Question 1

(a) The atomic numbers of elements X, Y and Z are 14, 20 and 17 respectively.
    (i)   What is atomic number?
    (ii)   Write the electronic structures of X, Y and Z.
(b) Z can combine with both X and Y to form compounds.
    (i)   Use valency electrons to explain briefly how the atoms X and Z, Y and Z form compounds.
    (ii)   Write the structural formula of the compound formed when X combines with Z.
(c) State two properties of the compounds formed between;
    (i)   X and Z
    (ii)   Y and Z

Question 2

(a) (i) Define the term rusting.
    (ii) State chemical name of rust and write its formula
(b) Describe an experiment to show that water is a necessary condition for rusting to take place.
(c) Give any two methods that can be used to prevent rusting and explain how they are able to prevent it.
(d) Outline two disadvantages of rusting.

Question 3

When hard water is treated with soap, scum is formed.

(a) State the chemical name of;
    (i)   Soap
    (ii)   Scum
(b) (i) Identify two ions that lead to the formation of scum when soap is used to clean fabrics.
    (ii) Write equation of reaction leading to the formation of scum.
(c) (i) Identify one compound that can be used to break the hardness in water.
    (ii) Write equation to show how the compound named in (c)(i) breaks down the hardness in water.
(d) (i) Distinguish between hard water and soft water.
    (ii) State two sources of;
        • Hard water
        • Soft water
(e) Give one advantage of hard water.

Question 4

(a) Briefly describe how a pure dry sample of iron(II) sulphate heptahydrate crystals, $FeSO_4.7H_2O$ can be prepared in the laboratory from iron(II) oxide.

(b) State what is observed when ;
   (i) Crystals of iron(II) sulphate, $FeSO_4.7H_2O$ are heated strongly. Write equations for the reaction(s) that occur.
   (ii) Concentrated nitric acid is added to a solution of iron(II) sulphate.

(c) Describe a chemical test you would carry out to show that $FeSO_4.7H_2O$ solution contains sulphate ions.

Question 5

(a) Describe the structure of graphite.

(b) State two properties in which graphite differs from diamond.

(c) Graphite was heated in excess air and the gas given off passed through aqueous calcium hydroxide for a long time.
   (i) State what was observed.
   (ii) Write equation(s) for the reaction(s) that take place.

(d) Carbon monoxide reacts with iron(III) oxide according to the equation below.

$$Fe_2O_{3(s)} + 3CO_{(g)} \longrightarrow 2Fe_{(s)} + 3CO_{2(g)}$$

If excess carbon monoxide was passed over 3.5g of heated iron(III) oxide, calculate the volume of carbon dioxide evolved at s.t.p.

(Fe = 56, C = 12, O = 16; 1 mole of a gas occupies 22.4dm^3 at s.t.p)

Question 6

(a) Describe how a dry sample of oxygen gas can be prepared from sodium peroxide in the laboratory.

(b) Write an equation for the reaction leading to the formation of oxygen from sodium peroxide.

(c) state what is observed and write an equation for the reaction that takes place when a piece of burning sodium metal is lowered in a gas jar containing:
   (i) little oxygen
   (ii) excess oxygen

(d) The product in c(i) was dissolved in water, and a sample of the resultant solution was added dropwise until in excess to a solution containing cation **X**. A blue precipitate insoluble was observed.
   (i) identify **X**
   (ii) Explain what is observed when excess ammonia is added to a solution containing cation **X.**

(e) Write equation for the reaction that takes place when magnesium is burnt in oxygen.

(f) State two uses of oxygen gas.

Question 7

(a) (i) Name the process by which sulphur is extracted
    (ii) Describe briefly how sulphur is extracted by the process named in (a) (i)
    above
(b) Write equations to show how fuming sulphuric acid can be obtained from
    sulphur.
(c) Concentrated sulphuric acid was added to sugar crystals in a beaker.
    (i)   State what was observed.
    (ii)   Write the equation for the change that occurs.
    (iii)   Name the property of sulphuric acid exhibited in the change described
             in (c) (i) above.

