K.C.S.E YEAR 2011
PAPER 1 (MARKING SCHEME)

1. (a) Fermentation

(b) Ethanol forms hydrogen bonds with water while Ethane does not / remains molecular / only weak Vanderwaals forces (intermolecular force. Ethane is non polar while Ethanol is polar.

2. (a) oe 1

\[
\begin{array}{cccccc}
\text{t}/2 & \text{t}/2 & \text{t}/2 & \text{t}/2 & \text{t}/2 & \\
50g & 25g & 12.5g & 6.25g & 3.125g & 1.5625g
\end{array}
\]

Or \[\text{NW} = 0.4(\frac{1}{2})^n\]
\[\text{NW} = 50 \times (\frac{1}{2})^5 = 1.5625g\]

(b) Instant / cause death
Cause cancer
Cause gene mutation

3. (i) Heat the mixture to sublime the NH₄Cl
Add water to dissolve the NaCl or copper (II) oxide does not dissolve. Filter and evaporate the filtrate to obtain sodium chloride.

(ii) Add water to the mixture to dissolve NH₄Cl and NaCl. Cuo does not dissolve. Filter and evaporate the filtrate to dryness. Heat to sublime NH₄Cl. NaCl remains behind.

(iii) Add water to dissolve. Filter to obtain NaCl & NH₄Cl. Cuo does not undergo traditional crystallization i.e. concentrate and cool. NaCl crystallizes first.

4. (a) NaNO₂ reacts with NH₄Cl to form NH₄NO₂. The NH₄NO₂ decomposes to form N₂ gas. Or
\[\text{NaNO}_2 (s) + \text{NH}_4\text{Cl} \rightarrow \text{NaCl (s)} + \text{NH}_4\text{NO}_2(s)\]
\[\text{NH}_4\text{NO}_2(s) \rightarrow \text{N}_2 (g) + 2\text{H}_2\text{O (l)}\]

(b) Provides inert atmosphere in certain industrial processes e.g. packaging / used in light bulbs.
Storage of semen (for artificial insemination)
Drilling of oil to provide inert atmosphere
Dilute effect of O₂ gas
Fill aircraft tyres
Fill empty oil tankers
Provide inert atmosphere during welding

5. (a) 2:\8 / 2.8 / 2,8 / 2:8 / 2 8 deny 2-8

(b) 3\text{v (s)} + \text{Q}_2 (g) \rightarrow \text{V}_3\text{Q}_2 (s)
Or \[3\text{Mg (s)} + \text{N}_2 (g) \rightarrow \text{Mg}_3\text{N}_2(s) \text{ or } \text{N}_2\text{Mg}_3\]
(c) T has a lower ionization energy than M or M higher than T. 
T has an extra energy level and hence e’s are less attracted by the positive nucleus M has 
higher e’s are more attracted.

6. \[
\frac{P_1V_1 + P_2V_2}{T_1} \frac{P_1V_1 x T_2}{T_1 P_2} = \frac{98.648.5 x 0.15 x 273}{293 x 101,3285}
\]

\[V_2 = 0.136 \text{dm}^3\] (go to minimum of 2d.p)

7. (a) \[2 \text{ Pb (No}_3\text{)}_2 (s) \rightarrow 2 \text{PbO (s) + 4 No}_2 (g) + \text{O}_2 (g)\]

(b) Moles of \(\text{No}_2\) gas = \[\frac{0.29}{24} = 0.01208\]
Moles of \(\text{Pb (No}_3\text{)}_2\) = \[\frac{1}{2} \times 0.01208 = 0.006\] or \[\frac{1}{2} \times \frac{0.29}{24} = 0.006\]
Mass of \(\text{Pb (No}_3\text{)}_2\) = \[0.006 \times 331 = 1.9998 \text{ g} / 1.986 \text{ g}\]

Or 2 moles \(\text{Pb (No}_3\text{)}_2\) \[4 \times 24 \text{ dm}^3 \text{ No}_2 (g)\]
\[
\frac{0.290 \times 2 \times 331}{4 \times 24} = \frac{0.290 \text{ dm}^3}{2g}
\]

8. (a) An acid that ionizes fully / dissimates fully / completely gives all the \(\text{H}^+\) ions

(b) Curves start at the same point. Curve of Hcl above ethanoic. Curve ethanoic below. Joining at some point.

