J. J. Zimbs

Essential

MSCE

Physical Science Practicals

Questions and Model Answers

PATRIOTS PUBLISHERS

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INTRODUCTION

MSCE Physical Science Practicals Questions and Model Answers text book has covered questions from the year 2000 to 2015 of Physical Science Paper II (Practical) – Malawi National Examinations Board (MANEB).

This book has also taken into account tips and hints in handling practical examinations, general instructions and additional explanations to some questions.

This book takes a simplified approach using short but comprehensive answers and solutions to the questions (problems). Throughout the answers' section, there are many simple and well explained experiments for the reader to easily comprehend. Guidance is given to the reader on the results of these experiments. Where the learner finds the book difficult, the teacher should help in giving guidance which will lead the learner in working out correct solutions.

I hope you will find MSCE Physical Science Practicals Questions and Model Answers interesting as well as useful and helpful in preparing for your national examinations and in your everyday life experiences.

ACKNOWLEDGEMENTS

Very many thanks to St. Mary's Secondary School teachers (Mr. S. Mota and Mr. D. Namikungulu) and pupils, Mr. Moses Zulu (Mfera CDSS), Mr. Stanely Ngoma (Liwonde SS) and Patriots Publishers for the editorial and production of this edition.

I owe a lot of thanks to my parents (Mr. & Mrs. M.M. Mtambo) and family (Thoko, Takondwa and Praise) for their honourable work which they did by sending me to school and supporting me as well. Many thanks should go to all my teachers at all levels.

My special gratitude to **MANEB** for the examination items which have been tackled in this book.

Lastly, I thank the Almighty God for the gift of life and knowledge.

Kumalo E. Mtambo

TABLE OF CONTENTS

HINTS AND TIPS IN WRITING PRACTICAL EXAMINATIONS

1. **Identity card**

   Do not forget your ID otherwise you will not be allowed to enter the exam room.

2. **Pens and pencils**

   Some exams require the use of **pens**, while others have to be completed in **pencil**. Make sure you know what you should be using in every paper before you go in. In addition, mathematical sets and electronic calculators may also be required in some exams. Make sure calculators are working perfectly and all pieces are available in the mathematical box.

3. **Websites**

   All the major examination boards have websites these days, usually with sample papers and examiners' reports that you can download. These sites are well worth a visit as they may offer a lot of sound advice. The examiners' report, for instance, can give you an idea of exactly what it is that they are looking for. Consult your teachers if you cannot handle this on your own.

4. **Take spares**

   Take spare pens and pencils just in case the one you are using stops working.

5. **On time not in time**

   Allow for problems, hold-ups and traffic jams on the way and make sure you arrive with time to spare so that you can go in calmly rather than in a frantic rush.

6. **It may sound stupid, but ...**

   Don't forget to read the instructions and make sure you know what you are being asked to do. You should go into the exam well aware of what is expected of you, but you should always check. Don't, however, waste a lot of time on this.

7. **Zzzzzz**

   Try to get a good night's sleep the night before any exam.

8. **Hangovers**

   Try to avoid alcohol the night before an exam, especially in quantity, as bad hangover is among the very worst things to be suffering from in an exam room.

9. **Seating plan**

   Check the seating plan on display to determine where you seat in the room. Enter the room until instructed to do so by the exam room supervisor.

10. **Examination conduct**

    - Raise your hand to attract the attention of an invigilator if you have a question or if you suspect there is a mistake on the exam paper. Do not communicate with any person during the exam, other than the invigilator.
    - Raise your hand and wait for an

invigilator if you need to leave the room, e.g. in case of illness. Do not leave the room unless permitted by the invigilator.

- Listen carefully to the announcements made by the invigilator as they may also announce restrictions on removal of questions papers.

11. **Disallowed!**
    - Unauthorised material (including revision notes) or equipment relevant to the exam.
    - Good luck charms and items.
    - Coats and bags must be left in the area supplied, either at the back of the room or just outside the room.
    - Non-clear bottles.
    - Medicines (unless prior approval granted).
    - Mobile phone, laptops, i-pads. (**Do not** take valuable items to the exam site.)

General instructions for physical science paper ii examinations

1. You are supposed to check the whole paper to ensure that all the pages are well printed and there is no missing page. **Number of pages** is always indicated in the instructions.
2. Before beginning, fill in your **Examination Number** at the top of each page of the question pa
3. Write your answers on the paper in the spaces provided.
4. Physical Science paper II c **two** sections, **A** and **B**.
5. In section **A** there are **two** questions to be answered in 1
6. You should spend 30 minute question. The 30 minute perio for each question includes to tidy up the apparatus an checked by the supervisor.
7. Marks for section **A** will be observation, accuracy and inte of results.
8. Section **B** consists of **two** d questions on practical wo answered in **1 hour**. Marks wi for accurate and orderly prese facts supported by relevant d
9. In the table provided on the of the paper, **tick** against the the question you have answ table looks like the one giv and your ticking should be ir column and neat as demonstr

Question Number	Tick if answered	Do not v these col
1		
2		
3		
4		

10. Hand in your paper to the inv when time is called to do so.

Section A

25 marks

1. You are provided with dropper bottles labelled **K**, **L**, **M**, and **N**, which contain chloroalkane, alkane, sodium bicarbonate solution and sodium hydroxide not necessarily in that order. You are also given the following: a spatula, a burner, phenolphthalein indicator, and dilute hydrochloric acid (HCl).

On each unknown compound perform the test shown in **table 1** and record your observations in the appropriate spaces. Remember to wash the tube with distilled water after each test.

Table 1

Test / Substance	Add 5 drops phenolphthalein to 15 drops unknown	Add 5 drops HCl (acid) to 15 drops unknown	Put 2 drops of unknown on spatula and bring burner flames
	Results	Results	Results
K			
L			
M			
N			

(8 marks)

On the basis of your results identify the unknowns: K, L, M and N.

(4 marks)

2. You are provided with a retort stand, spring, metre ruler, carriage weight, 50 g, 100 g, 150 g and 200 g masses.

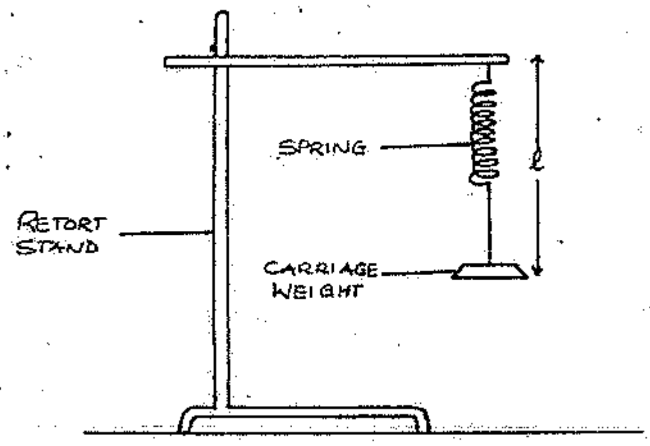


Figure 1

a. Hang the spring and attach the carriage weight to its lower end as shown in figure 1 above.

b. Measure the initial length, l (initial) of the spring and carriage weight and record under zero mass in the appropriate row in table 2 below.

c. Add the 50 g mass to the carriage weight.

d. Measure the new length, l (new) and record it in the table under the 50g mass.

e. Subtract the initial length, l (initial) from the new length, l (new) and record it in the appropriate place.

f. Repeat steps c, d, and e for masses 100 g, 150 g and 200 g to complete the table of results.

Table 2

Mass (g)	0	50	100	150	200
Length (cm)					
Change in length (extension) cm l (new) – l (initial)					

(9 marks)

g. From the values in the table, plot a graph of mass (g) against extension (cm). **(3 marks)**

h. Calculate the gradient of your graph. **(1 mark)**

Section B 25 marks

3. a. What is a solution? (2 marks)

b. Write any two ways of expressing the concentration of a solution. **(2 marks)**

c. Describe how you would prepare 250 ml of a 0.2 M solution of sodium hydroxide, NaOH using solid sodium hydroxide pellets. (Relative Formula Mass of sodium hydroxide is 40). **(9 marks)**

4. With the aid of a clearly labelled diagram describe the arrangement you would use to produce a pure spectrum of white light on a screen. In your description include an explanation on why each component is used. **(12 marks)**

Section A

25 marks

1. You are provided with 2 test tubes in a rack, a measuring cylinder, stirring rod, thermometer, spatula, tap water and substances A and B.

   a. Pour 5 cm^3 of tap water into each test tube.

   b. Measure the temperature of the water in each test tube and record in the table below.

   c. Add half a spatula of substance A into one test tube and stir gently using a stirring rod.

   d. Measure the temperature of the solution and record in the table.

   e. Remove the thermometer from the test tube and rinse it with water.

   f. Add half a spatula of substance B into the second test tube and stir gently.

   g. Measure and record the temperature of the solution.

   h. Dry the thermometer and return it into its case.

Solution	Initial Tempera-ture (°c)	Final Tempera-ture (°c)	Change In Temperature (°c)
A			
B			

(5 marks)

   i. Complete the fourth column of the table.

   j. State whether the change in each case is endothermic or exothermic.

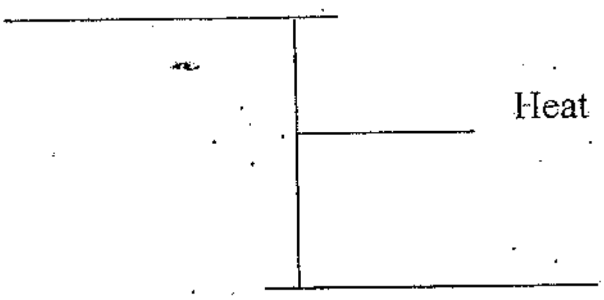
   A: ____________________

   B: ____________________

(2 marks)

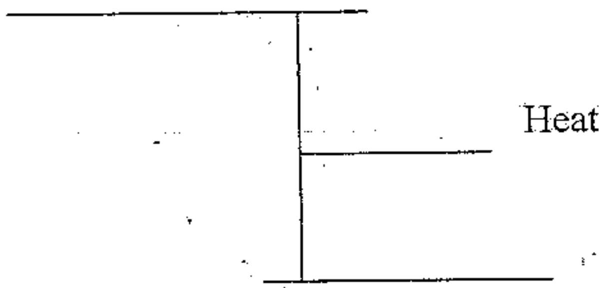
   k. Complete the energy level diagrams to illustrate the reactions in solutions of A and B.

   (i) Solution A



(3 marks)

   (ii) Solution B



(3 marks)

2. You are provided with 5 lengths of PVC pipes.

   a. Measure the mass of each length of pipe and record in the table below.

Length of pipe (cm)	0	5	10	15	20	25

Mass of pipe (grams)	0.					

(3 marks)

b. Plot a graph of mass of pipe against length of pipe. (Use a scale of 2 cm to represent 5 g on the vertical axis and 2 cm to represent 5 cm length on horizontal axis).

(7 marks)

c. Calculate the slope of the graph.

(2 marks)

Section B

25 marks

3. A new brand of red soap is found to cause skin irritation when used. An old brand of the same soap did not cause skin irritation. A chemist decides to compare the components of the dyes of the two brands of soap to see if they are different.

Describe an experiment that could be done to isolate the components of the dyes.

J J Zomba **(13 marks)**

4. a. Why does sound travel faster in solids than in gases?

(2 marks)

b. With the aid of a labelled diagram describe an experiment which can be used to find out if sound waves require a medium for their propagation.

(10 marks)

Section A

25 marks

1. You are provided with a thermometer, water, beaker, ethanol in a lamp, tripod stand, retort stand, stop watch, some matches and a beam balance.

   a. Pour 200 cm^3 of water into a beaker.

   b. Set up the apparatus as shown in **Figure 1**.

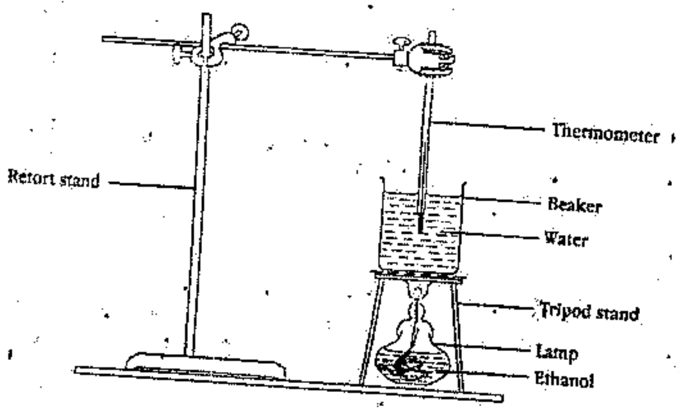


Figure 1

   c. Measure and record the temperature of water before heating.

   d. Weigh and record mass of lamp plus ethanol before heating.

   e. Light the lamp and heat the water for 10 minutes.

   f. Record the temperature of the water after heating.

   g. Weigh and record the mass of the lamp plus ethanol after heating.

   - temperature of water before heating =
   - temperature of water after heating =
   - mass of lamp plus ethanol before heating =
   - mass of lamp plus ethanol after heating =
   - mass of ethanol used up =

   (5 marks)

   h. Calculate the amount of heat gained by the water (specific heat capacity for water is 4.2J/g °C) **(3 marks)**

   i. How much heat was supplied by ethanol? **(1 mark)**

   j. Calculate heat supplied per gram of ethanol. **(2 marks)**

   k. State **one** source of error in this experiment. **(1 mark)**

2. You are provided with a burette, a funnel, a measuring cylinder, a beaker, clamp and clamp stand, 0.1 M hydrochloric acid (HCl), sodium hydroxide (NaOH) of unknown concentration, phenolphthalein indicator, a white tile or paper.

   a. Set up the apparatus as shown in Figure 2.

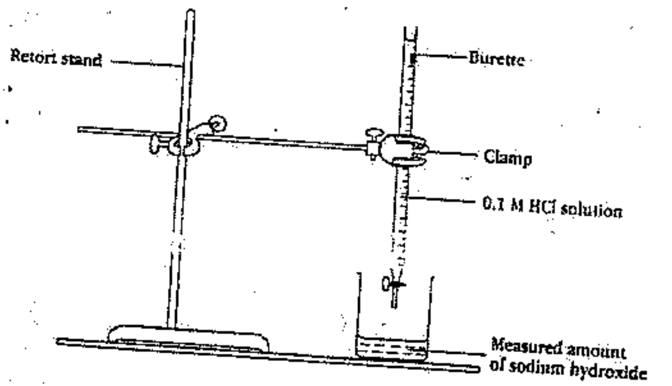


Figure 2

   b. Fill the burette with hydrochloric acid (HCl) to the zero mark.

c. Pour 10 cm^3 of sodium hydroxide into a beaker.

d. Add a drop of phenolphthalein indicator to the sodium hydroxide.

e. Slowly add hydrochloric acid from the burette to sodium hydroxide, shaking the beaker all the time, until pink colour disappears.

