REDSPOT

O LEVEL

CLASSIFIED
UNSOLVED EXAM PAPERS

CHEMISTRY

Paper 2 (Theory) - All Variants

(Syllabus 5070)

period	**2013 to 2022**
contents	**June & November, Paper 2 (P21 & P22) With Solutions**
form	**Topic By Topic**
compiled for	**O Levels**

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Address : P.O. Box 5041, Model Town, Lahore, Pakistan.

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TOPIC 1

Experimental Chemistry

Experimental design, Methods of purification and analysis, Identification of ions and gases

1. ***[June 2011/P21/Q2]***

Small pieces of copper were added to excess concentrated sulfuric acid and the mixture heated for 30 minutes. A colourless gas **Z** was formed. When **Z** was tested with filter paper dipped into acidified potassium dichromate(VI), there was a colour change from orange to green.

The reaction mixture was cooled and then diluted with water. A blue solution, **Y**, was formed. Aqueous sodium hydroxide was added drop by drop to the blue solution. Eventually a blue precipitate, **X**, was formed. On heating the blue precipitate turned black to form compound **V**. Analysis of **V** showed that it contained 79.9 % copper and 20.1 % oxygen by mass.

(a) Name gas **Z**.

..... [1]

(b) Name the blue solution **Y**.

..... [1]

(c) When aqueous sodium hydroxide was added to the cooled reaction mixture, it initially reacted with excess sulfuric acid.

Write the ionic equation for this reaction.

[1]

(d) (i) Name the blue precipitate **X**.

..... [1]

(ii) Write an ionic equation, including state symbols, to show the formation of this blue precipitate.

[2]

(e) Calculate the empirical formula of the black solid **V**.

empirical formula of **V** is ..... [2]

2. ***[June 2011/P22/Q6]***

Proteins are natural polyamides which can be hydrolysed to form amino acids.

(a) Name a synthetic polyamide.

..... [1]

(b) The hydrolysis of proteins forms a mixture of colourless amino acids.

Describe, with the aid of a labelled diagram, how paper chromatography can be used to identify a mixture of amino acids.

.....

.....

.....

.....

..... [4]

---

3. ***[June 2011/P22/Q1]***

Choose from the following compounds to answer the questions below.

ammonia
carbon monoxide
copper(II) carbonate
copper(II) chloride
copper(II) sulfate
sodium chloride
sodium hydroxide
sodium sulfate
sulfur dioxide
sulfuric acid
zinc carbonate
zinc nitrate

Each compound can be used once, more than once or not at all.

Which compound

(a) is a white solid with a high melting point that dissolves in water to form an alkaline solution,

..... [1]

(b) is a blue solid which, when dissolved in water, gives a white precipitate with aqueous barium nitrate,

..... [1]

(c) is a colourless gas that turns moist red litmus paper blue,

..... [1]

(d) is a white solid that decomposes on heating to form carbon dioxide?

..... [1]

---

4. ***[Nov 2011/P21/Q4 a]***

A plant contains the coloured compounds chlorophyll and carotene.

The mixture of coloured compounds is extracted with propanone to give a brown solution.

(i) Describe, with the aid of a labelled diagram, how you can show that there is more than one coloured compound in the brown solution.

.....

.....

.....

..... [3]

(ii) You are given a pure sample of chlorophyll.

How can you show that the brown solution contains chlorophyll?

.....

.....

..... [2]

---

5. ***[June 2012/P22/Q2]***

Small pieces of a silver coloured metal, **X**, were added to concentrated nitric acid. A brown gas, **Z**, and a colourless solution containing salt **Y** were formed.

Analysis of a 0.0914 mol sample of **Z** showed it contained 1.28 g of nitrogen and 2.93 g of oxygen.

The small sample of the colourless solution was diluted with water and then divided into two portions.

- To one portion, aqueous sodium hydroxide was added drop by drop until it was in excess. A white precipitate, **W**, was formed that redissolved in the excess sodium hydroxide.
- To the other portion, aqueous ammonia was added drop by drop until it was in excess. A white precipitate, **W**, was formed that redissolved in the excess ammonia.

(a) (i) Name the white precipitate, **W**.

..... [1]

(ii) Construct the ionic equation, with state symbols, for the formation of **W**.