9. It is expensive
It is explosive
It is difficult to store
10. (a) Greenish yellow / pale green colour of Cl₂ disappears
Brown solution / black solid is deposited

(b) Cl₂ (g) + 2 I⁻ (aq) → 2 Cl⁻ (aq) + I₂ (s)
Explanation: Iodine oxidation state changes from -1 to 0 hence oxidation while Cl₂ 0.5 changes from 0 to -1 hence reduction / increase is ON and decrease is ON or movement of electrons Cl₂ gains e’s where lose.

11. (a) Carbon (II) oxide is formed when fuel burns under limited oxygen / incomplete combustion of fuel.

(b) Carbon (IV) oxide / Co₂ – Sulphur (VI) oxide / So₃
Nitrogen (IV) oxide / NO₂
Sulphur (IV) oxide / So₂

12. (a) Small piece of sodium metal (pea size) with a lot of water
   Perform the experiment wearing goggles.

(b) Electrolysis

(c) Manufacture of paper (soften)
   Manufacture of soaps and detergents
   Fractional distillation of liquid air
   Extraction of aluminium metal
   Manufacture of bleaching agents  e.g. NaOCl. paper, textiles, oil refinery
   Making herbicides on weed killers
   It is boiled with
   Textile industry to soften

13. Deliquescent substance absorbs water from the atmosphere to form a solution / dissolve.
    Efflorescent substance loses water of crystallization to the atmosphere.

14. P is an alkanol / alcohol
    The alkanol reacts with sodium metal to produce the colourless gas / H₂ gas

15. (a) Ca(st)₂ or Mg(st)₂
    Ca(st)₂ or Mg(st)
    Ca(C₁₇H₃₅COO)₂ or Ca (c₁₇H₃₅COO)₂

(b) Ca²⁺ (aq) + CO₃²⁻ (aq) → CaCO₃(s)
    Or Mg²⁺ (aq) + CO₃²⁻ (aq) → MgCO₃ (s)

16. By adding conc H₂So₄ as a catalyst / adding H₂So₄

17. (a) (i) Black solid is deposited. Lead (II) sulphide (Pbs) is formed
    Bubbles are produced and seen. Gas is produced which is H₂S passes through the solution.
The indicator turns red/pink/orange. This is due to excess H₂S and/or SO₂ gas (formed are acidic).

(b) The experiment should be done in a fume chamber or in open air

18. (a) At room temperature cold and dilute sodium hydroxide

(b) Used in sterilizing of water / treatment of water / killing germs
   Used as a bleaching agent
   Antiseptic for mouth wash
   Fungicide

19. Plot A (Urea)
   \[ \text{% of } N₂ \text{ in } (\text{NH}_4)_2 \text{SO}_4 = \frac{28 \times 100}{132} = 21.2\%. \text{ Amount in } 50\text{kg} = \frac{21.2 \times 50}{100} = 10.6 \text{ kg} \]

Plot B ((NH₄)₂SO₄
   \[ \text{% of } N₂ \text{ in urea} = \frac{28 \times 100}{60} = 46.7\%. \text{ Amount in } 30\text{kg} = \frac{46.7 \times 30}{100} = 14.01 \text{ kg} \]

Plot B is more enriched with N₂ since it has a higher amount of N₂ than Plot A.

20. Add universal indicator to match the colour of solution with pH chart and read the value using a pH meter.
   Add water to dissolve the anti-acid powder. Dip electrodes directly into solution and read the pH from the screen.