Note and record the volume of hydrochloric acid used.

Initial volume of Hydrochloric acid (cm^3)	Final volume of Hydrochloric acid (cm^3)	Volume of HCl used (cm^3)

(6 marks)

f. Empty the beaker and rinse it with distilled water.

g. Pour 10 cm^3 of sodium hydroxide into the beaker and add a drop of phenolphthalein indicator.

h. Repeat step **2e**.

i. Note and record volume of hydrochloric acid used in the table of results.

j. Calculate the average volume of hydrochloric used. **(1 mark)**

k. Calculate the concentration of sodium hydroxide solution.

(6 marks)

Section B

25 marks

3. a. Define resonance. **(2 marks)**

b. Describe with the aid of a diagram, an experiment you would carry out to obtain resonance between a tuning fork and a column of air in a bottle. **(9 marks)**

c. State **two** instances where resonance is useful. **(2 marks)**

4 Explain in terms of collision theory how reaction rate is affected by the following factors:

a. concentration **(4 marks)**

b. temperature **(4 marks)**

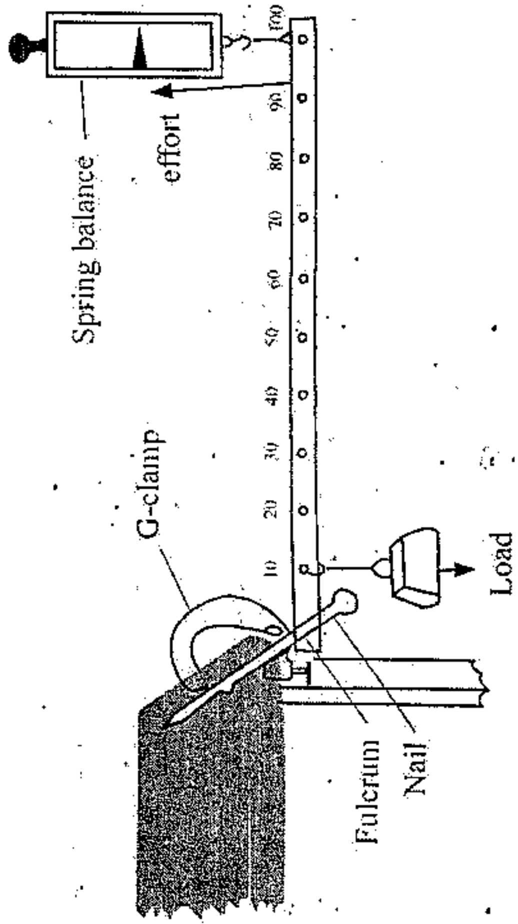
c. particle size **(4 marks)**

Section A

25 marks

1. You are provided with a 500 g mass, clamp, a spring balance, a nail, a metre rule with holes drilled into it at regular intervals of 10 cm and a wire hook or a string.

   a) Arrange the apparatus as shown in diagram below.



   b) Hook the 500 g mass 10 cm from the fulcrum.

   c) Hook the spring balance on the last hole (100 cm from fulcrum).

   d) Lift the spring balance so that the metre rule is in horizontal position

   e) Record the reading on the spring balance in the appropriate space in the table.

Distance between mass and fulcrum (cm)	Effort (N)
10	
20	
30	
40	
50	
60	

(6 marks)

   f) Repeat procedures **b** to **e** using the distances shown in the table.

   g) Plot a graph of effort against distance between mass and fulcrum. (Scale: 2cm to represent 0.5N on the vertical axis and 2cm to represent 10cm on horizontal axis).

(6 marks)

   h) What is the relationship between the effort applied and the distance from the mass to the fulcrum?

(1 mark)

2. You are provided with copper sulphate, an evaporating basin, a gas burner, a triple beam balance, a tripod stand and a wire gauze.

   a) Weigh the evaporating basin on triple beam balance and record the mass.

____

______________________ **(1 mark)**

b) Add crystals of hydrated copper sulphate until the reading increases by approximately 5g.

c) Record the mass of the evaporating basin plus hydrated copper sulphate.

____

_______________ **(1 mark)**

d) Mass of hydrated copper sulphate = _______________ **(1 mark)**

e) Heat the evaporating basin gently until the hydrated copper sulphate turns into a white powder.

f) Weigh the evaporating basin plus white powder and record the results. _______________ **(1 mark)**

g) Subtract mass of empty evaporating basin from the mass of evaporating basin and white powder and record the results.

_______________ **(1 mark)**

h) Mass of hydrated copper sulphate minus mass of white powder =

_______________ **(1 mark)**

i) Calculate the percentage of water in the hydrated copper sulphate.

(3 marks)

j) What name is given to water found in the crystals?

_______________ **(1 mark)**

k) Mention any two sources of error in the experiment. **(2 marks)**

Section B

25 marks

3. The electrolysis of dilute sulphuric acid (H_2SO_4) is essentially the electrolysis of water. With the aid of clearly labelled diagram show that this statement is true.

Support your answer by giving relevant ionic equations and explanations for the reactions that take place at the anode and cathode during the electrolysis of dilute sulphuric acid.

(13 marks)

4. a. A resistor with unknown resistance is connected in parallel to a 4ohm resistor. The voltage across the resistors and the total current in the circuit are measured.

(i) Draw a circuit diagram for this experiment. **(3 marks)**

(ii) Calculate the value of unknown resistor if the effective resistance is 2 ohms.

(3 marks)

b. (i) Draw an electric circuit comprising diode, a cell and a bulb such that the diode is forward biased.

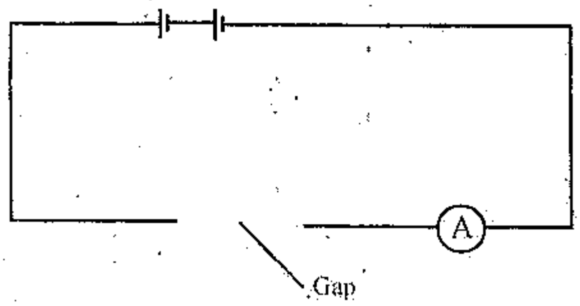
(3 marks)

(ii) Explain the effect of reversing the cell on the bulb. **(3 marks)**

Section A — 25 marks

1. You are provided with 2 cells, a cell holder, an ammeter, connecting wires and nichrome wire with different number of strands.

   a. Set the apparatus as shown below.



   b. Complete the circuit by placing nichrome wire with one strand in the gap.

   c. Note the ammeter reading and record it in the table of results.

   d. Remove the nichrome wire from the gap.

   e. Repeat steps **b** to **d** using nichrome wires with two, three, four and five strands.

Table of results

Number of strands	Current (A)
1	
2	
3	
4	
5	

(5 marks)

   f. Plot a graph of current against number of strands. **(5 marks)**

   g. Use the graph to explain the results of the experiment. **(3 marks)**

2. You are provided with four unknown organic compounds labelled **P**, **Q**, **R** and **S** belonging to the following families: alkanes, alkenes, alkanol and carboxylic acid **not** necessarily in that order.

   You are also provided with dilute sodium hydroxide, phenolphthalein and bromine solution in dropper bottles, four test tubes in a rack and distilled water in a wash bottle.

   a. On each substance, perform the tests shown in the **table of results** and record your observations in the appropriate space. Wash the test tubes after use.

Table of results

Test / Substance	Add 1 – 2 drops of substance to 15 drops of distilled water	Add 1 drop of phenolphthalein to 15 drops NaOH then 1 drop of substance	Add 1 – 2 drops of substance to 15 drops of bromine
	RESULT	RESULT	RESULT
P			
Q			
R			
S			

(9 marks)

   b. Identify the families to which the compounds belong.

   P ____________________

Q ______________________

R ______________________

S ______________________

(4 marks)

Section B

25 marks

3\. a. With the help of well labelled sketch diagram, explain how a convex lens would form a real image of a burning candle.

In your diagram show the position of the object, image, principal focus and principal axis.

(11 marks)

b. What would happen to the image if the candle was moved further away from the lens?

(2 marks)

4\. A newly discovered element represented by the symbol X is suspected to belong to Group 1 of the Periodic Table.

(i) Describe an experiment you would do to prove that the element belongs to Group 1.

(9 marks)

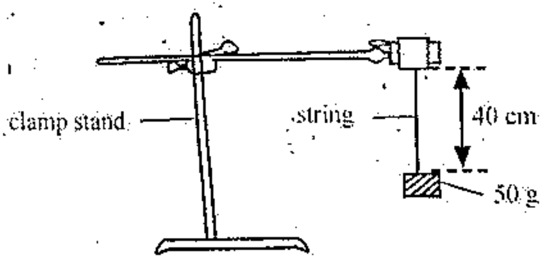
(ii) Write a balanced chemical equation for the reaction between **element X** and **water**.

(3 marks)

Section A 25 marks

1. You are provided with a stop watch, metre rule, 50 g mass, clamp stand, clamp and a string.

   a. Set up the apparatus as shown in the figure below:



   b. Pull the mass to one side and leave it to vibrate freely.

   c. Record the time taken to make 10 complete vibrations.

   d. Calculate the number of vibrations performed in 1 second.

   e. Record the readings in the appropriate space in the following table.

Table of results

Length in cm	Time for 10 complete vibrations (sec)	Number of vibrations per second
40		
30		
20		
10		

(6 marks)

   f. Repeat the procedures (b) to (e) using lengths 30 cm, 20 cm and 10 cm.

   g. Plot a graph of number of vibrations per second against length of string. **(5 marks)**

   h. Using the graph, determine how the length of string affects number of vibrations per second.

(1 mark)

   i. Mention a variable that is kept constant. **(1 mark)**

2. You are provided with a thermometer, two test-tubes, a piece of magnesium ribbon, potassium hydrogen carbonate or sodium hydrogen carbonate, dilute hydrochloric acid solution, spatula or tea spoon and a measuring cylinder.

   a. Pour 2 cm^3 (or 2 cm column) of hydrochloric acid into a test-tube.

   b. Measure temperature of the acid and record it as initial temperature in the **table of results.**

   c. Drop the magnesium ribbon in the acid and record the changes taking place as the reaction occur.

   d. Record the final temperature reached in the **table of results.**

   e. In the second test-tube, pour 2 cm^3 (or 2 cm column) of hydrochloric acid and record its temperature as its initial temperature in the **table of results.**

   f. Add $\frac{1}{4}$ spatula full of potassium hydrogen carbonate or sodium hydrogen carbonate to the acid. record the final temperature reached and other changes taking place as the reaction proceeds.

Table of results

Liquid in the test tube	Initial temperature (°C)	Substance added	Final temperature reached during reaction (°C)	Temperature change (°C)	Other changes observed during reaction
Hydrochloric acid		Magnesium ribbon			
Hydrochloric acid		Potassium hydrogen carbonate or sodium hydrogen carbonate			

(7 marks)

g. Which one of the reactions above is an endothermic reaction?

(1 mark)

h. Give a reason for the answer to (g). **(2 marks)**

i. Draw an energy level diagram for the reaction of hydrochloric acid and magnesium ribbon.

(3 marks)

Section B

25 marks

3. a. With the help of a labelled diagram, explain how a step down transformer works. In your diagram, show the coils in primary and secondary circuits and current source. (8 marks)

b. Explain how a fuse works.

J J Zumbe **(4 marks)**

4. a. Define the following terms:

(i) "oxidation" **(1 mark)**

(ii) "reduction" **(1 mark)**

b. With the aid of well labeled diagrams, describe an experiment you would carry out to show that both air and water are necessary conditions for rusting. **(10 marks)**

Section A

25 marks

1. You are provided with sugar, a tin, tripod stand, wire gauze, a gas or ethanol burner, matches and a balance.

   a. Weigh the empty tin and record the mass in the **table of results**.

   b. With the tin still on the balance, add sugar until the mass increases by approximately 10 g.

   c. Record the mass of sugar in the **table of results**.

   d. Heat the sugar in the tin until black solid (carbon) is formed.

   e. Weigh the tin + black substance.

   f. Heat and reweigh several times until the mass is constant.

   g. Record the mass of tin + carbon in the **table of results**.

   h. Calculate the mass of carbon **(g – a)**.

   i. Record mass of carbon in the **table of results**.

Table of results

tem	Mass (g)
Empty tin	
in + Sugar	
ugar	
in + Carbon	
arbon	

(5 marks)

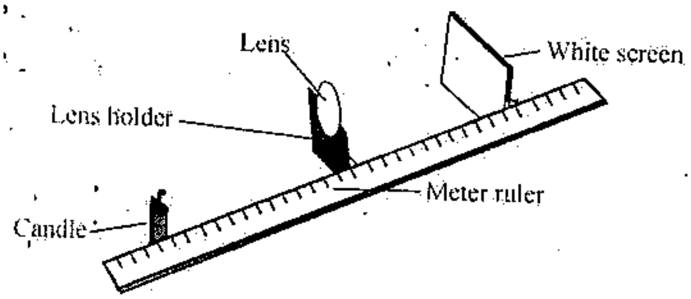
   j. Calculate the percentage composition by mass of carbon in sugar. **(3 marks)**

   k. Calculate the number of moles of carbon produced (RAM of C = 12). **(3 marks)**

   l. Mention any **two** sources of error in this experiment. **(2 marks)**

2. You are provided with a candle, matches, a lens holder, convex lens, a white screen and a metre rule.

   a. Arrange the candle, convex lens and screen as shown below.



   b. Light the candle.

   c. With the candle at 22.5 cm from the lens, produce a well focused image of the flame on the screen.

   d. Measure and record the image distance in the **table of results**.

   e. Repeat steps **(c)** and **(d)** for the object distances shown in the **table of results**.

