5th Year

Separate Award

Chemistry

REIGATE GRAMMAR SCHOOL

Practice Paper 2

Anwsers and Comments

1. This question is about the elements in Group 1 of the periodic table.
   Sodium reacts violently with sulphur to form sodium sulphide, Na_2S.

a) i) Draw a dot and cross diagram to show the bonding present in sodium sulphide.
   Examination technique
   When drawing IONIC dot and cross diagrams make sure that;
     You draw separate ions that have full outer shells.
     You include the charges on the ions that form.

Answer - Diagram shows 8 electrons in outer shell of TWO Na ions 1
    Diagram shows 8 electrons in outer shell of S (Two from Na) 1
    Separate ions drawn with correct + and 2– charges 1

ii) Explain in terms of the bonding involved why like sodium sulphide has a higher
  melting point than sodium chloride.
  Examination technique *- Points to look for;*
  For [2] marks you must give an answer worthy of two marks.
  Explain *is the command word for including some scientific basis for your answer.*

Answer - Sulphide ions have twice the charge of chloride ions 1
    Sodium sulphide has stronger ionic bonds than sodium chloride 1

b) Potassium reacts even more violently with sulphur.
  Explain why potassium reacts more violently than sodium.
  Examination technique *- Points to look for;*
  For [3] marks you must give an answer worthy of three marks.
  Explain *is the command word for including some scientific basis for your answer.*

Answer - Potassium has more electron shells / outer electron further from nucleus 1
    Less attraction to the protons in the nucleus / greater sheilding 1
    Less energy needed to remove the outer electron 1
              Total 8 marks

2. Diamond and graphite are both formed from carbon atoms.
   Diamond is the hardest substance on Earth and graphite is soft enough to be used in pencils.

a) Draw a diagram to show the arrangement of the carbon atoms in diamond and use it
  to explain why diamond is the hardest substance on Earth.
  Examination technique *- Points to look for;*
  For [4] marks read the question carefully and think where each mark will be awarded.
   [2] for the diagram and [2 for the explanation].
  Explain *is the command word for including some scientific basis for your answer.*

Answer - Diagram shows Carbon atoms with 4 covalent bonds. 1
         Repeated tetrahedral shape. 1
    Explanation Lots of strong covalent bonds 1
         Need lots of energy to break them 1

b) Draw a diagram to show the arrangement of the carbon atoms in graphite
  and use it to explain why graphite is soft enough to be used in pencils.
  Examination technique *- Points to look for;*
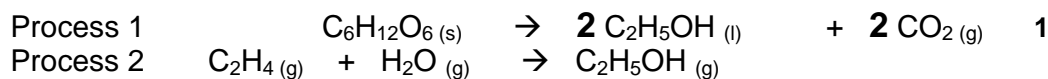 *For [4] marks read the question carefully and think where each mark will be awarded.*
   [2] for the diagram and [2 for the explanation].
  Explain *is the command word for including some scientific basis for your answer.*

Answer - Diagram shows Layers of C atoms 1
         Hexangonal arrangement. 1
    Explanation Weak bonds / forces between the layers 1
         Need little of energy to break them 1
              Total 8 marks

3. The most common member of the alcohol homologous series is ethanol.
It may be produced by both fermentation or by the catalytic hydration of ethene.
The equations for these reactions are;

Process 1 $C_6H_{12}O_{6\,(s)}$ $\rightarrow$ $2\,C_2H_5OH_{\,(l)}$ + $2\,CO_{2\,(g)}$ **1**

Process 2 $C_2H_{4\,(g)}$ + $H_2O_{\,(g)}$ $\rightarrow$ $C_2H_5OH_{\,(g)}$

a) Balance the equation for process 1.
Examination technique - Points to look for;
Too many students neglect to answer questions like this. As there are no lines to write on they don't realize they have be asked to write the answer above.