..... [2]

(b) Name **X** and **Y**.

X is .....

Y is ..... [2]

(c) (i) Calculate the relative formula mass, M_r, for gas **Z**.

M_r = ... [2]

(ii) Determine the molecular formula for **Z**.

molecular formula is ..... [2]

6. ***[June 2013/P22/Q5 c,d,e]***

Analysis of compound **X** shows it has the following composition.

element	percentage by mass
hydrogen	3.40
nitrogen	12.0
oxygen	41.0
vanadium	43.6

The formula of compound **X** is H_4NO_3V.

(a) Aqueous sodium hydroxide is added to solid **X** and the mixture is warmed.

A colourless gas that turns moist red litmus blue is evolved.

Deduce the formula of each of the two ions present in **X**.

.....

..... [2]

(b) An acidified aqueous solution of **X** reacts with aqueous potassium iodide to form iodine.

State and explain what you can deduce about the chemical nature of **X**.

.....

..... [2]

(c) When solid **X** is heated only V_2O_5, water and gas **Z** are formed. Name gas **Z**.

..... [1]

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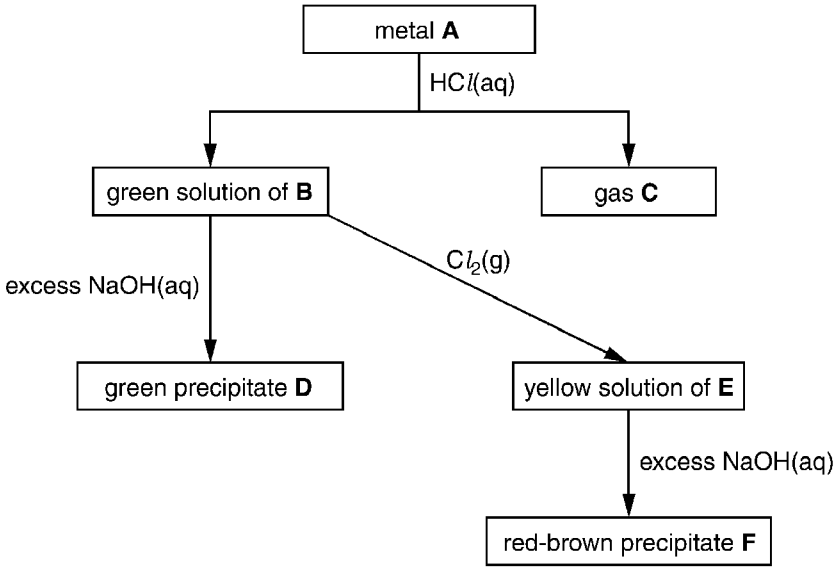
7. ***[June 2014/P22/Q6]***

The flow chart shows the reactions of metal **A** and some of its compounds.



Identify, by name, each of the substances.

A .....

B .....

C .....

D .....

E .....

F .....

[6]

---

8. ***[Nov 2014/P21/Q3 a,b,c(i)]***

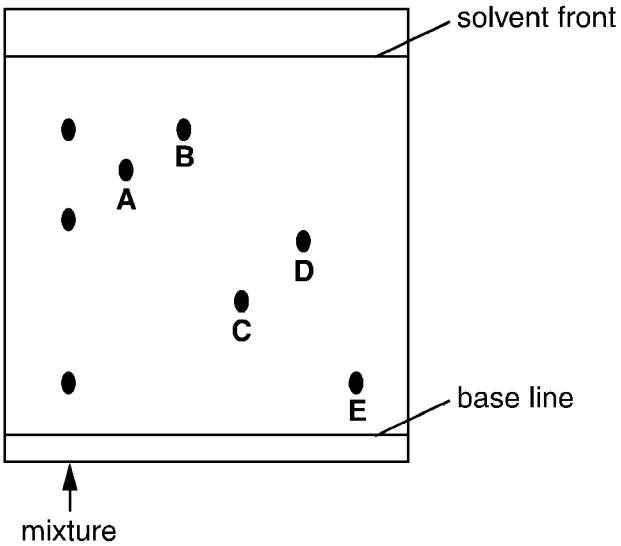
Paper chromatography can be used to separate metal ions in a mixture and identify them by comparison with known samples of metal ions (**A–E**).