Table of results

Object distance (cm)	Image distance (cm)
22.5	

28.0	
37.5	
45.0	
52.5	

(5 marks)

f. Draw a graph of image distance against object distance. (6 marks)

g. Using the graph, find the object distance when the image distance is 30 cm. **(1 mark)**

Section B

25 marks

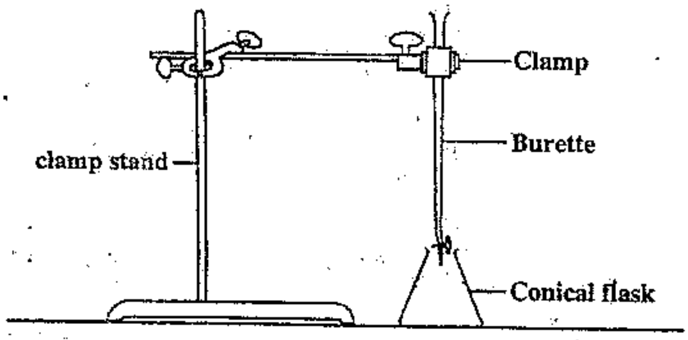
3. Describe an experiment that could be carried out in order to determine the length of nichrome wire that could be used to make a 1.5 Ω resistor. **(13 marks)**

4. Using the following materials only: a balance, water of density 1 g/cm³, cooking oil and a clear empty bottle, describe an experiment that could be done to determine the density of cooking oil. **(12 marks)**

Section A 25 marks

1. You are provided with a burette, clamp and clamp stand, measuring cylinder, conical flask, phenolphthalein indicator, 0.1 M sodium hydroxide (0.1 M NaOH) and hydrochloric acid (HC*l*) of unknown concentration.

   a. Set up the apparatus as shown in the **figure** below.



   b. Fill the burette to the mark with the hydrochloric acid (HCl).

   c. Record the volume of HCl.

   d. Measure 10 ml of the 0.1 M NaOH and transfer it into the conical flask.

   e. Add 2 drops of phenolphthalein indicator into the conical flask.

   f. Add the HCl gradually, in small amounts, from the burette into the conical flask.

   g. Shake the conical flask as you gradually add the HCl.

   h. Stop adding HCl when a colour change is observed in the flask.

   i. Record the volume of HCl remaining in the burette.

   j. Subtract the final volume of HCl from the initial volume and record.

   Initial volume of HCl = ________ **(1 mark)**

   Final volume of HCl = ________ **(1 mark)**

   Volume of HCl used = ________ **(1 mark)**

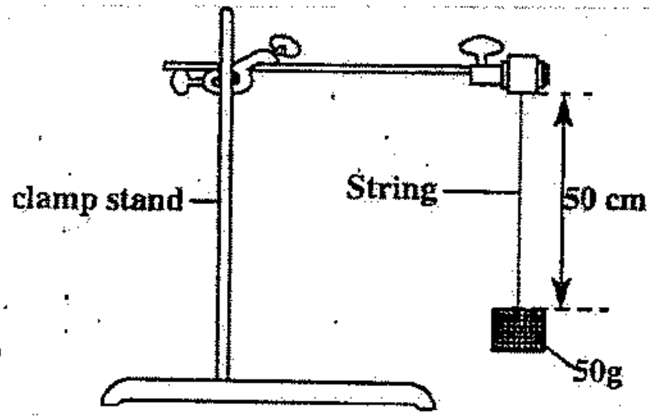
   k. Write a balanced equation for the reaction. **(3 marks)**

   l. Calculate the concentration of HCl. **(4 marks)**

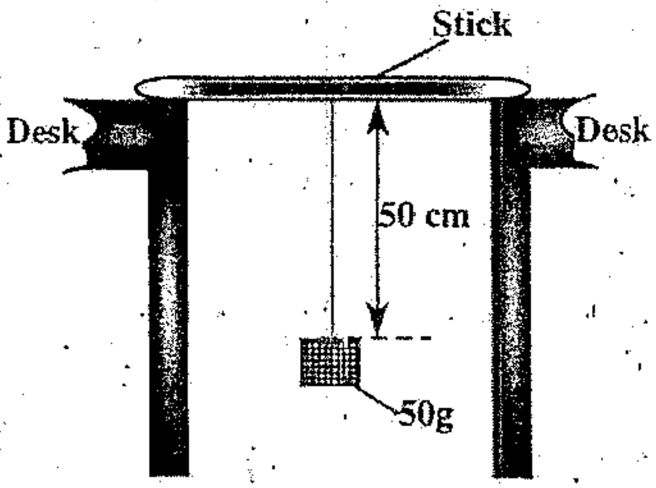
   m. State any **two** sources of error in the experiment. **(2 marks**

2. You are provided with a string, meter ruler, stop watch and 4 masses (50 g, 100 g, 150 g and 250 g).

   a. Arrange the apparatus as shown below.



or



b. Pull the mass to one side and leave it to vibrate freely.

c. Record the time taken to make 10 complete vibrations.

d. Repeat steps **b** and **c** using the 100 g, 150 g and 250 g masses respectively.

e. Complete the column for **number of vibrations per second** in the table.

Table of Results

Mass (g)	Time for 10 complete vibrations (sec)	Number of vibrations per second (frequency)
50		
100		
150		
250		

(6 marks)

f. Plot a graph of number of vibrations per second (frequency) against mass. **(5 marks)**

g. Using the graph, determine how mass affects the number of vibrations per second. **(1 mark)**

h. Give **one** variable that has been kept constant in the experiment.

(1 mark)

Section B

25 marks

3. Construct a flow diagram that could be used to identify acetic acid, ethanol, hexene and hexane, using tests that make use of distilled water, bromine solution, sodium hydroxide solution and phenolphthalein indicator. **(12 marks)**

4. With the aid of a diagram, describe an experiment that could be done to identify unknown substances **W**, **X** and **Y** given that they are a diode, an insulator and a resistor but not necessarily in that order. **(13 marks)**

$Na_2SO_3 + 2HCl \rightarrow 2NaCl + SO_2 + H_2O$

Section A

25 marks

1. You are provided with four test tubes, distilled water, bromine solution, sodium hydroxide solution and phenolphthalein indicator. You are also provided with unknown liquids labelled **W**, **X**, **Y** and **Z** which are hexane, ethanol, cyclohexene and ethanoic acid but not necessarily in that order.

   a. Perform the tests given in the Flow diagram in the figure below and complete the diagram by filling in the letters **W**, **X**, **Y** and **Z** in the appropriate boxes.

   (8 marks)

   b. Identify liquids **W**, **X**, **Y** and **Z**.

   W: ______________________

   X: ______________________

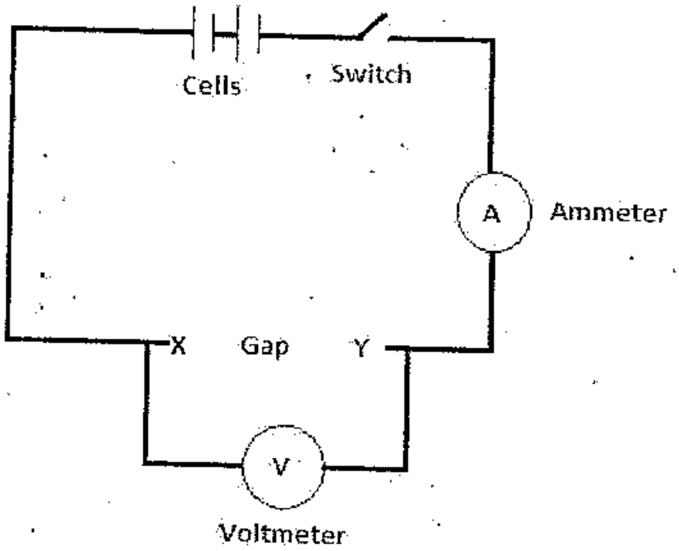
   Y: ______________________

   Z: ______________________

   (4 marks)

2. You are provided with a nichrome wire, metre rule, 2 cells, a cell holder, a voltmeter, an ammeter, a switch and connecting wires.

   a. Connect the circuit shown in the figure.



   b. Measure 80 cm of the nichrome wire and connect it on the gap **XY**.

   c. Close the switch.

   d. Read and record the ammeter and voltmeter readings in the appropriate spaces in the **table of results**.

   e. Calculate resistance and record it in the appropriate space in **table of results**.

   f. Repeat steps (**b**) to (**e**) for the lengths of nichrome wire shown in the **table of results**.

Table of results

Length (cm)	**Ammeter reading (A)**	**Voltmeter reading (V)**	**Resistance (V/I)**
80			
60			
40			

20			

(6 marks)

g. Plot a graph of length against resistance. **(6 marks)**

h. What is the relationship between length of wire and resistance?

(1 mark)

Section B

25 marks

3. a. Define a "standard solution". **(1 mark)**

b. Explain how 500 cm^3 of a 0.2 M sodium chloride solution can be prepared using sodium chloride crystals. Explanation should include all the necessary mathematical calculations. (Relative atomic mass of Na = 23 and Cl = 35.5). **(12 marks)**

4. a. Describe an experiment that could be carried out to determine the average speed of an athlete given the following materials: tape measure, stop watch and a whistle. **(10 marks)**

b. State any **two** possible sources of error in the experiment.

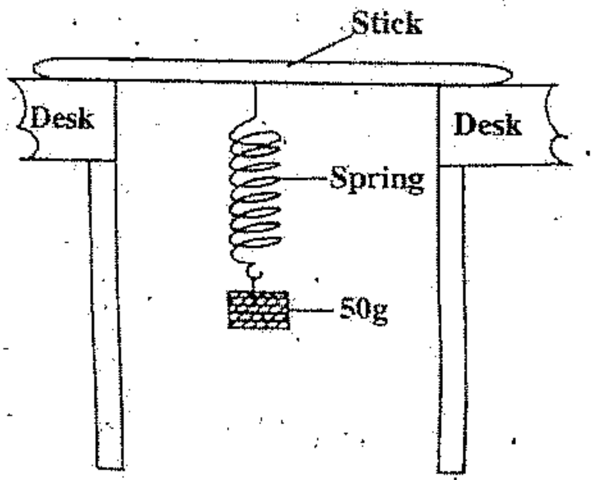
(2 marks)

Section A

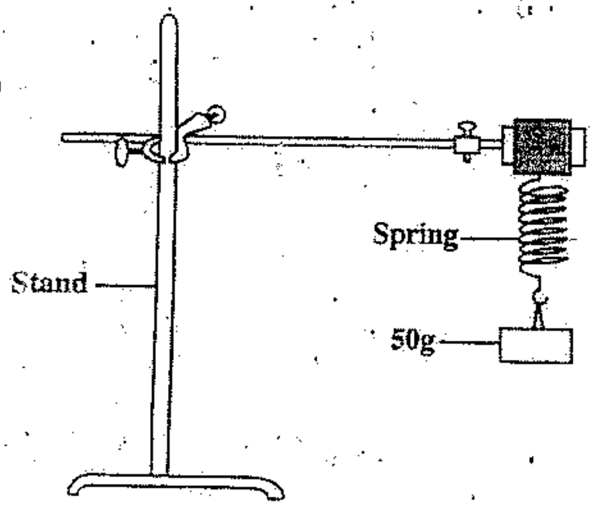
25 marks

1. You are provided with a spring, clamp and clamp stand, stop watch and 4 masses (50 g, 100 g, 150 g and 200 g).

   a. Arrange the apparatus as shown below.



or



   b. Pull the mass downwards by a small amount and leave it to vibrate freely.

   c. Record the time taken to make 10 complete vibrations.

   d. Repeat steps **b** and **c** using 100 g, 150 g and 200 g masses respectively.

   e. Complete the column for number of **vibrations per second** in the table.

Mass (g)	Time for 10 complete vibrations (sec)	Number of vibrations per second (frequency)
50		
100		
150		
200		

(6 marks)

   f. Plot a graph of number of vibrations per second (frequency) against mass. **(5 marks)**

   g. Using the graph, determine how mass affects the number of vibrations per second. **(1 mark)**

2. You are provided with four beakers, distilled water, a measuring cylinder, sand paper and solutions of copper sulphate, zinc sulphate, iron sulphate and magnesium sulphate. You are also provided with pieces of copper, zinc, iron and magnesium metals.

   a. Pour about 2 cm^3 of copper sulphate solution into each of the four beakers.

   b. Clean the copper, zinc, iron and magnesium metals using sand paper.

   c. Put a piece of each metal into each of the four beakers containing copper sulphate solution.

d. Observe the contents of the beakers for 2 to 3 minutes.

e. Record the results in the table below by indicating **"Reaction"** or **"No reaction"**.

f. Rinse the beakers with distilled water.

g. Repeat steps **(a)** to **(f)** using solutions of zinc sulphate, iron sulphate and magnesium sulphate, respectively.

Table of Results

Metals / Solutions	Copper	Zinc	Iron	Magnesium
Copper sulphate				
Zinc sulphate				
Iron sulphate				
Magnesium sulphate				

(12 marks)

h. Use the results to arrange th metals in order of increasin reactivity. (1 mark)

Section B 25 marks

3. a. Mention any **two** properties of light. **(2 mark**

b. With the aid of a labelled diagrar describe how a pure spectru could be produced from whi light. **(11 mark**

4. With the aid of a clearly labell diagram, describe how impure copp could be purified by electrolysis. T description should include releva chemical equations.

(12 mark

Section A 25 marks

1. You are provided with a candle, matches, meter ruler, lens, lens holder and a screen.

   a. Arrange the apparatus as shown in **Figure 1** below.

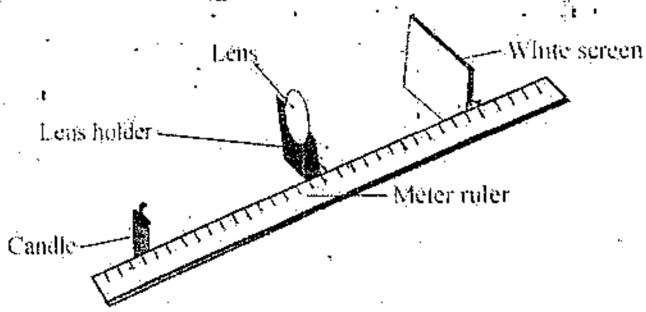


Figure 1

   b. Light the candle.

   c. Move the object (candle) until it is 20 cm away from the lens.

   d. Move the screen until a clear image of the object is formed on the screen.

   e. Measure the image distance, **V** and record it in the table of results.

   f. Repeat steps **c** to **e** for object distances shown in the table.

   g. Complete the (U + V) column of the table.

Table of results

Object distance, U (cm)	Image distance, V (cm)	(U + V) cm
20		
25		
30		
40		
50		

(5 marks)

   h. Plot a graph of **(U + V)** against **U**.

(5 marks)

   i. Use the graph to find the focal length of the lens. **(2 marks)**

2. You are provided with two test tubes in a rack, a measuring cylinder, thermometer, spatula, tap water, ammonium chloride (NH_4Cl) crystals and sodium hydroxide ($NaOH$) pellets.

   a. Pour 5cm^3 of water into each test tube.

   b. Measure the initial temperature of water in each test tube and record the results in the appropriate spaces in the table.

   c. Add half spatula of ammonium chloride (NH_4Cl) crystals in one test tube and shake gently.

   d. Measure the temperature of the ammonium chloride solution and record the results in the table.

   e. Repeat steps c and d using sodium hydroxide ($NaOH$) pellets.

Table of Results

Solution	Initial Temperature (^0C)	Final Temperature (^0C)	Temperature change (final temperature − initial temperature) (^0C)
Ammonium Chloride (NH_4Cl)			
Sodium hydroxide (NaOH)			

(6 marks)

f. State whether the change in each case is exothermic or endothermic.