21. (a) Sulphur / Phosphorous / oxygen
   (b) Carbon atoms in graphite are arranged in layers of hexagon which are held by weak van der waals forces. The layers slide over each other when force is applied.

22. (a) Bromite
   At room temp (25°C) Bromite is liquid since its M.P and B.P is between -7°C and 59°C /58.8°C. Room temp is between M.P and B.P
   (b) Atomic mass / molecular mass / molecule of iodine is higher than that of Cl₂
   Van der waals forces are stronger in I₂ than Cl₂ hence iodines b.p is highest than that of Cl₂

23. \[
\text{CS}_2 (l) \\
\text{DH} = +117.0 \text{Kj/mol}
\]
   \[
\text{C (s) + 2s (s)} \\
\]
24. (a) Y
   (b) Y and Z. They have the same number of protons (8) but different atomic masses/mass numbers/no of neutrons.
25. (a) When gases combine together at constant temp and pressure they do so in volumes which bear a simple ratio to each other, and to the volumes of the products if gaseous.

   (b) C_{2}H_{x} (s) + 3O_{2} (g) → 2CO_{2} (g) + 2H_{2}O (g)

<table>
<thead>
<tr>
<th>Vol</th>
<th>10</th>
<th>30</th>
<th>20</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mol</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Ratio</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Therefore X = 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

26. (a) (i) 10.352 – 10.240 = 0.112g
   (ii) 10.400 – 10.352 = 0.048g or (10.400 – 10.240) – 0.112 = 0.048g

(b) Elements
   - M
   - O

<table>
<thead>
<tr>
<th>Mole ratio</th>
<th>0.112</th>
<th>0.048</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>56</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>0.0020</td>
<td>0.0030</td>
</tr>
</tbody>
</table>

| Simplest Ratio | 2 | 3 |

<table>
<thead>
<tr>
<th>E.F</th>
<th>M_{2}O_{3}</th>
</tr>
</thead>
</table>

27. (a) Zinc blende or calamite

(b) 2 ZnO (s) + C (s) → 2Zn (s) + CO_{2} (g)
   ZnO (s) + C (s) → Zn (s) + CO (g)
   3ZnO (s) + 2C (s) → 3Zn (l) + CO_{2} (g) + CO (g)
   ZnO (s) + CO (s) → Zn (s) + CO (g)

(c) Dry cells
   - Galvanizing iron sheets
   - As electrodes
   - Making of alloys e.g. brass

28. (a) Single covalent bonding/covalent
       Dative/co-ordinate bonding

   (b) 7 bonds x 2 = 14 electrons

29. (a) Mg metal has free/mobile delocalized electrons which may carry the current.

   (b) It has (Mg^{2+} and Cl^-) ions which are free/mobile to move. Accept if ions only. Not necessarily free/mobile.

30. Add aqueous ammonia until in excess.
    A formation of white ppt which dissolves in excess shows presence of zinc ions.
Add aqueous acidified \( \text{Ba(NO}_3\text{)}_2/\text{BaCl}_2/\text{Pb(NO}_3\text{)}_2 \).

Formation of a white ppt shows presence of \( \text{SO}_4^{2-} \) ions.

31. Alkaline earth metals
1. The flow chart below shows some of the processes involved in large scale production of sulphuric (IV) acid. Use it to answer the question that follow.

(a) Describe how oxygen is obtained from air on a large scale (3 marks)
   Purity to remove impurities, bubble through NaOH/KOH to remove CO₂, reduce the temp, to remove water vapor compress to liquefy the residual air, then fractional distillation to obtain oxygen at \(-183^\circ\text{C}\)

(b) (i) Name substance A.
   Concentrated sulphuric (vi) acid

   (ii) Write an equation for the process that takes place in the absorption chamber (1 mark)
   \[\text{SO}_3(\text{g}) + \text{H}_2\text{SO}_4(\text{l}) \rightarrow \text{H}_2\text{SO}_7(\text{l})\]

(c) Vanadium (V) oxide is a commonly used catalyst in the contact process.