Question 8

(a) Sulphur dioxide can be prepared in the laboratory using sodium sulphite.
    (i)   State the conditions for the reaction.
    (ii)   Explain how a dry sample of sulphur dioxide can be prepared in the
             laboratory from sodium sulphite.
(b) The flow diagram below shows a series of chemical reactions in order to
    prepare sulphuric acid from sulphur dioxide.

$$SO_{2(g)} \;+\; O_{2(g)} \xrightarrow{\quad X \quad} \boxed{A}$$

$$\downarrow Y$$

$$2H_2SO_{4(l)} \xleftarrow{\quad H2O \quad} H_2S_2O_{7\,(l)}$$
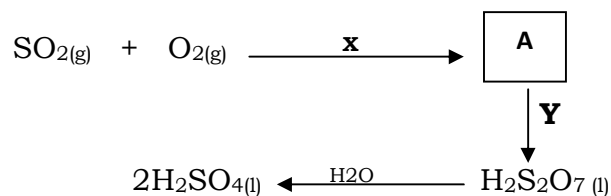
    (i)   Name the substances **X** and **Y**.
    (ii)   State two other conditions leading to the formation of substance **A**
             other than addition of **X**
(c) Explain the reaction of sulphur dioxide with acidified potassium dichromate.
(d) State one use of sulphur dioxide gas in the paper industry.

Question 9

A sample of hydrogen can be prepared in the laboratory using zinc and dilute
sulphuric acid in the presence of a catalyst.

(a) (i) Draw a diagram to show a set up of the apparatus that can be used to
    prepare a dry sample of hydrogen gas in the laboratory.
    (ii) Name the catalyst that can be used in this reaction.
    (iii) Write the equation for the reaction leading to the formation of hydrogen.
    (iv) State how hydrogen can be identified.
(b) Dry hydrogen was passed over heated lead(II) oxide.
    (i)   State what was observed.
    (ii) Write equation for the reaction that took place.
(c) Hydrogen burns in oxygen according to the following equation.
    $$2H_2(g) \;+\; O_2(g) \longrightarrow 2H_2O(l) \;+\; Heat$$

(i) Name one substance that can be used to identify the product of the combustion of hydrogen in oxygen.

(ii) State what would be observed if the reagent you have named in (c)(i) was used to identify the product.

(iii)Calculate the volume of oxygen that would burn in oxygen to produce 5720J of heat. (Molar heat of combustion of hydrogen = 286KJ/Mol; 1mole of a gas occupies 22.4dm³ at s.t.p)

Question 10

(a) Describe how a dry sample of ammonia gas can be prepared in the laboratory from ammonium chloride.

(b) State two conditions under which ammonia can react with oxygen and write equation in each case to show the reaction that takes place.

(c) The product in one of the reactions in (b) is used in the production of nitric acid on a large scale. Identify the product and write equation(s) to show how it is converted into nitric acid.

(d) Explain the reaction of nitric acid with copper.

Question 11

(a) (i) Define the term electrolysis
(ii) Give a reason why pure water does not conduct electricity whereas water containing a little dilute sulphuric acid does

(b) Draw a labeled diagram of the set up of apparatus that can be used to show that during electrolysis anions move to the anode whereas cations move to the cathode.

(c) Explain with aid of one suitable example in each case, how the selection of

the ion to be discharged at electrodes depends on the following factors
(i) position of metal or group in the electrochemical series.
(ii) concentration of the solution
(iii) Nature of the electrodes

Question 12

(a) An organic compound Q contains 52.17% carbon, 13.04% hydrogen and the rest being oxygen. 0.46g on vaporization occupied 224cm³ at s.t.p
(i) Determine the empirical formula of Q.
(ii) Calculate the molecular mass and hence the molecular formula of Q.

(b) Describe how Q can be prepared from maize grains.

(c) State one use of Q.

(d) (i) Write equation for the reaction leading to formation of ethene from Q.
(ii) State the condition(s) for the reaction in d(i) above.

Question 13

The scheme below was used to prepare soap.

Fat → NaOH$_{(aq)}$ / Boil **STEP I** → Solution of soap and → **STEP II** → Solid soap
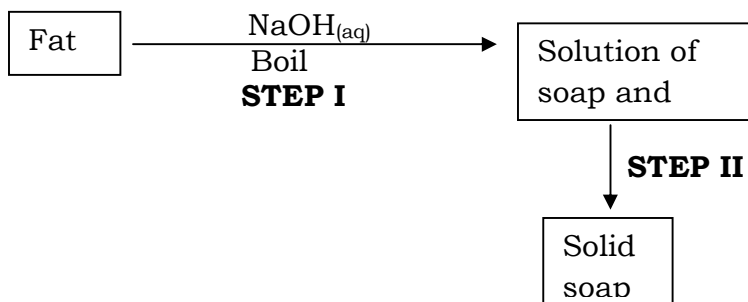
(a) What is meant by the term soap and state one example of soap.
(b) Name one chemical substance that can be added in step II and state the purpose of adding it.
(c) State one source of fat from which soap prepared.
(d) Briefly explain how soap can remove dirt from linen when linen is washed.
(e) When soap is used for washing using hard water, lathering does not occur immediately, when soapless detergent is used for washing in the same water, there is immediate lathering. Explain the observation.
(f) State one advantage and disadvantage of soap over soapless detergents.