b) i) Which process is the equation for fermentation?
Answer - Process 1   **1**

     ii) State two essential conditions for fermentation.
Examination technique - Points to look for;
State *is the command word for recall and write a fact.*
Answer -   Condition 1 **Temperature 36-37 ºC**   **1**
                      Condition 2 **Yeast / Pressure 1 atm / absence of oxygen**   **1**

     iii) Give a use for the ethanol produced by fermentation.
Answer - Alcoholic drinks   **1**

c) i) State two essential conditions for the catalytic hydration of ethene.
Examination technique - Points to look for;
State *is the command word for recall and write a fact.*
Answer -   Condition 1 **Temperature 250-450 ºC**   **1**
                      Condition 2 **Pressure 60-70 atm / Phosphoric acid catalyst**   **1**

     ii) Give a use for the ethanol produced by the catalytic hydration of ethene.
Answer - Solvents   **1**

d) Suggest two reasons why countries like Cuba manufacture their ethanol by fermentation rather than the catalytic hydration of ethene.
Examination technique - Points to look for;
When suggest *is the command word,* you are not expected to know the answer,
but to be able to work it out based on knowledge and understanding of material you have been taught.
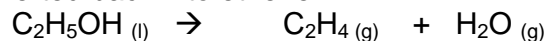**Answer -**   **Cuba doesn't have access to crude oil to make ethene.**   **1**
                   The glucose can be made from sugar cane a renewable source.   **1**

e) Ethanol can be converted back into ethene
                  $C_2H_5OH_{\,(l)}$ $\rightarrow$ $C_2H_{4\,(g)}$ + $H_2O_{\,(g)}$
   i) State the type of reaction used.
Examination technique - Points to look for;
State *is the command word for recall and write a fact.*
Answer -   **Dehydration**   **1**

   ii) State two conditions used for the reaction.
Examination technique - Points to look for;
State *is the command word for recall and write a fact.*
Answer -   **Aluminium oxide / high temperature**   **2**

f) i) Calculate the volume of ethene gas, measure at room temperature and pressure (rtp), that can be formed from 322 kg of ethanol, C_2H_5OH.
(The molar volume of any gas = 24 dm^3 at rtp).
Examination technique - *Points to look for;*
Calculate *is the command word for -* Use the numbers given. Show your working.
As with all moles questions you should at least turn mass into moles.
Take care! The mass is in kg and must be converted to g.
As the question has [3] marks you will need to do three things.

Answer – Convert mass in kg to mass in g.   322 kg = 322 000g
RFM Ethanol = 46
Convert mass into moles   moles = 322000 / 46 = 7000 moles   1
Use the balanced equation to find the moles of ethene (1:1 ratio)
Moles ethene formed = 7000   1
Convert moles to volume of gas = moles x 24 = 7000 x 24 = 168000 dm^3 1

ii) Use the answer from part i) to calculate the percentage yield if 42000 dm^3 of ethene is formed from 322 kg of ethanol at rtp.
Examination technique - *Points to look for;*
% yield cannot be over 100%.
If your calculation gives an answer over 100% you have made an error.

**Answer – % yield = actual / theoretical = 42000 / 168000 = 25%   1**

g) Ethene can be used to form an important monomer $HOCH_2CH_2OH$.
Draw the polymer formed by the monomers below, showing the structure of the repeat unit.
Examination technique -
When drawing polymers make sure the molecule has continuation lines (outside of the square brackets).
If in doubt use the water lassoing method.

Answer -
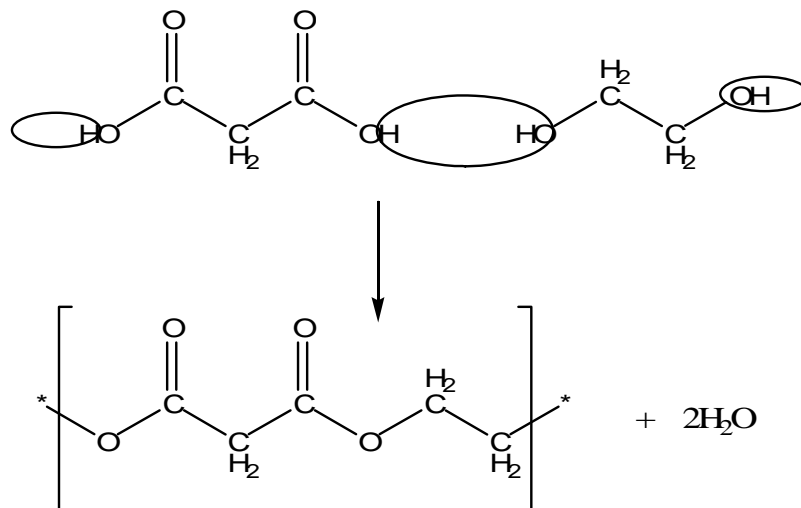
**Middle link   1   Continuation lines 1   Repeat unit   1**