(d) Name another catalyst which can be used for this process. (1 mark)
   Platinum/platinum asbestos

(e) Give two reasons why vanadium (V) oxide is the commonly used catalyst
   (2 marks)
   - It is cheap/cheaper
   - Not easily poisoned/action stopped by impurities

(f) State and explain the observation made when concentrated sulphuric (VI) acid is added to crystals of copper (II) sulphate in a beaker. (2 marks)
   Turns blue & white. Forms white powder sulphuric (VI) acid dehydrates copper(II) sulphate crystals/ remove water of crystallization.

(e) The reaction of concentrated sulphuric (VI) acid with sodium Chloride produces hydrogen chloride gas. State the property of concentrated sulphuric (VI) acid illustrated in this reaction.
   It is less volatile/volatility / involatile

(f) Name four uses of sulphuric (VI) acid. (2 marks)
   Manufacture of sulphate fertilizer/superphosphate fertilizer/production of Ray on making dyes/used in car batteries/ As an electrolyte manufacture of sospalhes detergents/cleaning of metals manufacture of paint HCL/HNO₃/Oleum.
   As a drying agent, as dehydrating agent/manufacture of nylon AL₂SO₄/ALCOH₃/sulphate drugs, pigments

2. The set-up below was used by student to investigate the products formed when aqueous copper (II) chloride was electrolyzed using carbon electrodes.

(a) (i) Write the equation for the reaction that takes place at the cathode. (1 mark)
   \[\text{CU}^{2+}_{(\text{G})} + 2\text{E} \rightarrow \text{CU}_{(\text{S})}\]

   (II) Name and describe a chemical test for the product initially formed at the anode when a highly concentrated solution of copper (II) chloride is electrolyzed. (3 marks)
   Chlorine gas
   Moist blue litmus paper/fresh or moist coloured petals/ change from blue to white/

   (III) How would the mass of the anode change if the carbon anode was replaced with copper metal? Explain. (2 marks)
   Decrease the anode is not inert so 1+ dissolves/reacts/iodine oxidized
(b) 0.6 g of metal B were deposited when a current of 0.45 A was passed through an electrolyte for 72 minutes. Determine the charge on the ion of metal B.
(Relative atomic mass of B=59, 1 Faraday = 96 500 coulombs) 
(3 marks)
(c) The electrode potentials for cadmium and Zinc are given below:
Cd2+ (aq) + 2e ___ Cd (s) ; Eº = - 0.4v
Zn2+ (aq) + 2e ___ Zn(s) ; Eº = - 0.76v
Why is it not advisable to store a solution of cadmium nitrate in a container made of Zinc.
(2 marks)
Zinc reacts with cadmium ions/displaces/cadmium ions/Zinc container dissolve because Zinc is more reactive/Electropositive than calcium or calculate
Zn is a stronger reducing /Zinc is oxidized
3. (a) Ethanol can be manufactured from ethane and steam as shown in the equation below:
C2H4 (g) + H2O (g) _____ CH3CH2OH (g)
Temperature and pressure will affect the position of equilibrium of the above reaction.
Name the other factor that will affect the position of equilibrium of the above reaction.
Concentration/volume
(b) The data table below was recorded when one mole of ethane was reacted with excess steam.
The amount of ethanol in the equilibrium mixture was recorded under different conditions of temperature and pressure.

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Pressure (Atm)</th>
<th>Amount of ethanol at Equilibrium (Moles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>300</td>
<td>50</td>
<td>0.40</td>
</tr>
<tr>
<td>300</td>
<td>60</td>
<td>0.46</td>
</tr>
<tr>
<td>300</td>
<td>70</td>
<td>0.55</td>
</tr>
<tr>
<td>250</td>
<td>50</td>
<td>0.42</td>
</tr>
<tr>
<td>350</td>
<td>50</td>
<td>0.38</td>
</tr>
</tbody>
</table>

(i) State whether the reaction between ethane and steam is exothermic or endothermic.
Explain your answer.
(3 marks)
Exothermic I increased in temp at constant pressure. The amount of ethanol formed at eqm decreases and vise versa decrease in temp at
(ii) State and explain one advantage and one disadvantage of using extremely high pressure in this reaction.
(2 marks)
I. Advantage
Amount of ethanol increases, pressure favours the side with less molesle products/eqm shifts to the right/forward rxn is favoured.