Ammonium chloride: _ **(1 mark)**

Sodium hydroxide: ___ **(1 mark)**

g. Draw **two** energy level diagrams to illustrate the dissolving of ammonium chloride and sodium hydroxide. **(4 marks)**

h. State any **one** source of error in the experiment. ______ **(1 mark)**

Section B 25 marks

3. a. Give **one** advantage of local method of preparing alcohol over modern technology. **(1 mark)**

b. With the aid of a well labelled diagram, describe how alcohol (Kachasu) can be produced locally from cereals, sugar and water.

4. **Figure 2** is a diagram showing forces A, B and C acting on a ball which is falling through a liquid.

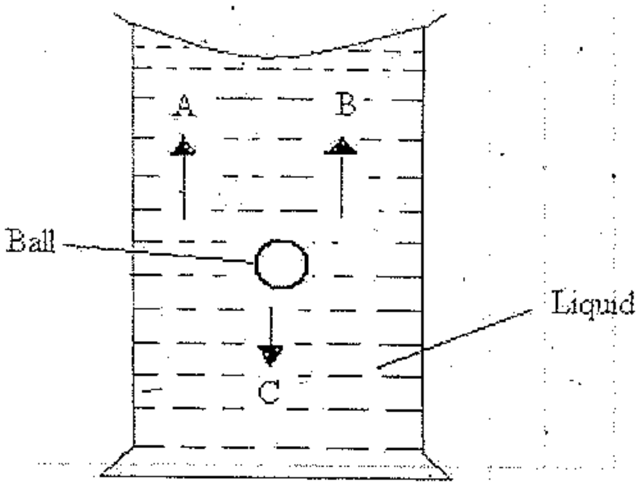


Figure 2

a. Name the forces **A, B** and **C**.

A: ____________________

B: ____________________

C: ______________ **(3 marks)**

b. With the aid of a well labeled diagram, describe an experiment that could be done to demonstrate that resistance of a media affects the speed of an object falling through the media.

Your description should use: 2 identical ball bearing, water, oil and 2 transparent jars of the same size. **(9 marks)**

Section A

25 marks

1. You are provided with a voltmeter, an ammeter, a resistance wire, a cell and connecting wires.

   a. Connect a circuit as shown in **Figure 1**.

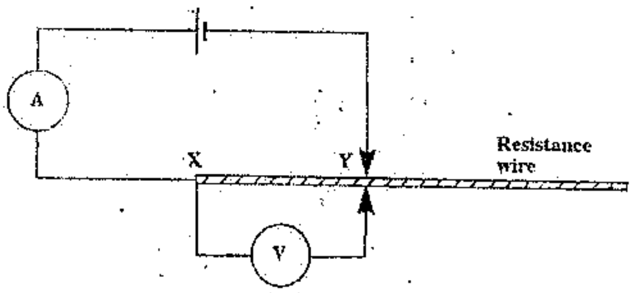


Figure 1

   b. Move the crocodile clip **Y** along the resistance wire until the ammeter reads 0.9A.

   c. Measure the voltage across length **XY** of the resistance wire.

   d. Record the voltmeter reading in appropriate space in **Table 1**.

   e. Move the crocodile clip **Y** along the resistance wire until the ammeter now reads 0.7A.

   f. Measure the new voltmeter reading across the new length **XY** of the wire.

   g. Record the voltmeter reading in **Table 1** under 0.7A.

   h. Repeat steps **e**, **f** and **g** for ammeter readings of 0.5A, 0.4A, and 0.3A.

Table 1

Ammeter reading (A)	0.9	0.7	0.5	0.4	0.3
Voltmeter reading (V)					

(5 marks)

   i. Disconnect the circuit.

   j. Plot a graph of voltage against current. **(6 marks)**

   k. From your graph find the voltage when current is zero. **(1 mark)**

   l. What can you say about the voltage in (**k**)? **(1 mark)**

   m. Arrange the apparatus as you found it.

2. You are provided with a set of test tubes and unknown organic substances labelled **X**, **Y** and **Z**. You are also given the following reagents: Bromine solution, dilute NaOH, distilled water and phenolphthalein indicator. On each unknown compound perform the tests shown in **Table 2** and record your observations in the appropriate spaces. Remember to wash the tube after each test.

Table 2

Test	Substance X	Substance Y	Substance Z

Add 2 drops of unknown substance to 15 drops of distilled water in a test tube.			
Add 2 drops of unknown substance to 15 drops of bromine solution in a test tube			
To 15 drops of dilute NaOH in a test tube add 2 drops of phenol-phthalein indicator. now add 2 drops of unknown substance.			

(9 marks)

On the basis of observations made, state the family of organic compounds to which each of the substances belongs.

X: ______________________

Y: ______________________

Z: ______________________ **(3 marks)**

Section B

25 marks

3. With the aid of a well labelled diagram, describe an experiment that could be done to show that frequency of a vibrating pendulum increases with decrease in length of string.

(12 marks)

4. a. What is the difference between "strong acid" and "weak acid"?

(1 mark)

b. With the aid of a well labelled diagram, describe an experiment that could be done to distinguish a strong acid from a weak acid using the conductivity apparatus.

(12 marks)

Section A — 25 marks

1. You are provided with a string, a meter ruler, mass, stop watch, clamp and clamp stand.

   a. Arrange the apparatus as shown in **Figure 1**.

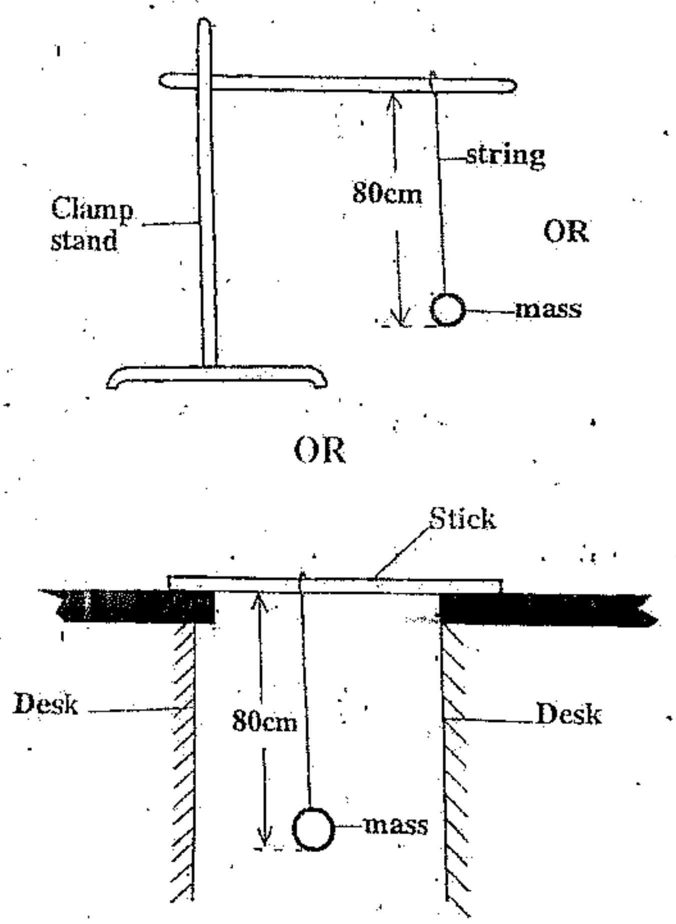


Figure 1

   b. Pull the mass sidewards by a small amount and allow it to swing freely.

   c. Record in the table of results the time taken to make 10 complete vibrations.

   d. Calculate frequency and record it in the table.

   e. Repeat steps **b**, **c**, and **d** for the following lengths of the string: 60 cm, 40 cm and 20 cm.

Table of results

Length of pendulum (cm)	Time for 10 vibrations (s)	Frequency $\left(\frac{\text{Number of vibrations}}{\text{Time (s)}}\right)$
80		
60		
40		
20		

(6 marks)

   f. Plot a graph of frequency against length of pendulum. **(5 marks)**

   g. Use the graph to describe the relationship between frequency and length of a pendulum.

(2 marks)

2. You are provided with a burette, beaker or conical flask, a retort stand, a measuring cylinder, ethanoic acid (CH_3COOH), 0.1 M sodium hydroxide (0.1 M NaOH) and phenolphthalein indicator.

   a. Set up the apparatus as shown in **Figure 2**.

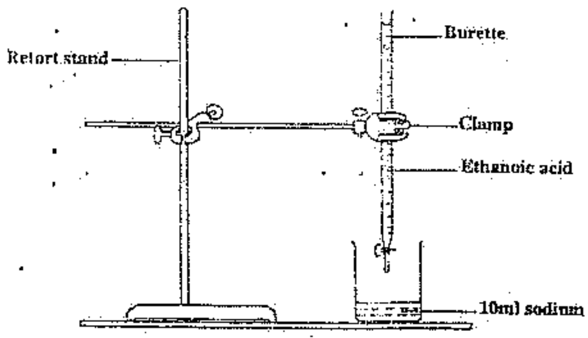


Figure 2

   b. Measure 10 ml of the 0.1 M

sodium hydroxide and pour it into a beaker.

c. Add 2 drops of phenolphthalein indicator into the beaker.

d. Pour 20 ml of ethanoic acid into the burette.

e. Slowly add the ethanoic acid from the burette into the beaker and shake until colour change is observed.

f. Record the results in the appropriate spaces in the table of results.

Table of Results

Initial volume of acid (ml)	Final volume of acid (ml)	Volume of acid used (ml)

(3 marks)

g. Write a balanced chemical equation for the reaction.

(3 marks)

h. Calculate the concentratio[n] of ethanoic acid used in th[e] experiment. **(4 marks**

i. Give **two** ways of reducing erro[r] in the experiment. **(2 marks**

Section B

25 marks

3. In a laboratory, labels fell off fro[m] bottles containing an alkane, an alken[e] an alkanol and a carboxylic aci[d] Describe an experiment that could b[e] done to identify the contents of th[e] bottles. **(12 marks)**

4. a. State any **three** properties of wate[r] waves. **(3 marks)**

   b. Plain water waves are passe[d] through two obstacles; one with [a] narrow gap and the other with [a] wide gap. With the aid of diagrams describe the waves emerging fro[m] the gaps. **(10 marks)**

Section A

25 marks

1. You are provided with a candle, matches, meter ruler, lens, lens holder and a screen.

   a. Arrange the apparatus as shown in **Figure 1** below:

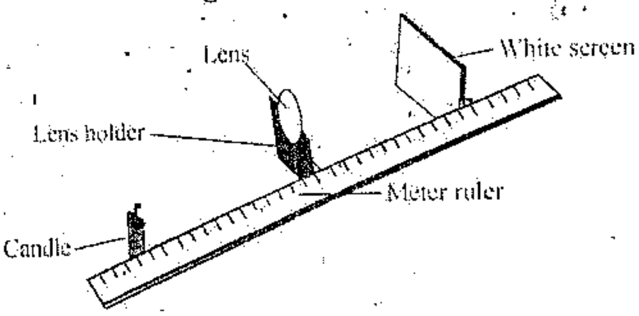


Figure 1

   b. Light the candle.

   c. Move the object (candle) until it is 50 cm away from the lens.

   d. Move the screen until a clear image of the object is formed on the screen.

   e. Measure the image distance, **v** and record it in the table of results.

   f. Repeat steps (c) to (e) for object distances shown in the table.

   g. Complete the **1/v** and **1/u** columns of the table.

Table of results

Object distance, u (cm)	Image distance, v (cm)	1/v	1/u
50			
40			
30			
25			
20			

(6 marks)

   h. Plot a graph of **1/v** against **1/u**. **(5 marks)**

   i. Use the graph to find the focal length of the lens. **(2 marks)**

2. You are provided with 3 test tubes, measuring cylinder, distilled water, a test tube rack, copper sulphate solution, aluminium sulphate solution, iron sulphate solution, copper foil, aluminium foil and iron nails.

   a. Pour 2 cm^3 of copper sulphate solution in each of the 3 test tubes.

   b. Place a piece of copper foil, aluminium foil and an iron nail in each test tube.

   c. Observe and record the results by indicating "reaction" or "no reaction" in the appropriate spaces in the table below.

   d. Rinse the test tubes using distilled water.

   e. Repeat steps (a) to (d) using aluminium sulphate and iron sulphate solutions.

Table of results

Metal	Copper sulphate solution	Aluminium sulphate solution	Iron sulphate solution
Copper			

Aluminium			
Iron			

(9 marks)

f. Arrange the metals in order of their reactivity, with the most reactive metal at the top.

(2 marks)

g. Which of the metals is the strongest reducing agent?

(1 mark)

Section B

25 marks

3. With the aid of a labelled velocity – time graph, describe the motion of a sky diver dropped from an aeroplane in the sky before and after the parachute opens. **(12 marks)**

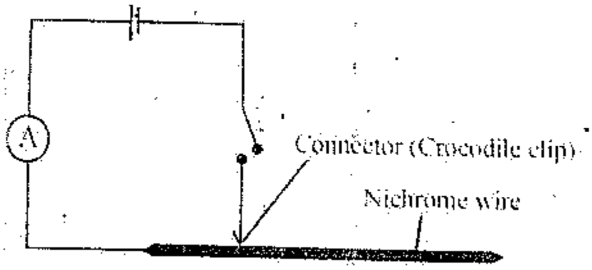
4. Using concentrated solutions of ammonia and hydrochloric acid, describe an experiment that could be done to demonstrate that light particles travel faster than heavy particles. The description should include the following materials: glass tube, corks and cotton wool. **(13 marks)**

Section A

25 marks

1. You are provided with a cell, cell holder, ammeter, voltmeter, 1 meter nichrome wire, connecting wires and a switch.

   a. Connect a circuit as shown in the following figure:



   b. With the switch open, measure the voltage across the cell and current in the circuit.

   c. Record the voltage and current in the **table of results.**

   d. Close the switch and adjust the connector until the ammeter reads 0.2 A.

   e. Read the voltage across the cell and record in the appropriate space in the **table of results.**

   f. Repeat steps (**d**) and (**e**) using the ammeter readings given in the table.

   g. Complete the table by working out the voltage losses. (Voltage with switch open minus (-) voltage with switch closed).

Table of results

Current (A)	Voltage across cell (V)	"Lost voltage" (V)
0.2		
0.4		
0.6		

(4 marks)

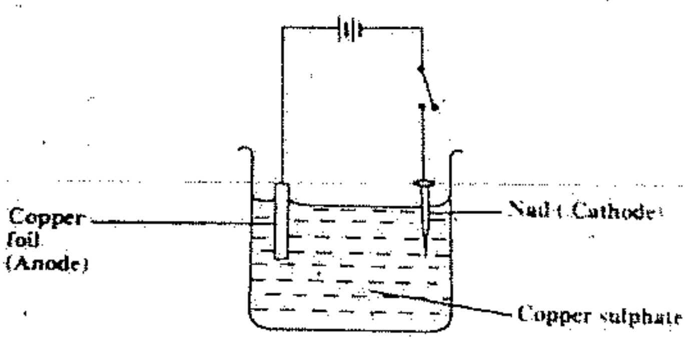
   h. Plot a graph of voltage across cell against current. **(5 marks)**

   i. Explain the cause of "voltage loss" when the switch is closed.