Total 20 marks

4.   Magnesium is extracted by electrolysis of molten magnesium chloride.

a)   Write equations for the processes which occur at the anode and cathode.
      Examination technique -
      Although the question doesn't specifically say write a balanced symbol equation
      that is what the examiner wants.

Answer - Cathode Mg^{2+} + $2e^-$ →   **Mg**

           Anode $2Cl^-$ - $2e^-$ → Cl_2
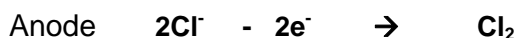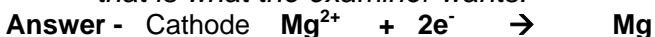
Correct formulae of products	**1 mark**
Correct products at anode + cathode	**1 mark**
Correct charge on both ions	**1 mark**
Balancing	**1 mark**

b)   State one difference between the way in which current is conducted through molten
      magnesium chloride, and the way in which it is conducted through a metal wire.
      Examination technique
      State is the command word for recall and write a fact.

Answer –   **when molten conduction is caused by mobile ions carrying charge. 1**
        In a wire conduction is caused by mobile electrons carrying charge. 1

c)   Explain why magnesium cannot be extracted from the electrolysis of magnesium
      chloride solution.
      Examination technique - Points to look for;
      Explain is the command word for including some scientific basis for your answer.

Answer -   Magnesium is a reactive metal / magnesium ions are too stable   **1**
        Hydrogen will form at the cathode instead of the magnesium occurs.   **1**

d)   Calculate the mass of magnesium produced in one hour when a current of 200 amps
      flows. (One faraday is 96000 coulombs).
      Examination technique - Points to look for;
      Calculate is the command word for - Use the numbers given. Show your working.

Answer –   Charge carried = Q = I x t = 200 x 60 x 60 = 720000 coulombs   **1**
        Time must be in seconds (not hours)
        Moles of electrons flowing = 720000 / 96000 = 7.5
        Moles of Mg formed = moles of electrons / 2 = 7.5 / 2 = 3.75   **1**
        (mole ratio 1:2 from balanced equation)
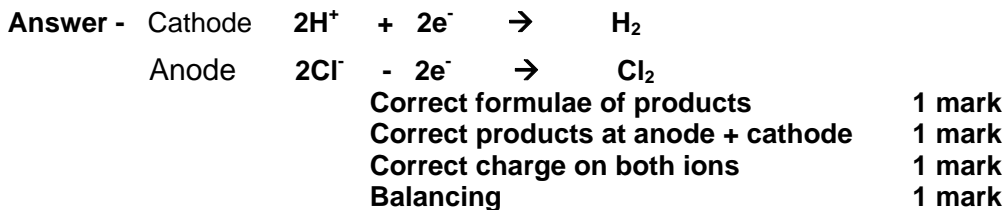   **Mass Mg = moles x RFM = 3.75 x 24 = 90 g**   **1**

Total 11 marks

5. Brine, sodium chloride solution, is an important material for the manufacture of chlorine by electrolysis.

a) Write equations for the processes which occur at the anode and cathode during the electrolysis of brine.
    Examination technique -
    Although the question doesn't specifically say write a balanced symbol equation that is what the examiner wants.