Question 14

Ethene an alkene, undergoes polymerization to form Z.
(a)   (i) what is meant by the term polymerization?
     (ii) Write equation for the polymerization of ethene.
     (i)   Name product Z.
(b)   Distinguish between synthetic and natural polymer. In each case, give two examples.
(c)   State two advantages of synthetic polymers over natural polymers.
(d)   Distinguish between thermosetting plastic and thermo softening plastic and in each case, give one example.

Question 15

(a) What is meant by the term 'rate of a chemical reaction'?
(b) Explain how the following factors affect the rate of a chemical reaction.
     (i)   Temperature
     (ii)   Surface area
     (iii)   Concentration of reactants
(c) The table below shows the variation of volume of hydrogen gas collected at various time intervals when 2gm of zinc powder was reacted with excess 2M hydrochloric acid.

Time (**minutes**)	0	1	2	3	4	5	6	7	8
Volume of hydrogen /**cm³**	0	40	56	65	71	75	77	78	78

     (i)   Plot a graph of volume of hydrogen collected against time.
     (ii)   State why excess 2M Hydrochloric acid was used.

(iii)   From the graph, determine the rate of reaction at 2 minutes and at 5 minutes. Comment on the values of the rate obtained.

(iv)   Explain the shape of the graph in (i) above.

(d) If the experiment was repeated using zinc granules instead of zinc powder, sketch graphs on the same axes showing how rate of reaction would vary.

(e) Draw a labeled diagram to show how the rate of production of hydrogen gas can be determined.

Question 16

Iron metal can be extracted from its ore by the method of reduction.

(a) (i) Define the term 'ore'.
(ii) Name the chief ore from which iron can be extracted and write its chemical formula.
(iii) Name the major impurity in the ore.

(b) Describe with the aid of equations how;
(i)   Impure iron can be extracted from its ore using coke.
(ii)   The impurity can be removed using limestone.

(c) One of the bi products of extraction of iron is slag.
(i)   Write the chemical formula of slag.
(ii)   Give two uses of slag.

(d) Stainless steel is an alloy containing iron. What is the difference between stainless steel and iron?

Question 17

(a) Sodium metal is extracted by the electrolysis of molten sodium chloride to which calcium chloride has been added.
(i)   Give a reason for the addition of calcium chloride.
(ii)   Name the material that can be used as the cathode and another that can be used as the anode.
(iii)   Write equation for the reaction that take place at each electrode.
(iv)   Describe how the product at the cathode can be collected
(v)   Name one other element that can be extracted by a similar method.

(b) Name one place in Uganda where a plant for the extraction of sodium could be constructed. Give a reason for your answer.

(c) State what would be observed and write equation for the reaction that would take place when sodium metal;
(i)   Is dropped in a beaker of cold water.
(ii)   Is reacted with chlorine gas.

Question 18

(a) Define the term 'enthalpy of neutralization'.
(b) The table below shows the maximum temperature of the resultant solution formed when various volumes of 2M potassium hydroxide solution was added to $20cm^3$ portion of 2M nitric acid.

Volume of KOH (cm^3)	0	4	10	15	20	25	30	35
Volume of HNO_3 + KOH (cm^3)	20	25	30	35	40	45	50	55
Temperature (^0C)	22	25.5	29.2	32.8	35.6	31.8	27.8	23.8

Plot a graph of temperature against volume of potassium hydroxide.
(c) Using the graph, determine
   (i)   The volume of potassium hydroxide required to completely neutralize $20.0cm^3$ of 2M nitric acid.
   (ii)   Temperature of the resultant solution at the neutralization point
(d) Calculate the
   (i)   Number of moles of nitric acid used.
   (ii)   Molar enthalpy of neutralization of nitric acid. (SHC is $4.2Jg^{-1}K^{-1}$, density of the resultant solution is $1gcm^{-3}$)
(e) State how the neutralization of ethanoic acid by potassium hydroxide would compare with that of nitric acid. Explain your answer.

Question 19

(a) (i) What is water pollution?
    (ii) How can you tell that water is polluted? Give two ways.
(b) (i) What is sewage?
    (ii) How does sewage pollute water?
    (iii) Describe how urban sewage is treated.
    (iv) How can sewage be useful to the society?

Question 20

(a) Name one reagent that can be used to differentiate between each of the following pairs of cations. In each case state what would be observed if each cation is treated with the reagent.
   (i) Mg^{2+} and Pb^{2+}
   (ii) Al^{3+} and Zn^{2+}
   (iii) Cu^{2+} and Ca^{2+}
(b) Name one reagent that reacts with chloride ions and sulphate ions to show similar observation and another one which can be used to distinguish the two anions. In each case state the observation.