(3 marks)

2. You are provided with copper sulphate ($CuSO_4$) solution, a beaker, copper strip, 2 cells, connecting wires, an iron nail and a switch.

   a. Arrange the apparatus as shown in the following figure:



   b. Close the switch and observe the experiment for 5 minutes.

   c. Record your observations in the **table of results.**

Will conduct this one

Table of results

Metal	Initial colour	Final colour
Iron nail		
Copper foil		

(4 marks)

d. Using appropriate half equation, explain the observation on the iron nail. **(8 marks)**

e. Why is a copper strip used as the anode in the experiment?

(1 mark)

Section B

25 marks

3. a. With the aid of a labelled diagram describe an experiment that could be done to show how the frequency of a vibrating spring is affected by mass hung on the spring.

(12 marks

b. Mention **one** source of error in the experiment. **(1 mark)**

4. With the aid of a diagram, describe an experiment that could be done to show whether sugar and sodium chloride are molecular or ionic compounds.

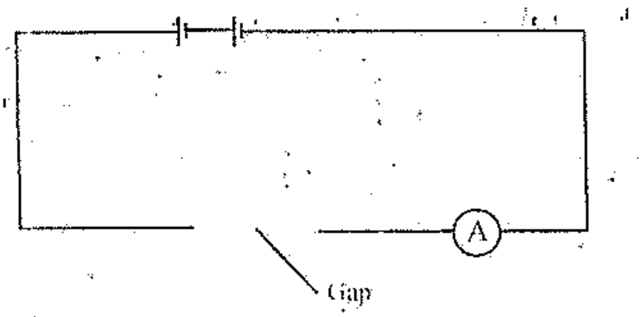
(12 marks

Section A

25 marks

1. You are provided with 2 cells, a cell holder, an ammeter, connecting wires and nichrome wire with different number of strands.

h. Set the apparatus as shown below.



i. Complete the circuit by placing nichrome wire with one strand in the gap.

j. Note the ammeter reading and record it in the table of results.

k. Remove the nichrome wire from the gap.

l. Repeat steps **b to d** using nichrome wires with two, three, four and five strands.

Table of results

Number of strands	Current (A)
1	
2	
3	
4	
5	

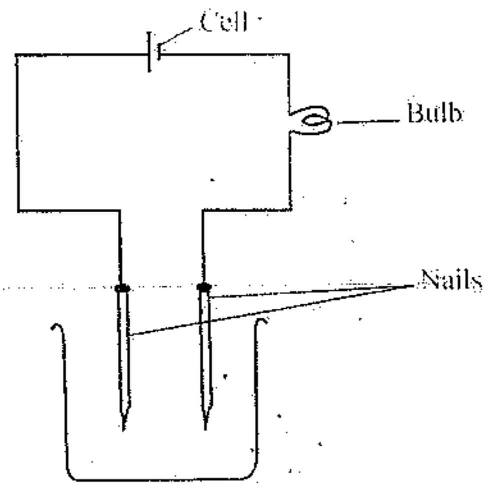
(5 marks)

m. Plot a graph of current against number of strands. **(5 marks)**

n. Use the graph to explain the results of the experiment. **(3 marks)**

2. You are provided with a cell, a bulb, a beaker, 2 nails, connecting wires and 40 ml of different liquids labelled **J**, **K**, **L**, **M**, **N** and **O**.

a. Set up the apparatus as shown below:



b. Pour 40 ml of liquid **J** into the beaker.

c. Dip the nails into the liquid.

d. Observe the bulb and record "light" or "no light" in the appropriate space in the table of results.

e. Remove the nails from the beaker.

f. Rinse the beaker and the nails with distilled water.

g. Repeat steps b to f using liquids **K**, **L**, **M**, **N** and **O**.

Table of results

Liquid	Observation
J	

K	
L	
M	
N	
O	

(6 marks)

h. Classify the liquids as ionic or covalent.

Ionic: ____________________

Covalent; ____________________

(6 marks)

Section B

25 marks

3. With the aid of a labelled diagram, explain how a slide projector works to produce an image.

(12 marks)

4. With the aid of labelled diagrams, describe an experiment that could be carried out to show that both water and oxygen are necessary for rusting.

(13 marks)

SUGGESTED ANSWERS

2000 PAPER II Model Solutions

1.

TEST / SUBSTANCE	Add 5 drops phenolphthalein to 15 drops unknown RESULTS	Add 5 drops HCl (acid) to 15 drops unknown RESULTS	Put 2 drops of unknown on spatula and bring burner flames RESULTS
K	No colour change	No colour change	Burns in air (oxygen)
L	Turns pink or purple	No colour change	No burning
M	No colour change	No colour change	No burning
N	No colour change	Precipitate formed	No burning

K – Alkane, L – sodium hydroxide, M – chloroalkane, and N – sodium bicarbonate.

Note: In answering this question, the assumption is that the confidential instructions indicated that dropper bottles K, L, M and N contained alkane, sodium hydroxide, chloroalkane and sodium bicarbonate respectively.

2. f.

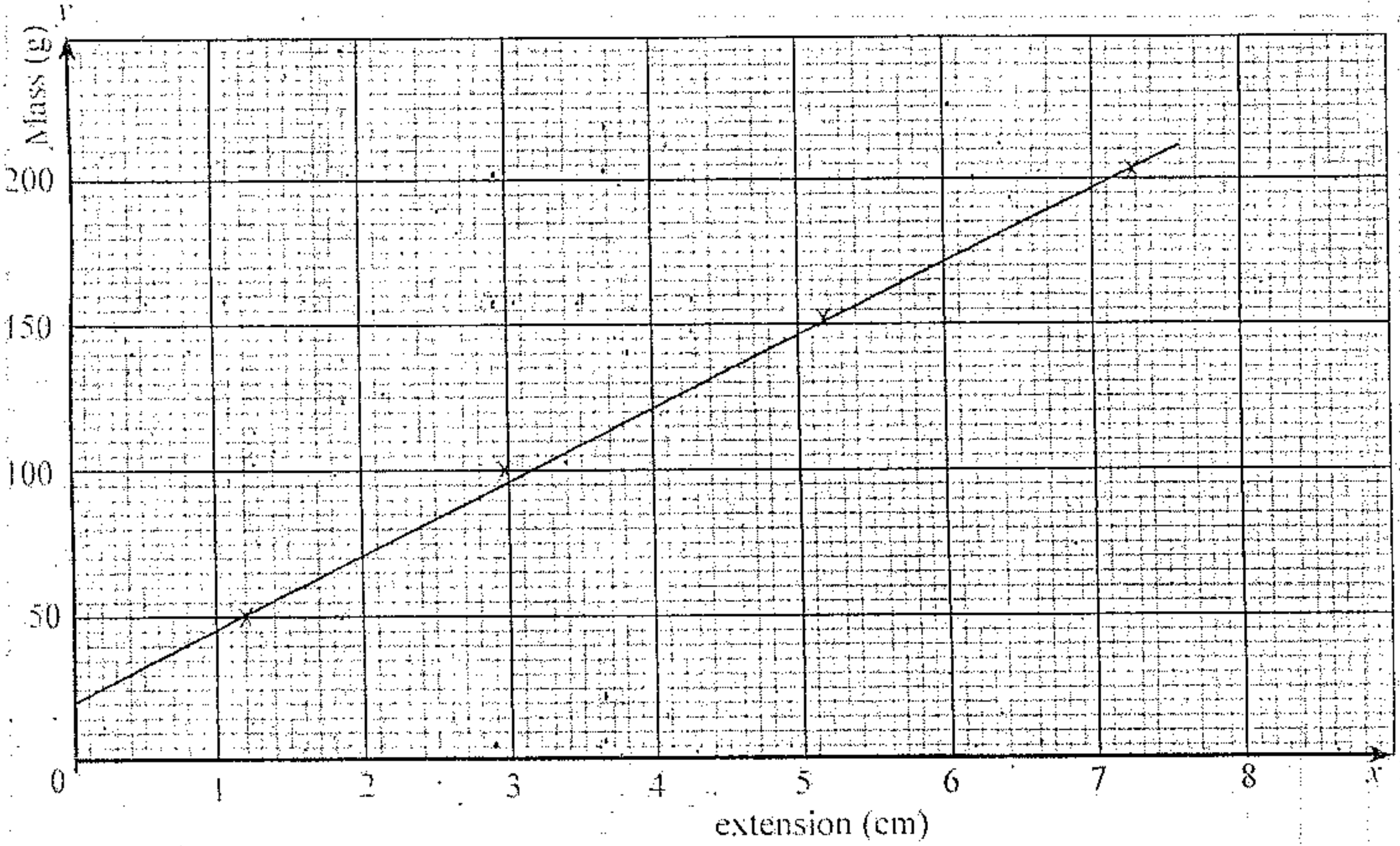
Mass (g)	0	50	100	150	200
Length (cm)	2.2	3.4	5.2	7.4	9.5
Change in length (extension) cm l (new) – l (initial)	0	1.2	3.0	5.2	7.3

g. graph paper to be provided

h. Gradient $= \frac{y_2 - y_1}{x_2 - x_1} = \frac{(150-50)g}{(5.2-1.2)cm}$

$= 25$ g/cm

Mass (g) against Extension (cm)



3. a. A solution is a mixture of a solute and solvent in which a solute has completely dissolved in a solvent.

   b. (i) grams per dm^3 or grams per litre and

      (ii) moles per dm^3 or moles per litre

   c. Firstly, mass of solid NaOH required must be calculated:

      Number of moles = molarity × volume

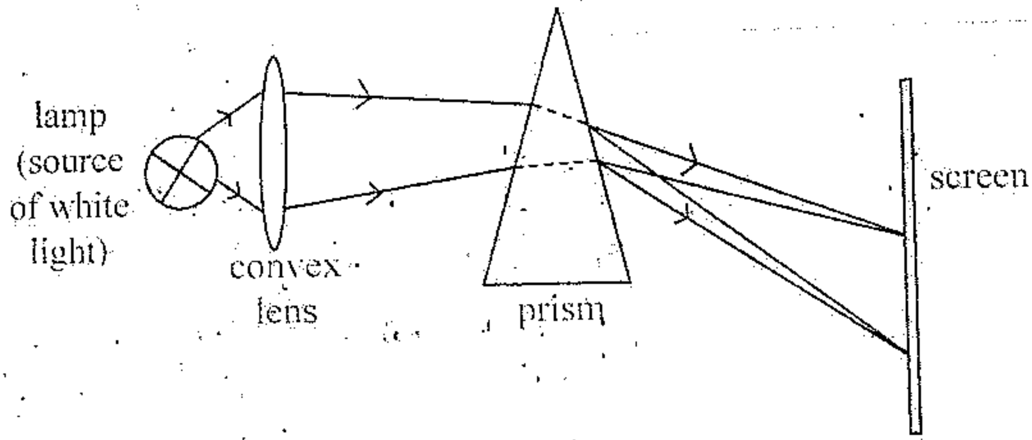
      0.2 M × (250/1000) litre = 0.05 mol

      Mass of NaOH required = number of moles × RFM

      = 0.05 mol × 40 g/mol = 2 g

Using a triple beam balance or electronic digital balance, an exact mass of 2 g solid NaOH is weighed and transferred into a volumetric flask of capacity 250 ml. Distilled water is slowly added to solid NaOH while stirring using a glass rod. The distilled water is added until all the mass is completely dissolved and the mark is reached. The solution prepared has a concentration of 0.2 M.

4.



An apparatus is arranged as shown in the diagram. The filament of a lamp (bulb) acts as a narrow source of white light. The rays of white light are incident on the convex lens. The convex lens converges (brings together) the parallel rays of light on the prism. As the light passes through the prism, the light splits into a range of colours. White light is actually a mixture of colours rather than a single colour, and the prism refracts these different colours by different amounts. The band of colours obtained on the white screen is called a spectrum and the colours are in this order: red, orange, yellow, green, blue, indigo and violet (ROYGBIV).

2001 PAPER II Model Solutions

1.

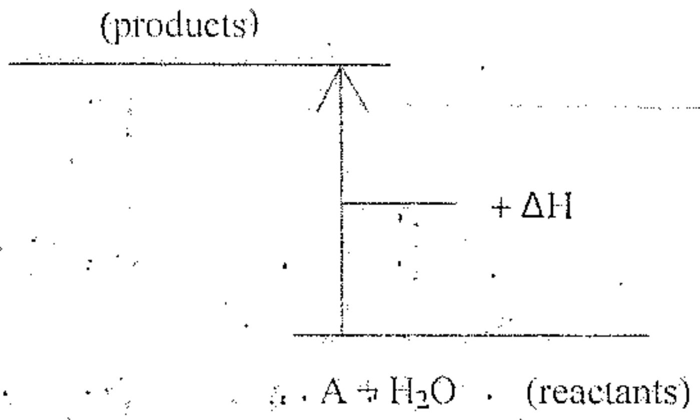
Solution	Initial temperature (°c)	Final temperature (°c)	Change in temperature (°c)
A	24	22	-2
B	24	29	+5

Note: In answering this question, the assumption is that the confidential instructions indicated that substance A is ammonium nitrate or ammonium chloride or sodium hydrogen carbonate and substance B is sodium hydroxide.