Answer - Cathode $2H^+ + 2e^- \rightarrow H_2$

Anode $2Cl^- - 2e^- \rightarrow Cl_2$

Correct formulae of products	**1 mark**
Correct products at anode + cathode	**1 mark**
Correct charge on both ions	**1 mark**
Balancing	**1 mark**

b) Explain how the electrolysis products are prevented from reacting together in the electrolysis equipment.
    Examination technique - *Points to look for;*
    Explain *is the command word for including some scientific basis for your answer.*

Answer – **A membrane is placed between the electrodes.** **1**
Prevents hydroxide ions moving to anode (reacting with Cl₂) **1**

c) i) Describe a test to show the presence of bromide ions in a sample of sea water.
    Examination technique - *Points to look for;*
    Explain *is the command word for including some scientific basis for your answer.*

Answer - **Add silver nitrate solution** **1**
Cream ppt forms / AgBr / Silver bromide forms **1**

ii) Sea water can be used to make the brine. It contains many a significant amount of halide ions.

Explain why the test for bromide ions carried out on sea water would not be reliable.
    Examination technique - *Points to look for;*
    Explain *is the command word for including some scientific basis for your answer.*

Answer - **Other halide ions react** **1**
Other ppts form / difficult to see the cream ppt **1**

Total 10 marks

6. A titration was carried out using 20.00 cm^3 samples of dilute sulphuric acid and sodium hydroxide solutions.
The results are shown in the table.

	1st titration	2nd titration	3rd titration
2nd burette reading	15.00	12.30	14.70
1st burette reading	2.30	0.10	2.50
Total volume of NaOH used	12.70	12.30 – 0.10 **= 12.20**	14.70 – 2.50 **= 12.20**

a) Complete the table.
Examination technique - Points to look for;
Too many students neglect to answer questions like this. As there are no lines to write on they don't realize they have be asked to write the answer above.
Make sure your answer is to the same level of accuracy as the other results in the table. i.e. 12.20 and not just 12.2.

2

b) Using the results in the table, explain why it was necessary to carry out three titrations.
Examination technique - Points to look for;
***Explain** is the command word for including some scientific basis for your answer.*

Answer – Inaccurate results can be ignored. / improves accuracy   1
Results too far apart / obtain results within 0.1 cm^3 1

c) State two pieces of glass apparatus (other than a burette) needed to carry out a titration.
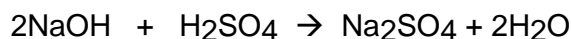*Examination technique*
***State** is the command word for recall and write a fact.*

Answer – pipette and conical flask   2

d) The equation for the reaction is

$$2NaOH \;+\; H_2SO_4 \;\rightarrow\; Na_2SO_4 + 2H_2O$$

The concentration sodium hydroxide (NaOH) solution used in the titration is 0.2 mol dm^{-3}.

Using the results from the 3rd titration, calculate the concentration in mol dm^{-3} of the dilute sulphuric acid.
Examination technique - Points to look for;
***Calculate** is the command word for -* Use the numbers given. Show your working.
As the question has [4] marks you will need to do four things.

Answer – Converts volumes from cm^3 to dm^3 1
Moles NaOH = Volume (in dm^3) x conc = 12.2 / 1000 x 0.2 = 0.00244 moles   1
Moles H_2SO_4 = Moles NaOH / 2 (Mole ratio 1:2) = 0.00244 / 2 = 0.00122 moles   1
Conc H_2SO_4 = Moles / Volume (in dm^3) = 0.00122 / 20 /1000 = 0.061 mol dm^3 1
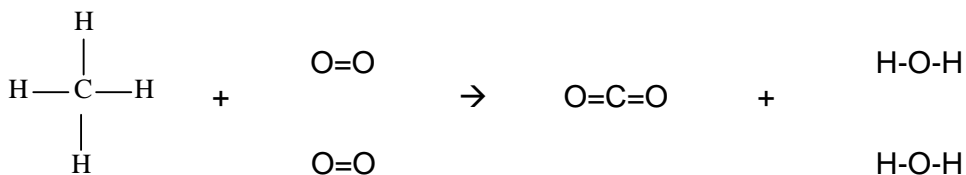
Total 10 marks