(a) Draw a labelled diagram to show the apparatus used in paper chromatography.
On your diagram show

- the solvent,
- where the mixture of metal ions and known samples of metal ions are placed at the start of the experiment.

[2]

(b) The completed chromatogram is shown.



(i) Which of the metal ions, **A**–**E**, were present in the mixture?

..... [1]

(ii) Calculate the R_f value of metal ion **A**.

R_f value = ... [1]

(c) Ammonia can be used as a locating agent for some metal ions on the chromatogram. Suggest why a locating agent may need to be used.

.....

..... [1]

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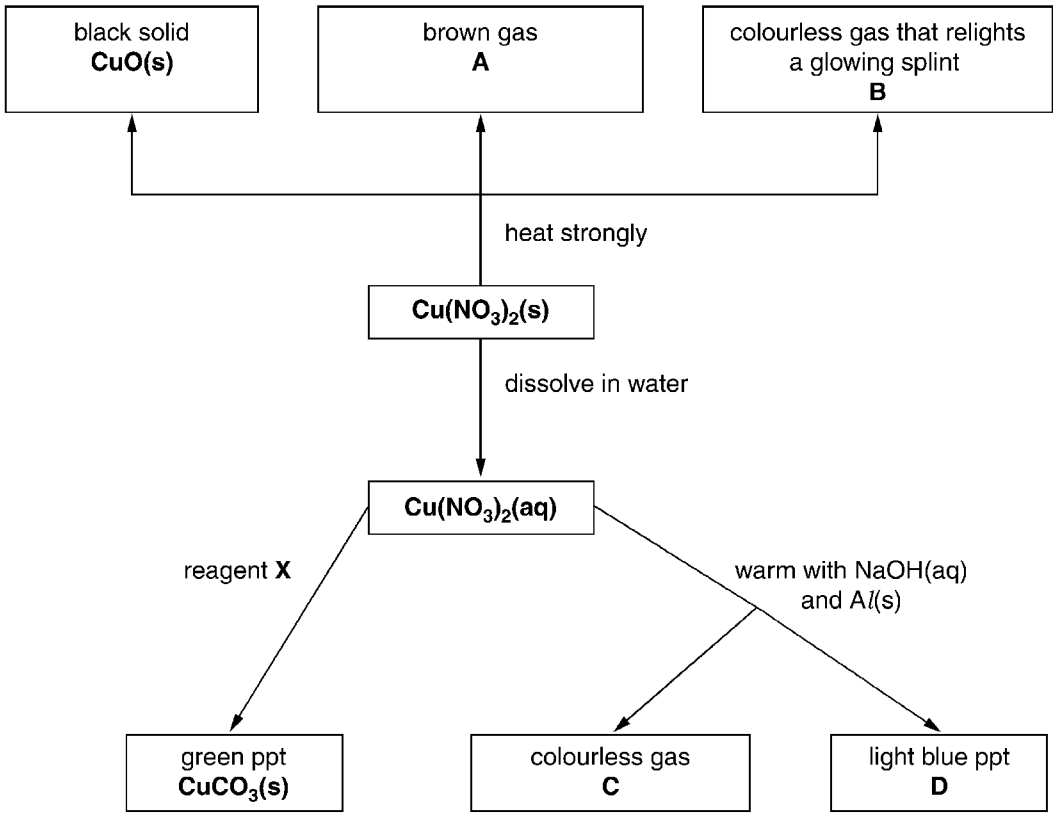
9. ***[June 2015/P21/Q5]***

The flow chart shows some reactions of copper(II) nitrate, $Cu(NO_3)_2$.



(a) When two moles of $Cu(NO_3)_2$ is heated strongly, two moles of CuO, four moles of **A** and one mole of **B** are made.

(i) Write the formula for **B**.

..... [1]

(ii) Construct the equation for the action of heat on $Cu(NO_3)_2$.

..... [2]

(b) Aqueous copper(II) nitrate is warmed with aqueous sodium hydroxide and aluminium powder.

Name **C** and **D**.

C is .....

D is .....

[2]

(c) Suggest the name of reagent **X** and construct the ionic equation, with state symbols, for the formation of the green precipitate, $CuCO_3(s)$.

name of reagent **X** .....

ionic equation .....