II. Disadvantage
It would be expensive/uneconomical. The cost would go up or maintaining / high pressure is costly. Explosion can occur hence costs will go up
It’s costly to maintain high pressure

(c) In an experiment to determine the rate of reaction between calcium carbonate and hydrochloric acid, 2g of calcium carbonate were reacted with excess 2 M hydrochloric acid. The volume of carbon (IV) oxide evolved was recorded at regular intervals of one minute for six minutes. The results are shown in the table below.

<table>
<thead>
<tr>
<th>Time (minutes)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume of carbon (IV) oxide (cm³)</td>
<td>170</td>
<td>296</td>
<td>405</td>
<td>465</td>
<td>480</td>
<td>480</td>
</tr>
</tbody>
</table>

4. Plot a graph of time in minutes on the horizontal axis against volume of carbon (IV) oxide on the vertical axis.

(3 marks)

5. Determine the rate of reaction at 4 minutes.

(2 marks)

Drawing tangent
Rate = \frac{Y_2-Y_1}{X_2-X_1} = \text{Ans CM}^3/\text{Min}

6. (a) When excess calcium metal was added to 50 cm³ of 2 M aqueous copper(II) nitrate in a beaker, a brown solid and bubbles of gas were observed.

7. Write two equation for the reactions which occurred in the beaker.

\begin{align*}
\text{Ca(s) + Cu}^{2+}(aq) \rightarrow & \text{Ca}^{2+} (aq) + \text{Cu(s)} \\
\text{Ca(s) + Cu(NO}_3)_2 (aq) \rightarrow & \text{Ca(NO}_3)_2 (aq) + \text{Cu(s)} \\
\text{Ca(s) + 2H}_2\text{O(l)} \rightarrow & \text{Ca(OH)}_2 (aq) + \text{H}_2 (g)
\end{align*}

8. Explain why it is not advisable to use sodium metal for this reaction.

The reaction is highly explosive/highly exothermic because sodium is more reactive than calcium.

Na is more electro positive than calcium.

(c) Calculate the mass of calcium metal which reacted with copper (II) nitrate solution. (relative atomic mass of Ca=40)

(2 marks)

\begin{align*}
\text{No of moles of} & = \frac{50}{1000} \times 2 \\
\text{Copper (ii) nitrate} & = 0.1 \text{ moles} \\
\text{Ratio} & = 1:1 \\
\text{Moles of Ca} & = 0.1 \\
\text{Mass of Ca} & = 0.1 \times 40 \\
& = 4 \text{g}
\end{align*}

(d) The resulting mixture in (a) above was filtered and aqueous sodium hydroxide added to the filtrate drop wise until in excess. What observations were made?

A white ppt is formed which is insoluble in excess

(e) (i) Starting with calcium oxide, describe how a solid sample of calcium carbonate can be prepared.
Add Cao to dil HNO₃/HCl/H₂O. Add Na₂CO₃/K₂CO₃/NH₄CO₃/CO₂ a solution filter out CaCO₃ as residue.

9. Name one use of calcium carbonate.
   Preparation of CO₂ in the laboratory
   Manufacture of Na₂CO₃ in s process
   Manufacture of CaO

10. (a) Other than their location in the atom, name two other differences between an electron and a proton.
    (2 marks)
    - Electron is negatively charged while proton is positively charged
    - Electron has a mass of units while proton has a mass of unit
    - Mass of proton is bigger that that of electron.