7. a)   When methane is burnt heat energy is released into the surroundings.
        What name is given to this type of reaction?
Answer –   Exothermic   **1**

   b)   The reaction between methane (CH_4) and oxygen (O_2) which takes place
        during burning produces is represented using the display formulae below.

$$
\begin{array}{c}
\text{H} \\
| \\
\text{H}-\text{C}-\text{H} \\
| \\
\text{H}
\end{array}
\quad + \quad
\begin{array}{c}
\text{O=O} \\[1em]
\text{O=O}
\end{array}
\quad \rightarrow \quad
\text{O=C=O}
\quad + \quad
\begin{array}{c}
\text{H-O-H} \\[1em]
\text{H-O-H}
\end{array}
$$

   i)   Name two different bonds which are broken during the reaction.
Answer –   C-H   **1**
           O=O   **1**
   ii) Which two bonds are made during the reaction?
Answer –   O-H   **1**
           C=O   **1**
   iii) Calculate the overall energy change for the reaction between methane and oxygen.
        The bond energies (in kJ mol^{-1}) are C-H: 435 , O=O: 497 , C=O: 803 , H-O: 464)
        Examination technique - *Points to look for;*
        Calculate *is the command word for* - Use the numbers given. Show your working!
Answer –   Bonds Broken   = 4 x C-H + 2 x O=O
                         = 4 x 435 + 2 x 497 = 1740 + 994 = 2734   **1**

           Bonds Formed = 2 x C=O   + 4 x O-H
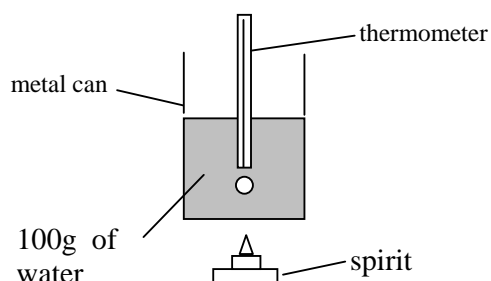   **= 2 x 803 + 4 x 464 = 1606 + 1856 = 3462**   **1**
           Energy change = Broken – Formed = 2734 – 3462 = -728 kJ mol^{-1}
                                                                                    Value 1
                                                                                    Units 1

                                                                          Total 9 marks

8. Look at the diagram. It shows the apparatus used to calculate the energy released when fuel is burnt.

The table below shows the results when 1.0 g of each fuel is burnt.

fuel	temperature of water at start	temperature of water at end
ethanol	$20^{\circ}C$	$40^{\circ}C$
paraffin	$19^{\circ}C$	$58^{\circ}C$
petrol	$21^{\circ}C$	$42^{\circ}C$

a)   Which fuel released the least amount of heat energy?
Answer –   Paraffin   1
Explain your answer
Examination technique *- Points to look for;*
Explain *is the command word for including some scientific basis for your answer.*
Answer –   Highest temperature rise   1

b)   Calculate the energy transferred when 1.0 g of ethanol burns.
(The specific heat of capacity of water is 4.2 $J^{-1}g^{-1}$ $^{\circ}C$).
Examination technique *- Points to look for;*
Calculate *is the command word for -* Use the numbers given. Show your working!
Answer –   Energy = mass of water x c x ∆T   1
Energy =   100 x 4.2 x 20 = 8400 J   Value 1
Units 1

c)   Calculate the enthalpy change, in kJ mol^{-1}, when 2.0 g of ethanol, C_2H_5OH, burns.
Give your answer the correct sign.
(Relative atomic masses: O = 16; H = 1; C = 12)
Examination technique *- Points to look for;*
Calculate *is the command word for -* Use the numbers given. Show your working!
Answer –   Enthalpy Change ∆H = Energy / moles
RFM Ethanol = 46   1
Moles of ethanol = 1 / 46 = 0.0217   1
∆H = Energy / moles = 8400 / 0.217 = 38710 J mol^{-1}
∆H = - 387 kJ mol^{-1} Value 1
Negative value 1

Total 9 marks