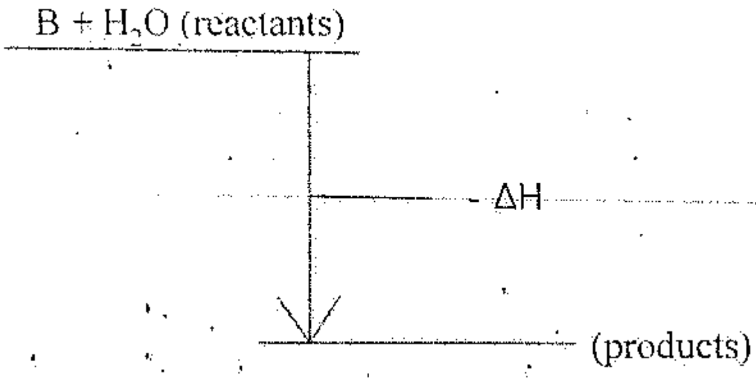
j. A is endothermic

B is exothermic

k. (i) Solution A



(ii) Solution B

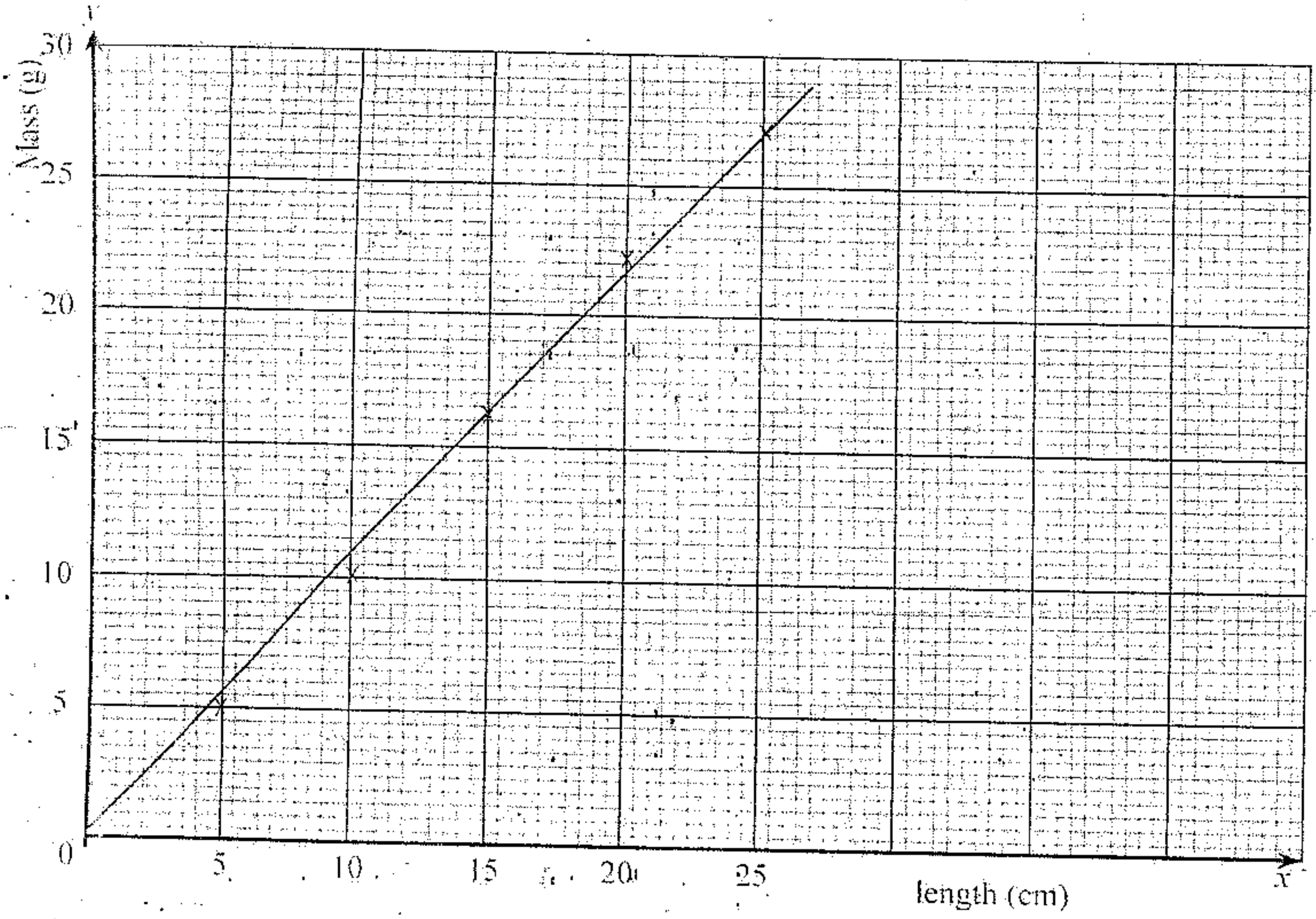


2. a.

Length of pipe (cm)	0	5	10	15	20	25
Mass of pipe (grams)	0	5	10	16	22	27

b.

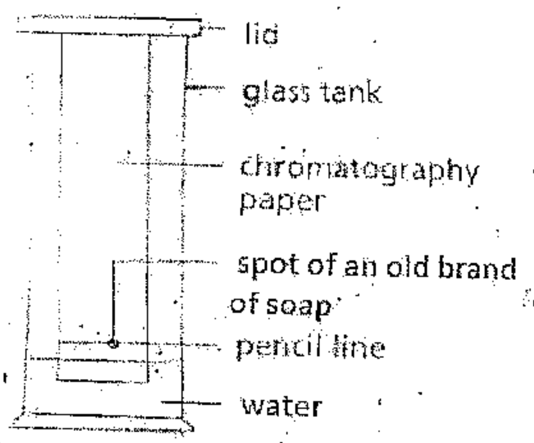
Mass (g) against Length (cm)

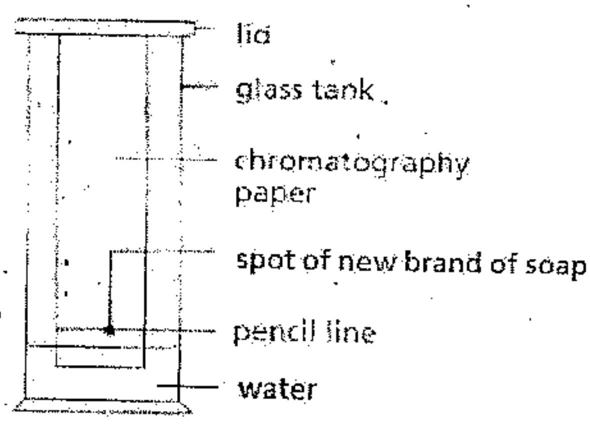


c. Slope $= \frac{y_2 - y_1}{x_2 - x_1} = \frac{(27-0)g}{(25-0)cm}$

$= 1.1$ g/cm

3.

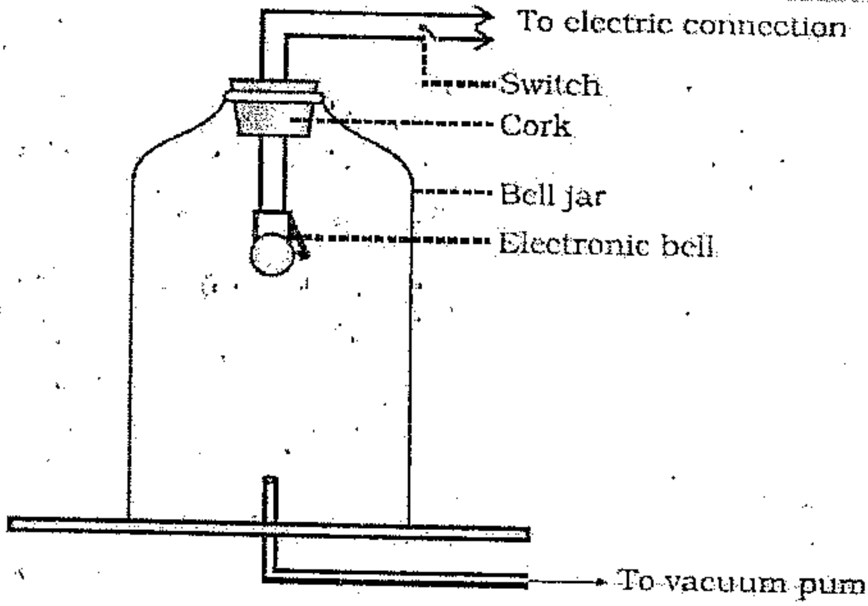




The apparatus is arranged as shown in the two diagrams. The liquid solvent (such as water rises by capillary action up the chromatography paper (filter paper). While passing ove the mixture spot (red soap spot), the solvent dissolves the spot and the mixture then rise up the paper; being carried inside the liquid solvent. But the ingredients of the mixtur have different solubilities i.e. some are more soluble than others in the solvent. The mor soluble ingredients adhere (cling) to the chromatography paper less strongly than the les soluble. Such difference makes the ingredients to rise up the chromatography paper a different speeds. This causes the separation of the ingredients thereby rising at differer heights. As each ingredient dries up, a pattern of spots is then formed and finally th components of the dyes of the soap could be isolated. Finally, the chemist can compar the components of the dyes of the two brands of soap to see if they are different.

4. a. Sound is produced by vibrations as such it travels faster in solids than in gase because the particles in solids are more closely packed than in liquids.

b.



An apparatus is arranged as shown in the diagram. The jar is well sealed and the electri bell is made to ring. The sound could be heard clearly from outside of the jar by a observer. The vacuum pump is then started up. After some time the sound becomes fainte (quieter) and fainter until finally the bell could no longer be heard from the outside. Th bell could be seen to be working, because of the continued movements of the strikin hammer from the outside. Finally, air is allowed to enter the jar once more and the resul is that the sound is heard again loudly. This is an indication, therefore, that sound cannc travel through a vacuum. Sound needs a medium to carry its energy.

In summary, the above experiment demonstrates that without a medium sound cannc propagate and hence for the propagation of sound medium must be present.

2002 PAPER II Model Solutions

1.

- temperature of water before heating = 24 °C
- temperature of water after heating = 42 °C
- mass of lamp plus ethanol before heating = 432 g
- mass of lamp plus ethanol after heating = 429 g
- mass of ethanol used up = (432 – 429) = 3 g

h. $\mathbf{H = m \times c \times \Delta T}$

$H = 200\ g \times 4.2\ J/g\,^\circ C \times 18\ ^\circ C$

$H = 15120\ J$

Note: 1 cm^3 of water has a mass of 1 g hence 200 cm^3 weighs 200 g. c is the specific heat capacity of water and temperature change (ΔT) = 42 °C – 24 °C = 18 °C

i. 15120 J

j. Heat supplied per gram of ethanol $= \frac{\text{heat supplied}}{\text{mass}} = \frac{15120\ J}{3\ g} = 5040\ J/g$

k. (1) Incorrect reading of the instruments i.e. thermometer and beam balance.

(2) Some of the heat energy supplied by ethanol is lost since the beaker is not covered (sealed).

(3) Faulty instrument (instrument error).

2.

Initial volume of Hydrochloric acid (cm^3)	Final volume of Hydrochloric acid (cm^3)	Volume of HCl used (cm^3)
00	9.8	9.8
9.8	19.7	9.9

j. Average volume of HCl used $= \frac{9.8 + 9.9}{2}$

$= 9.85$

$= 9.9\ cm^3$ (to 1 d.p.)

k. $$\frac{C_1 \times V_1}{n_1} = \frac{C_2 \times V_2}{n_2}$$

$$\frac{C_1 \times 10cm^3}{1} = \frac{0.1\ M \times 9.9cm^3}{1}$$

$$C_1 = 0.099$$

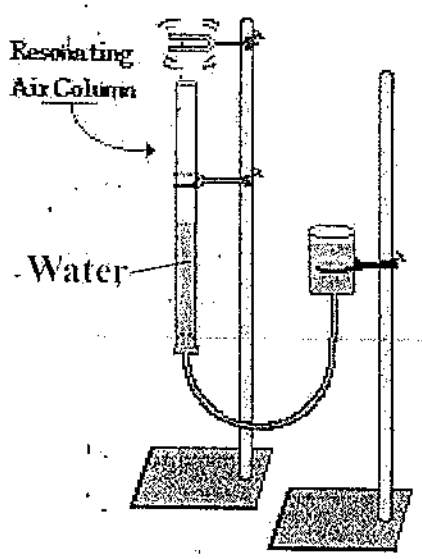
Concentration of NaOH is 0.1 M (to 1 d.p.)

Note: n_1 and n_2 are determined from a balanced chemical equation involving the reaction between HCl and NaOH i.e. 1 mole of HCl reacts with 1 mole of NaOH:

$HCl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$

3. a. Resonance is the effect that takes place when a body is made to vibrate at its natural frequency by vibrations received from another vibrating source of the same frequency.

b.



Tuning fork forcing air couran into resonance

The apparatus is set as shown in the diagram. The length of the air column is adjusted by raising and lowering a reservoir of water (dyed red). The raising and lowering of the reservoir adjusts the height of water in the open-air tube, and thus adjusts the length of the air column inside the tube. As the length of the air column is decreased, the natural frequency of the air column is increased.

While adjusting the height of the liquid in the tube, a vibrating tuning fork is held above the air column of the tube. When the natural frequency of the air column is tuned to the frequency of the vibrating tuning fork, resonance occurs and a loud sound results. The vibrating tuning fork forces air particles within the air column into vibrational motion.

In conclusion, resonance occurs when two interconnected objects share the same vibrational frequency. When one of the objects is vibrating, it forces the second object into vibrational motion. The result is a large vibration. And if a sound wave within the audible range of human hearing is produced, a loud sound is heard.

c. (i) A child's swing (a playground swing) can be made to swing high by someone pushing in time with the free swinging.

(ii) A person on a diving board – jumping up and down of the diver is the 'forcing vibration' and the 'following vibration' are the vertical oscillations of the diving board itself.

4. a. Concentration

The products of a reaction are formed as a result of the collisions between reactant particles. There are more particles in a more concentrated solution than in a less concentrated (dilute) solution. Collisions of particles occur more often in a more concentrated solution. The more often they collide, the greater the chance they have of reacting. This means that the rate of a chemical reaction will increase if the concentration of reactants is increased.

b. Temperature

When the temperature at which the reaction is carried out is increased, the energy that the particles have also increases – the particles move faster. This increases the number of collisions of reacting particles, and the collisions which occur are more energetic and so more likely to form products. Therefore, if the temperature at which a reaction takes place is increased then the rate of reaction will increase.

c. Particle size

When the particle size of the reactants is decreased it means the surface area has been increased i.e. there is an increased amount of surface of reacting particles with which to collide. The products of a reaction are formed when collisions occur between reactant particles. Therefore, the increase in surface area (or the decrease in particle size) of the reacting particles increases the rate of reaction.