[3]

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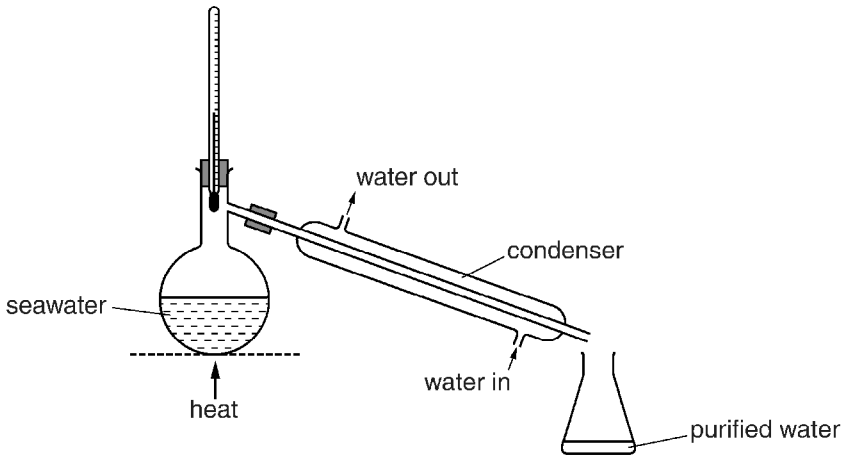
10. ***[Nov 2014/P22/Q3 a]***

Seawater contains a variety of dissolved salts.

The diagram shows a simple distillation apparatus that can be used to produce purified water from seawater.



Explain how distillation purifies seawater.

.....

.....

.....

..... [3]

TOPIC 1

Answers

1. **(a)** Sulfur dioxide (SO_2).

(b) Copper(II) sulfate ($CuSO_4$).

(c) $H^+ + OH^- \rightarrow H_2O$

(d) **(i)** Copper(II) hydroxide($Cu(OH)_2$)

(ii) $Cu^{2+}(aq) + 2OH^-(aq) \rightarrow Cu(OH)_2(s)$

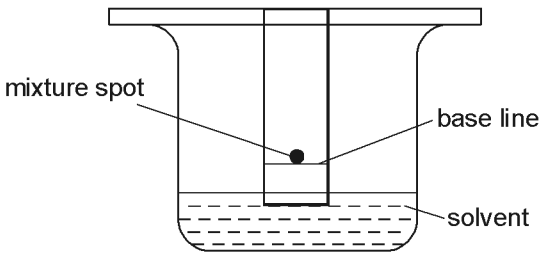
(e)

Element	Cu	O
Mole ratio	$\frac{79.9}{64}$	$\frac{20.1}{16}$
=	1.25	1.26
Simple ratio =	1	1

Empirical formula of **V** is CuO

2. **(a)** Nylon / Kevlar / Trogamid / Kermal / Nomex / Twaron / Technon / Teijinconex / Rilson / Ultramid.

(b)



Place a drop of mixture on filter paper at base line. Pour solvent into the container so that solvent just touches the lower end of the paper. Solvent will rise along the paper and take components in the mixture to different heights. The paper is then dried and sprayed with locating agent which makes spots visible.

EITHER

Run known and unknown amino acid on the same piece of paper. Compare unknown (amino acid) with distance travelled by known (amino acids).

OR

Measure R_f values

$$R_f = \frac{\text{Distance moved by spot (from base line)}}{\text{Distance moved by solvent front (from base line)}}$$

Rf value for each spot is measured and then compared with the standard Rf values of amino acids to identify them.

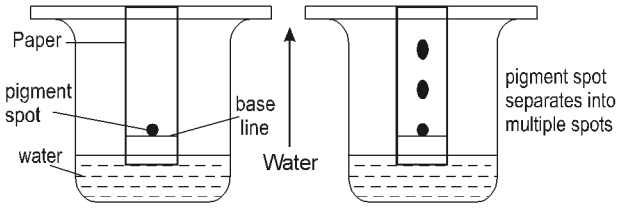
3. **(a)** Sodium Hydroxide / NaOH.

(b) Copper(II) Sulfate / $CuSO_4$.

(c) Ammonia / NH_3.

(d) Zinc Carbonate / $ZnCO_3$.