(b) The table below gives the number of electrons, protons and neutrons in particles A, B,C,D,E,F and G

<table>
<thead>
<tr>
<th>Particular</th>
<th>Protons</th>
<th>Electrons</th>
<th>Neutrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>B</td>
<td>10</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>C</td>
<td>12</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>D</td>
<td>6</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>E</td>
<td>13</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>F</td>
<td>17</td>
<td>17</td>
<td>18</td>
</tr>
<tr>
<td>G</td>
<td>8</td>
<td>10</td>
<td>8</td>
</tr>
</tbody>
</table>

(i) Which particle is likely to be a halogen? (1 mark)
   - F

(ii) What is the mass number of E? (1 mark)
    - 27

(iii) Write the formula of the compound formed when E combines with G. (1 mark)
    - E₂G₃/AL₂O₃

(iv) Name the type of bond formed in (iii) above. (1 mark)
    - Ionic bond/electrovalent

(v) How does the radii of C and E compare? Give a reason. (2 marks)
    - E has smaller atom in radius that C or Vice versa
    - E has more protons that C/nuclear attract stronger

(vi) Draw a dot (.) and cross (x) diagram for the compound formed between A and F.

(vii) Why would particle B not react with particle D? (2 marks)
    - B is inert/has stable configuration/has octet electron in the outermost/belong groups of periodic table /has noble gas configured

11. (a) Study the flow chart below and answer the questions that follow.

(i) I what observation will be made in Step 1? (1 mark)
   Acidified KMno₄ is decolorized/change from purple to colorless.

II Describe a chemical test that can be carried out to show the identity of Compound C. (2 marks)
   Add carbonate/HCO₃, effervescence is observed
   Add a mixture of alkanol and conc H₂SO₄ and warm a pleasant /smell occurs
(ii) Give the names of the following: 
I E polyethene 
II substance D sodium ethoxide 

(iii) Give the formula of substance B. 
\[ \text{CH}_2\text{BrCH}_2\text{Br} / \text{H-C-C-H/C}_2\text{H}_4\text{Br}_2 \] 

(iv) Name the type of reaction that occurs in: 
I step (II) dehydration 
II Step (IV) hydrogenation/Addition reaction 

(v) Give the reagent and conditions necessary for Step (VI). 
Reagent: Methanoic Acid/H COOH 
Conditions: concentrated sulphuric acid and warm 

(b) (i) Name the following structure. 
Hexan – I – OI 

12. Draw the structure of an isomer of pentene. 
\[ \text{CH}_3 – \text{CH} = \text{C-CH}_3 – \text{CH}_3 \] 

13. (a) What is meant by molar heat of combustion? 
Amount of heat liberated/energy change when one mole of a substance is burnt in excess oxygen 
(b) State the Hess’s Law 
Heat absorbed/evolved in a chemical change is the same regardless of the route taken 
(c) Use the following standard enthalpies of combustion of graphite, hydrogen and enthalpy of formation of propane. 
(i) Write the equation for the formation of propane. 
\[ 3\text{C(s)} + 4\text{H}_2 (g) \rightleftharpoons \text{C}_3\text{H}_8 (g) \] 
(ii) Draw an energy cycle diagram that links the heat of formation of propane with its heat of combustion and the heats of combustion of graphite and hydrogen. 
(iii) Calculate the standard heat of combustion of propane. 
\[ \text{DHc (C}_3\text{H}_8) = \text{HO}_4 + (3x-393) + (4x-286) \] 
\[ = -2219 \text{ KJ/MO1} \] 

(d) Other than the enthalpy of combustion, state one factor which should be considered when choosing a fuel. 
- Cost 
- Availability 
- Storage 
- Effect on environment 
- Ease of transportation 

(e) The molar enthalpies of neutralization for dilute hydrochloric acid and dilute nitric (V) acid are -57.2kJ/mol while that of ethanoic acid is -55.2kJ/mol. Explain this observation. 
(2 marks) 
- Ethanoic acid is a weak acid some heat is used to ionize before neutralization occurs. 
- Ethanoic acid dissociates partially than another