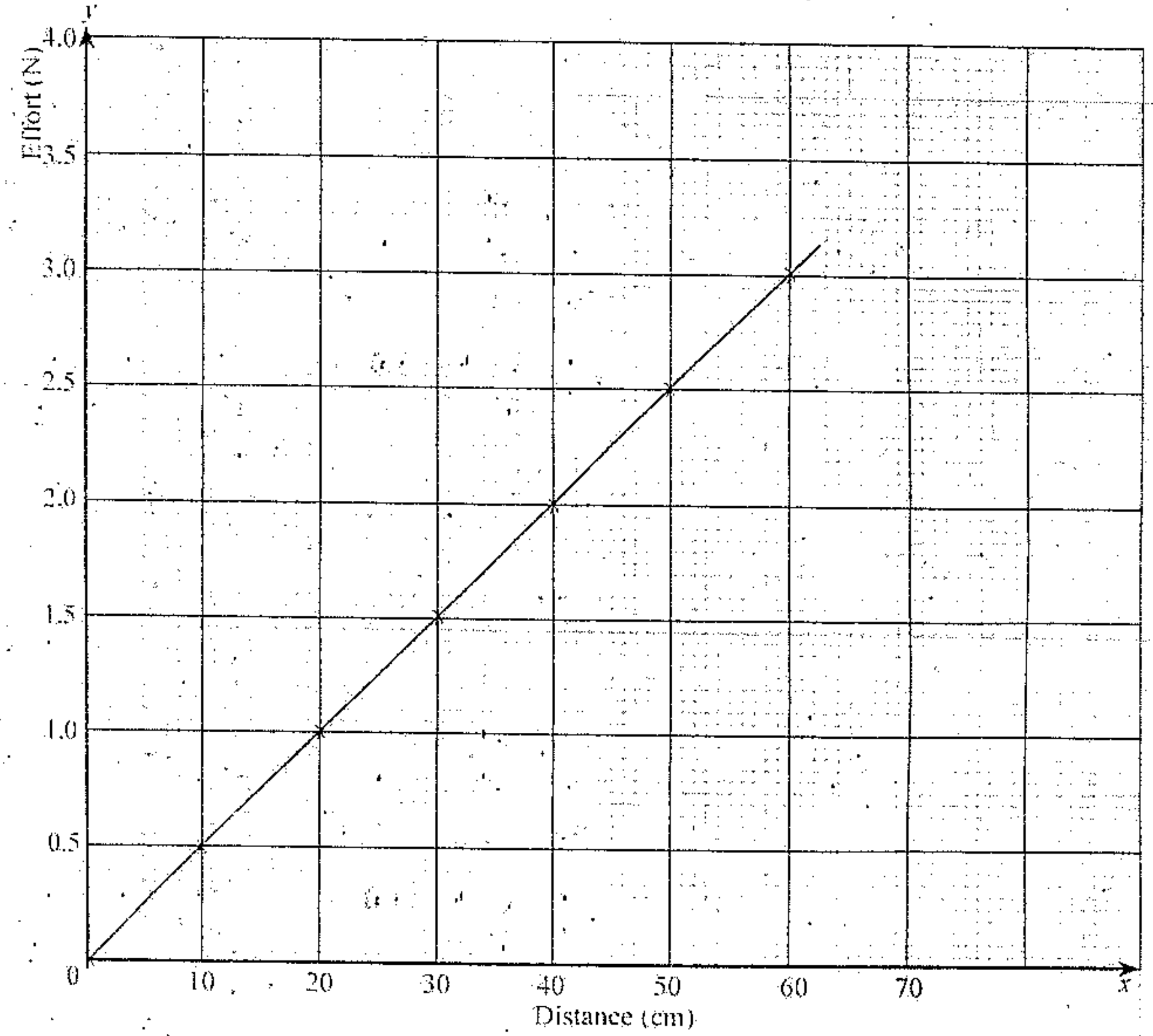
2003 PAPER II Model Solutions

1. e.

Distance between mass and fulcrum (cm)	Effort (N)
10	0.5
20	1.0
30	1.5
40	2.0
50	2.5
60	3.0

g.

Effort (N) against Distance (cm)



b. As the distance between mass and fulcrum increases the effort also increases. There is a direct relationship between distance and effort.

2. a. Mass of empty evaporating basin = 32.5 g

c. Mass of empty evaporating basin + hydrated $CuSO_4$ = 37.5 g

d. Mass of hydrated $CuSO_4$ = 5 g

f. Mass of empty evaporating basin + white $CuSO_4$ = 35.7 g

g. (Mass of evaporating basin + white $CuSO_4$) – mass of empty evaporating basin = 35.7 g – 32.5 g = 3.2 g

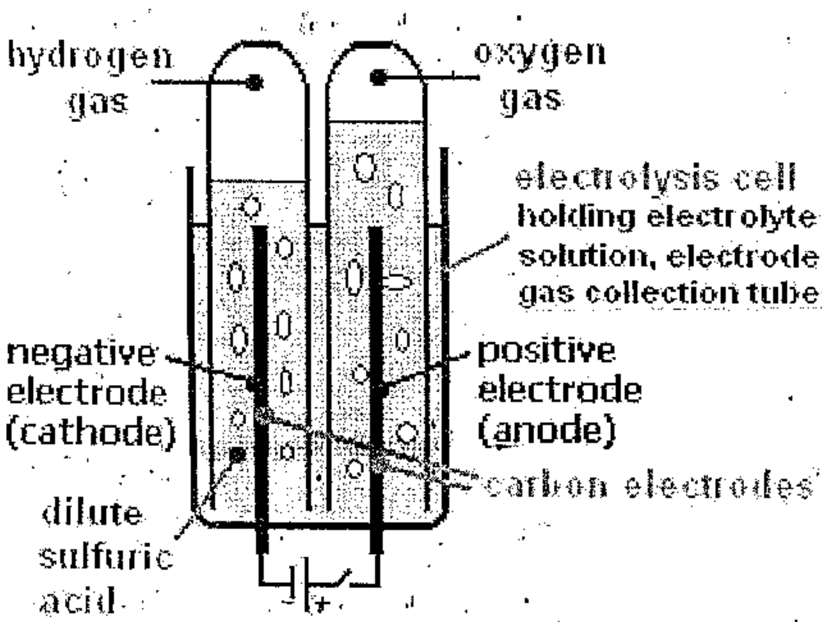
h. Mass of hydrated copper sulphate – mass of white powder = 5 g – 3.2 g = 1.8 g

i. Percentage of water in the hydrated copper sulphate = $\frac{1.8\ g}{5\ g} \times 100 = 36\%$

j. Water of crystallisation

k. (1) Faulty instrument or equipment e.g. a balance (2) Inaccurate reading of measurements i.e. mass on a balance (3) Incomplete heating of hydrated copper sulphate (i.e. not thoroughly heated to remove all the water

3.



The experiment is set up as shown in the diagram above. The switch is closed and observations are made and recorded. In the solution the following ions are present: H (aq), OH^- (aq), and SO_4^{2-} (aq).

The reaction at negative cathode electrode is a reduction (electron gain). The hydrogen ions (H^+) are attracted to the negative cathode and are discharged as hydrogen gas. So the hydrogen ions are reduced to hydrogen molecules by electron gain according to the half-equation:

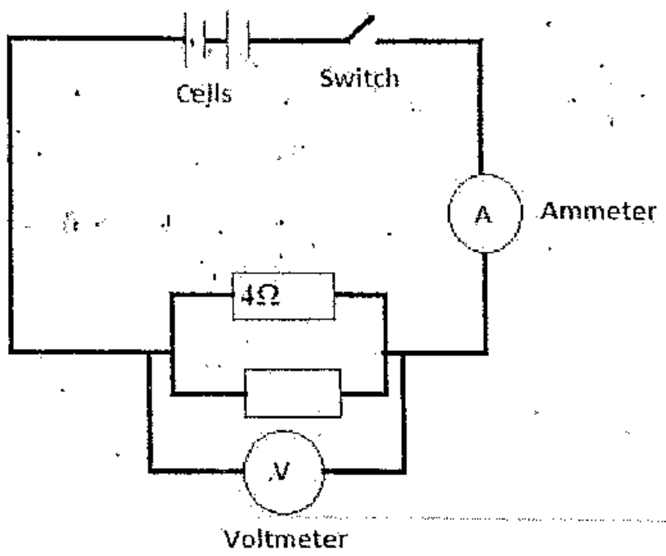
$2H^+ (aq) + 2e \rightarrow H_2 (g)$ (hydrogen gas, bubbles seen on the negative electrode)

The positive anode reaction is an oxidation electrode reaction (electron loss). The negative sulphate ions (SO_4^{2-}) or the traces of hydroxide ions (OH^-) are attracted to the positive electrode. But the sulphate ions are too stable and nothing happens. Instead either hydroxide ions or water molecules are discharged and oxidised to form oxygen.

$2H_2O (l) \rightarrow 4H^+ (aq) + O_2 (g) + 4e$ (oxygen gas released)

Overall equation for the electrolysis of dilute sulphuric acid is $2H_2O (l) \rightarrow 2H_2 (g) + O_2 (g)$; which is also the overall equation for the electrolysis of water.

4. a. (i)



(ii) Effective (combined) resistance = 2Ω

Using the following notations: $R_t = 2\Omega$, $R_1 = 4\Omega$, R_2 = unknown resistance

$$R_t = \frac{R_1 \times R_2}{R_1 + R_2}$$

$$2\Omega = \frac{4\Omega \times R_2}{4\Omega + R_2}$$

$2\Omega(4\Omega + R_2) = 4\Omega R_2$

$8\Omega^2 + 2\Omega R_2 = 4\Omega R_2$

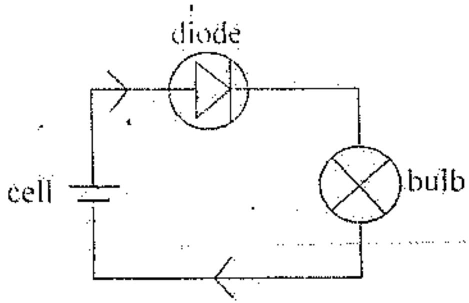
$8\Omega^2 = 2\Omega R_2$

$\frac{8\Omega^2}{2\Omega} = R_2$

$4\Omega = R_2$

Value of unknown resistance = 4Ω

b. (i)



(ii) When the cell is reversed the bulb does not give light. Practically, if the connections are the other way round, the diode does not conduct; its resistance is large and it is reversed biased.

2004 PAPER II Model Solutions

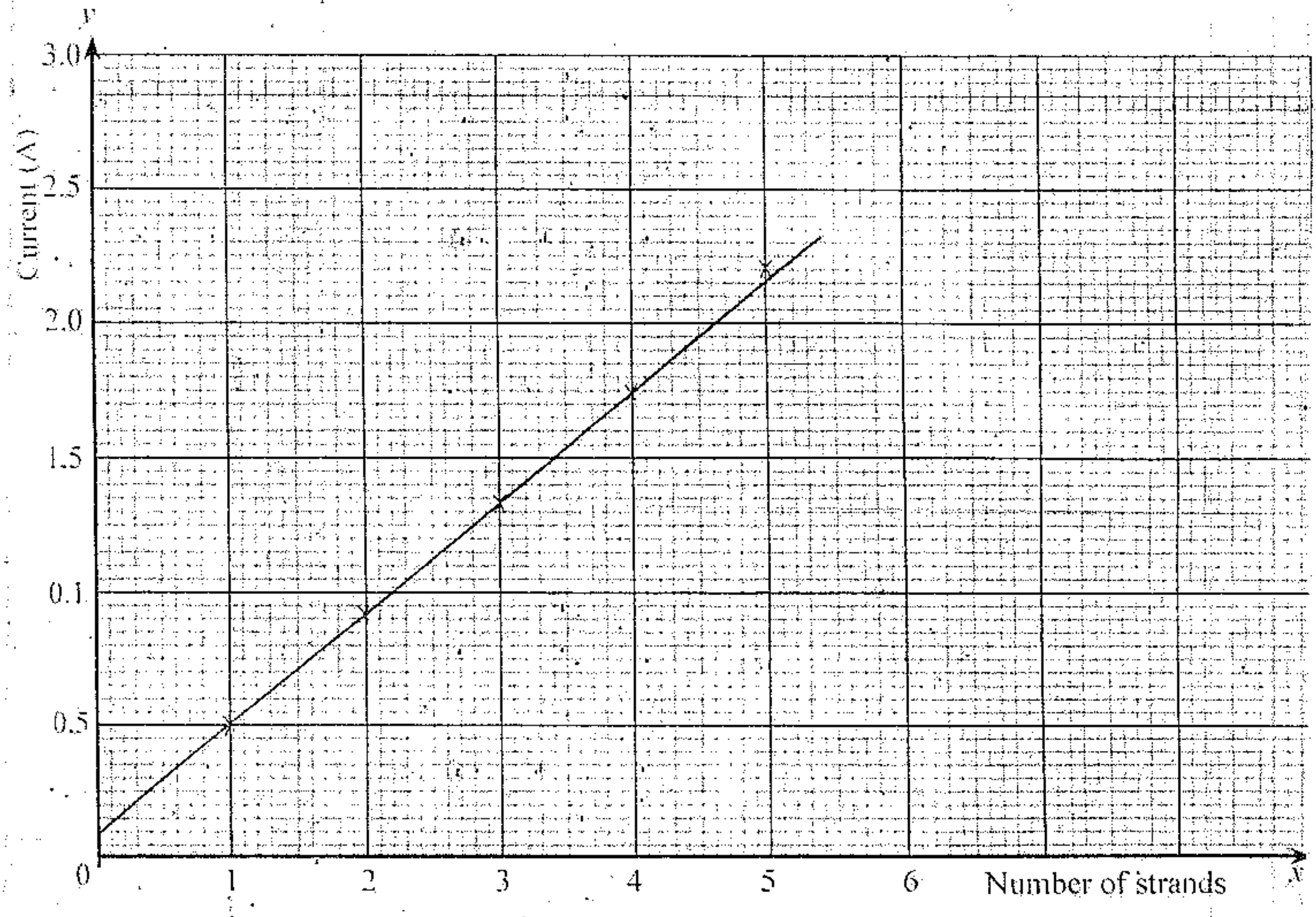
1. e.

Table of results

Number of strands	Current (A)
1	0.5
2	0.9
3	1.3
4	1.7
5	2.2

f.

Current (A) against Number of strands



g. The graph shows that as the number of strands increases the amount of curren flowing also increases (direct relationship). This is the case because increasin number of strands makes the thickness (cross-section area) to increase resultin into decreasing electrical resistance. As a result much current flows more easily i thicker wire (more strands) than in thinner wire (less strands).

2. a,

Test / Substance	Add 1 – 2 drops of substance to 15 drops of distilled water	Add 1 drop of phenolphthalein to 15 drops NaOH then 1 drop of substance	Add 1 – 2 drops of substance to 15 drops of bromine
	RESULT	RESULT	RESULT
P	One layer observed	The pink colour that is formed turns colourless	The brown colour remains the same
Q	Two layers observed	The pink colour remains the same	The brown colour remains the same
R	One layer observed	The pink colour remains the same	The brown colour remains the same
S	Two layers observed	The pink colour remains the same	The brown colour turns colourless

b.

P: Carboxylic acid

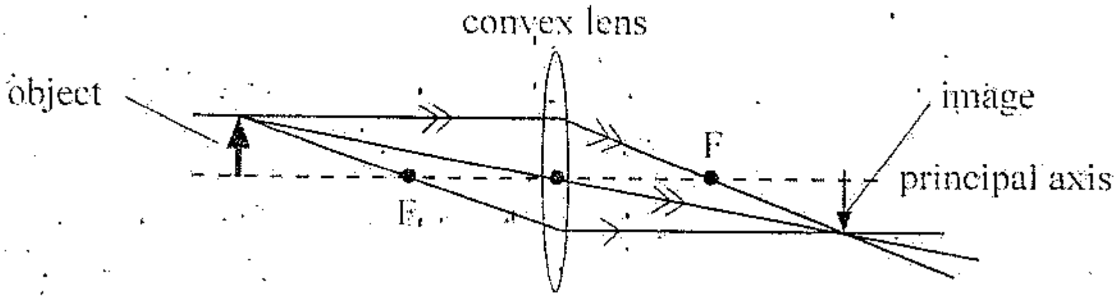
Q: Alkane

R: Alkanol

S: Alkene

Note: In answering this question, it is assumed that the confidential instructions indicated that compounds P, Q, R and S are carboxylic acid, alkane, alkanol and alkene respectively.