4. **(i)**



— Chromatography paper dipping in labelled solvent.

— Origin line marked above the solvent level.

— Pigment spot on origin line at start and then separates into more than one (coloured) spots.

(ii) • Run chromatogram with known sample and the brown solution.

• Same R_f value obtained for the two spots if chlorophyll present.

5. **(a)** **(i)** Zinc hydroxide ($Zn(OH)_2$).

(ii) $Zn^{2+}(aq) + 2OH^-(aq) \rightarrow Zn(OH)_2(s)$

(b) **X:** Zinc (Zn).

Y: Zinc nitrate / $Zn(NO_3)_2$.

(c) **(i)** Mass of sample = 4.21 g

$$M_r = \frac{4.21}{0.0914} = 46$$

(ii) Mole ratio, nitrogen : oxygen
= 0.0914 : 0.183
= 1 : 2
Molecular formula is NO_2

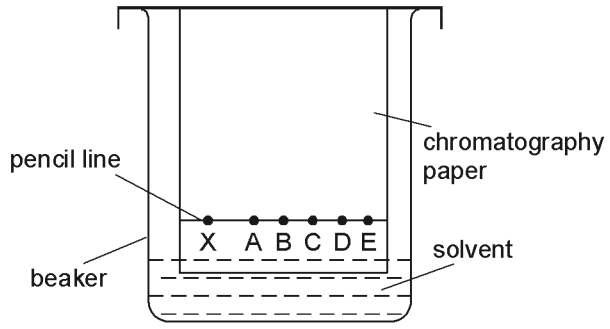
6. **(a)** NH_4^+. VO_3^-.

(b) **X** is an oxidising agent.
The oxidation number of iodine increases / iodide loses electrons / X gains electrons.

(c) Ammonia.

7. **A**: Iron.
B: Iron(II) chloride.
C: Hydrogen.
D: Iron(II) hydroxide.
E: Iron(III) chloride.
F: Iron(III) hydroxide.

8. **(a)**



(b) **(i)** **B** and **E**.

(ii) Using scale, R_f = 0.68 to 0.72

(c) Spots may not be colored / To make spots visible.

9. **(a)** **(i)** Formula for **B:** O_2

(ii) $2Cu(NO_3)_2 \rightarrow 2CuO + 4NO_2 + O_2$

(b) **C** is ammonia.
D is copper(II) hydroxide.

(c) *reagent **X**:* Any soluble carbonate e.g. sodium carbonate / potassium carbonate / ammonium carbonate.
Ionic equation:
$Cu^{2+}(aq) + CO_3^{2-}(aq) \rightarrow CuCO_3(s)$

10. — Water and salts have different boiling points.
— Water evaporates AND salts / residues / impurities / solids left in flask.
— Water condenses / turns into liquid in the condenser.

11. **Any two observations:**
— Solution gets warmer / heat given off.
— White precipitate formed. which redissolves in excess.
— Green precipitate formed.
— With excess the green precipitate remains.

Any two explanations:
— Acid is neutralised.
— Green precipitate is iron(II) hydroxide.
— White precipitate of zinc hydroxide which will redissolve in excess.

12. **(a)** Iron(II) chloride gives a green (or grey-green) precipitate with NaOH.
Iron(III) chloride gives a brown precipitate.

$$Fe^{2+} + 2OH^- \rightarrow Fe(OH)_2$$
or
$$FeCl_2 + 2NaOH \rightarrow Fe(OH)_2 + 2NaCl$$

$$Fe^{3+} + 3OH^- \rightarrow Fe(OH)_3$$
or
$$FeCl_3 + 3NaOH \rightarrow Fe(OH)_3 + 3NaCl$$

(b) Test: Pass chlorine gas over moist blue (or red) litmus paper.
Observation: Litmus paper is bleached (or goes white).

13. **(i)** Blue precipitate (or blue solid).
In excess becomes a dark blue solution.

(ii) Blue precipitate (or blue solid) which does not redissolve.

14. **(a)** **(i)** Blue precipitate (or blue solid) which does not redissolve.

(ii) Blue precipitate (or blue solid).
In excess ammonia gives a dark blue solution.

(b) $2CuCl \rightarrow CuCl_2 + Cu$