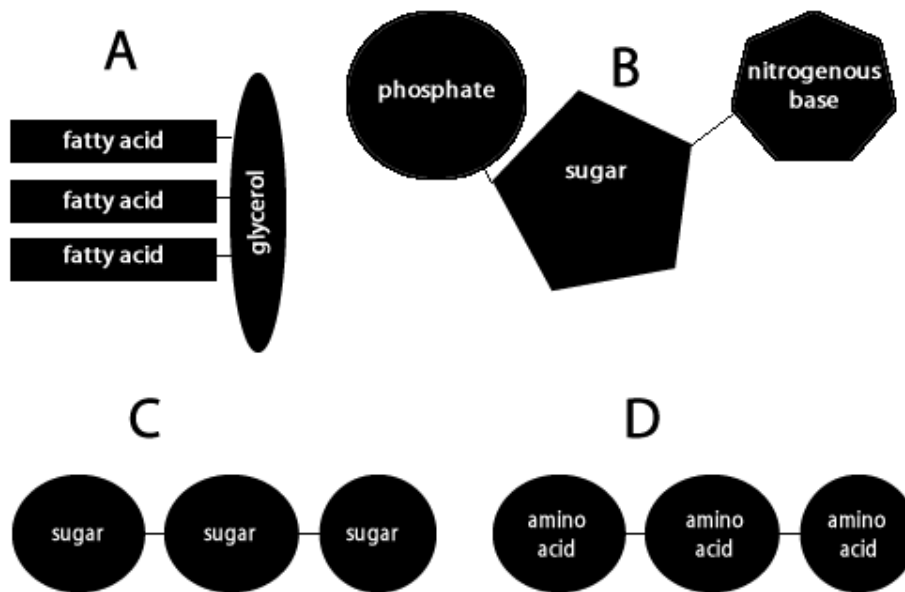
2 marks

d) What would happen to the amount of carbon dioxide gas that can be dissolved in a body of water if the pH of the water decreases? Explain

1 mark

e) Discuss why amino acids, or a H_2CO_3/HCO_3^- mixture, are used as buffer solutions and not HCl.

3 marks

9

12. Consider the diagram below showing the subunits of 4 bio-macromolecules.

a) i. In which molecule/s would an ester bond be found _____
    ii. In which molecule/s would an amide link be found _____
    iii. In which molecule/s would an ether link be found _____
    v. Which molecule/s are found in a nucleic acid _____

2 marks

b) Give the chemical formula of a molecule that is produced when the structural sub units bond to form the molecules shown above. _____
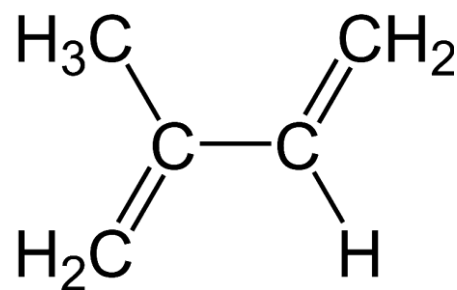
1 mark

c) A protein chain coils up into a unique shape as it is being synthesised. At temperatures above 50 °C the protein unfolds. Explain why and identify the type of bonds that are involved.

2 marks

d) The protein keratin is an important component of hair and nails. A large proportion of keratin is composed of cysteine. Explain how cysteine creates such a strong, structural protein.
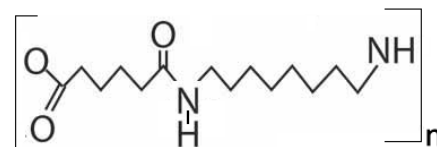
1 mark

6

e) What is the systematic name of the molecule known as isoprene, shown on the right.

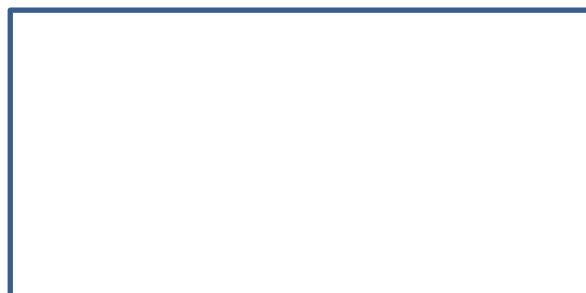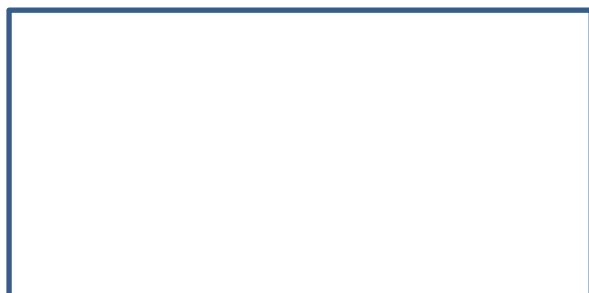*1 mark*

f) The structure shown on the right represents the repeating unit of a polymer used in the manufacture of plastic pipes.

i.   What are the structural formulae of the two monomers used to make this polymer.

2 marks

ii.   What type of reaction can this be classified as?

1 mark

iii.   What type of bond is formed between the two monomers?

1 mark

g) Isoprene reacts with hydrogen bromide (HBr) to produce new compounds.
   i.   Name all the possible isomers formed.

2 marks

ii.   What type of reaction takes place between isoprene and HBr?

1 mark

8

13. A student conducted an investigation to show that a brand of fertiliser, that stated it had 0% phosphate, did indeed have phosphate and was contaminating the local lake. She allowed farmers to use the fertiliser on a Monday and later measured the phosphate levels of the lake on Tuesday 9 am, Wednesday 4 pm, Thursday 1 pm, Friday 6 am and Saturday 7 pm. Each day she sampled a different location of the lake. The lake is also a source of drainage water from a local residential area where Saturday is a non-working day.
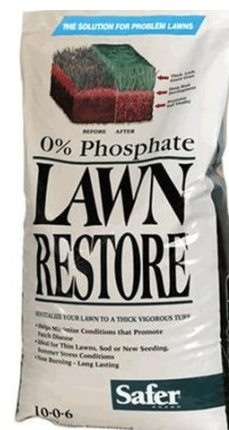
On each sampling day the student took a 150.0 mL sample of lake water from which she took three 20.0 mL samples and added excess 0.01M $Ca(NO_3)_2$ solution. She then filtered, washed and dried the $Ca_3(PO_4)_2$ precipitate before weighing it. Below are her results.

Day	Tuesday	Wednesday	Thursday	Friday	Saturday
Amount of PO_4^{-3} (grams)	88 ppm	85 ppm	78 ppm	92 ppm	160 ppm

From her results the student concluded the fertiliser definitely contained phosphate which was washing into the lake.

a) Give two reasons why her experimental technique will not enable her to reach a valid conclusion.

2 marks

2

b) Give three ways in which the investigation could be improved and the reason for the change.

Change	Reason

3 marks

3

End of Examination