3. a. Ray diagram showing position of object, image, principal focus and principal axis



An image of any object (e.g. burning candle) may be located by use of ray diagrams.

Ray diagrams are always drawn to scale using lines to represent rays. The position of the object decides what kind of light ray diagram will be drawn and the image position. Information about the images formed by a lens can be obtained by drawing any two of the following rays:

- A ray parallel to the principal axis which is refracted (bent) through the principal focus F on the other side of converging lens.
- A ray through the optical centre C which is undeviated (not refracted or bent)..
- A ray through the principal focus F which refracted (bent) parallel to the principal axis.

All rays always start from the same point and a combination of **any two** of three will give us the position of the image. Precisely, the image forms at the point where the rays cross each other and it is upside down as shown in the diagram above.

b. The image is diminished and it becomes clear (sharp) with decreasing image distance.

4. (i) A small piece of the element is cut using a knife and it is placed in a test tube containing distilled water. Observations are made and recorded as the reaction progresses.

A burning candle (the flame part) is brought closer to the mouth of the test tube. Observations are made and recorded.

A red litmus paper is dipped into the solution formed (or 1 – 2 drops of phenolphthalein indicator are added to the solution formed). Once again, observations are made and recorded.

Table of results

Activity	Observation
Bringing the flame closer to the mouth of a test tube	
Dipping a red litmus paper is dipped into the solution	
Adding 1 – 2 drops of phenolphthalein indicator to the solution	

Conclusion:

When a small piece of freshly cut alkali metal is put in a test tube with distilled wate bubbles of a gas are formed that give a 'pop' sound when ignited (brought near a flame). The gas is hydrogen. The liquid formed turns phenolphthalein solution into a pink colour or changes litmus paper to blue colour. The liquid is a base.

(ii) $2X(s) + 2H_2O(l) \rightarrow 2XOH(aq) + H_2(g)$

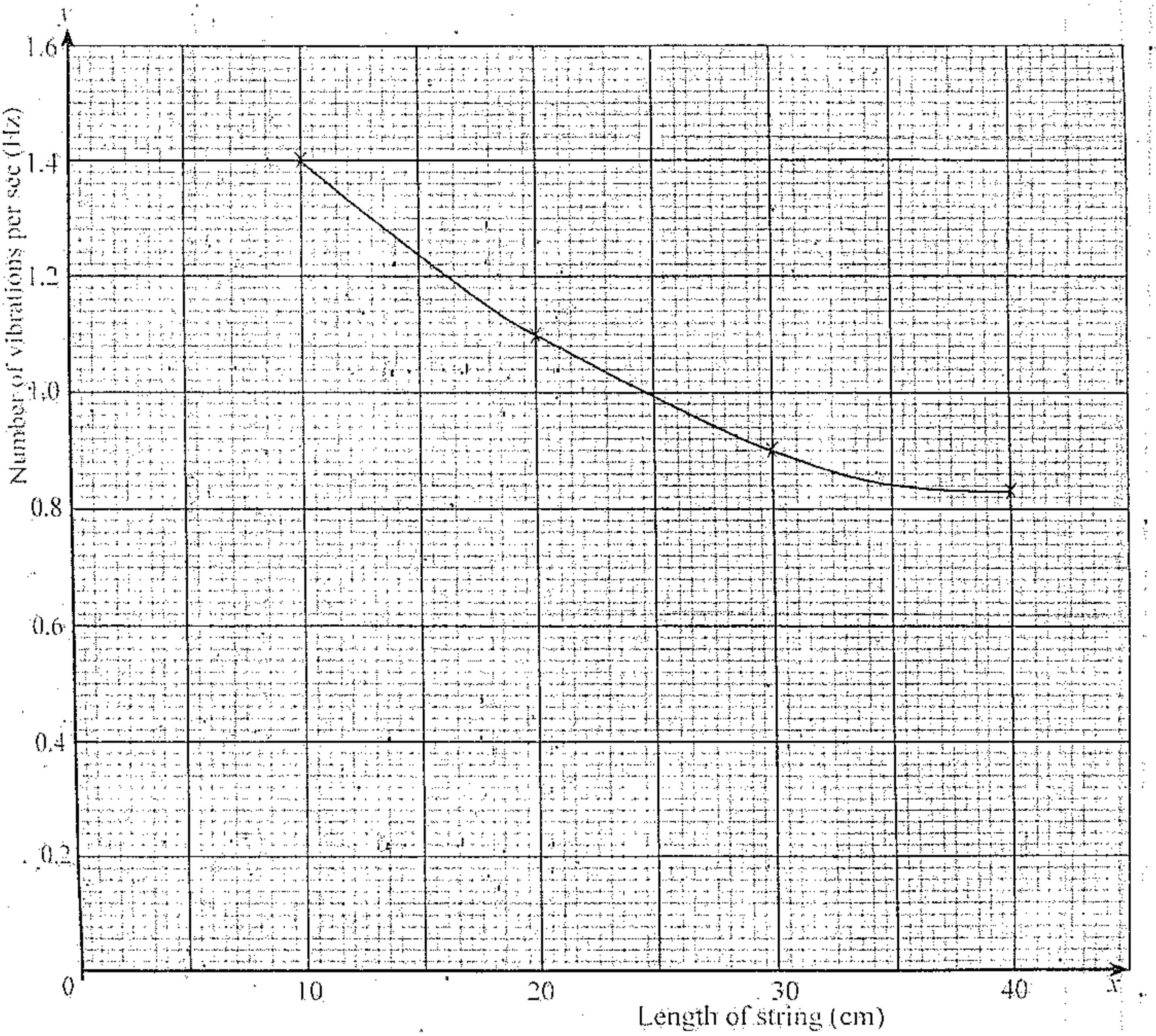
2005 PAPER II Model Solutions

1. e.

Length in cm	Time for 10 complete vibrations (sec)	Number of vibrations per second
40	12	10/12 = 0.83
30	11	10/11 = 0.9
20	9	10/9 = 1.1
10	7	10/7 = 1.4

g.

Number of vibrations per second (Hz) against Length of a string (cm)



h. As the length of string increases the number of vibrations per second (frequency) decreases. Thus, a decrease in the length of string results into an increase in the number of vibrations per second (frequency).

i. Mass on the string

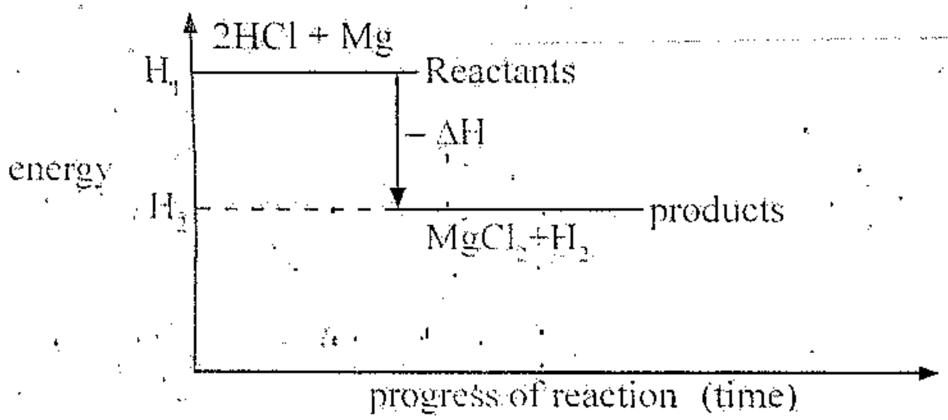
2. c.

Liquid in the test tube	Initial temperature (°C)	Substance added	Final temperature reached during reaction (°C)	Temperature change (°C)	Other changes observed during reaction
Hydrochloric acid	26	Magnesium ribbon	45	19	A gas evolves out of the test tube and the test tube becomes warmer (hotter)
Hydrochloric acid	26	Potassium hydrogen carbonate or sodium hydrogen carbonate	22	- 4	Some bubbles are formed and the test tube becomes colder.

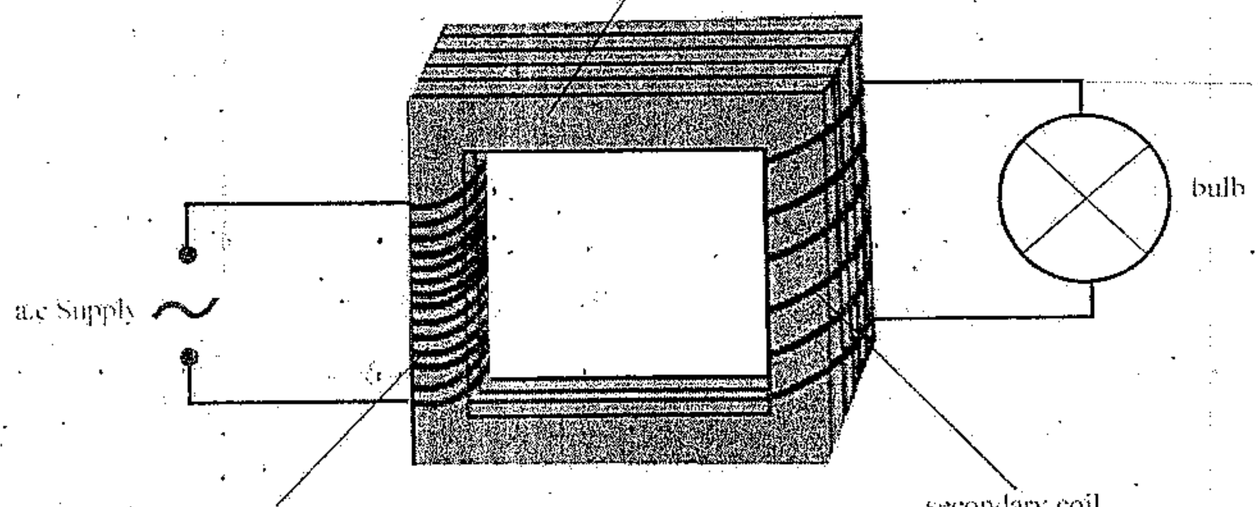
g. The reaction between hydrochloric acid solution and potassium hydrogen carbonate (or sodium hydrogen carbonate) is endothermic.

h. The reaction gains (or absorbs) heat energy from the surrounding into the system as result the surrounding temperature falls down. The change in heat energy (heats of reaction) is positive for this type of reaction.

i.



3. a.



With a **step-down** transformer, the primary is connected to a low voltage a.c supply. The secondary is connected to any electrical appliance (e.g. a small bulb) As current flows backwards and forwards and backwards through the primary, i sets up an alternating magnetic field in the core. This induces an alternating e.m.f and current in the secondary and so the bulb lights up.

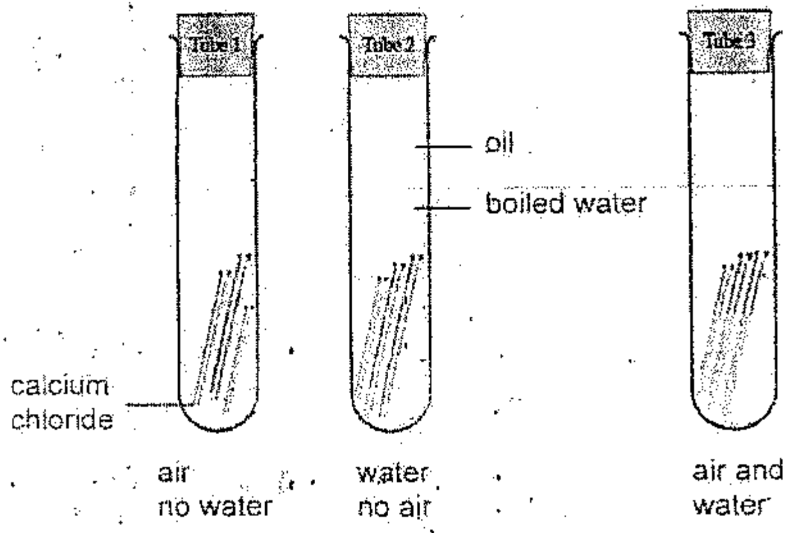
A transformer is said to be a **step-down** if it has few turns in secondary than i primary, and the secondary or output voltage is less than the primary or inpu voltage.

b. A fuse breaks the circuit if a fault in an appliance causes too much current flow. Thi protects the wiring and the appliance if something goes wrong. The fuse contains piece of wire that melts easily. If the current going through the fuse is too great, th wire melts and breaks the circuit.

4. a. (i) Oxidation is the loss of electron(s) by an element, molecule or ion.

(ii) Reduction is the gaining of electron(s) by an element, molecule or ion.

b.



a. Place three iron nails in a test tube (1) with some white dry calcium chloride solid. The top of the test tube plugged with some cotton wool. Calcium chloride absorbs water vapour from the air and so the air is dry – water is not present.

b. Place three iron nails in a stoppered test tube (2) of boiled water with a layer of oil on top of the water. The water is boiled for about 15 minutes to drive off all the dissolved oxygen. The oil prevents oxygen from the air dissolving in the water.

c. Three nails are placed in an open test tube (3) containing some water.

d. Allow the tubes to stand in a beaker or test tube rack for a few days and examine for rusting.

e. Expected results: Rusting only occurs in tube 3: no rusting without water or without oxygen.

f. Conclusion: Water and oxygen are together needed for rusting.

In summary;

Tube 1: No rusting. $CaCl_2$ being a drying agent makes the tube to have no water. There is only one essential requirement which is oxygen (from the air).

Tube 2: No rusting, in boiled water dissolved oxygen is removed and the layer of oil prevents air from dissolving in the water. As such water alone cannot make rust on the iron nails.

Tube 3: Rusting is observed on the iron nails since oxygen (from the air) and water are available.

2006 PAPER II Model Solutions

1. i

Item	Mass (g)
Empty tin	25
Tin + Sugar	35
Sugar	(35 – 25) = 10
Tin + Carbon	29.5
Carbon	(29.5 – 25) = 4.5

j. % Composition by mass of carbon in sugar = $\frac{\text{mass of carbon}}{\text{mass of sugar}} \times 100 = \frac{4.5\,g}{10\,g} \times 100 =$ 45%

k. Number of moles of carbon = $\frac{\text{mass of C}}{\text{RAM of C}} = \frac{4.5}{12} = 0.375$ mol

l. (i) Faulty instrument (faulty balance)

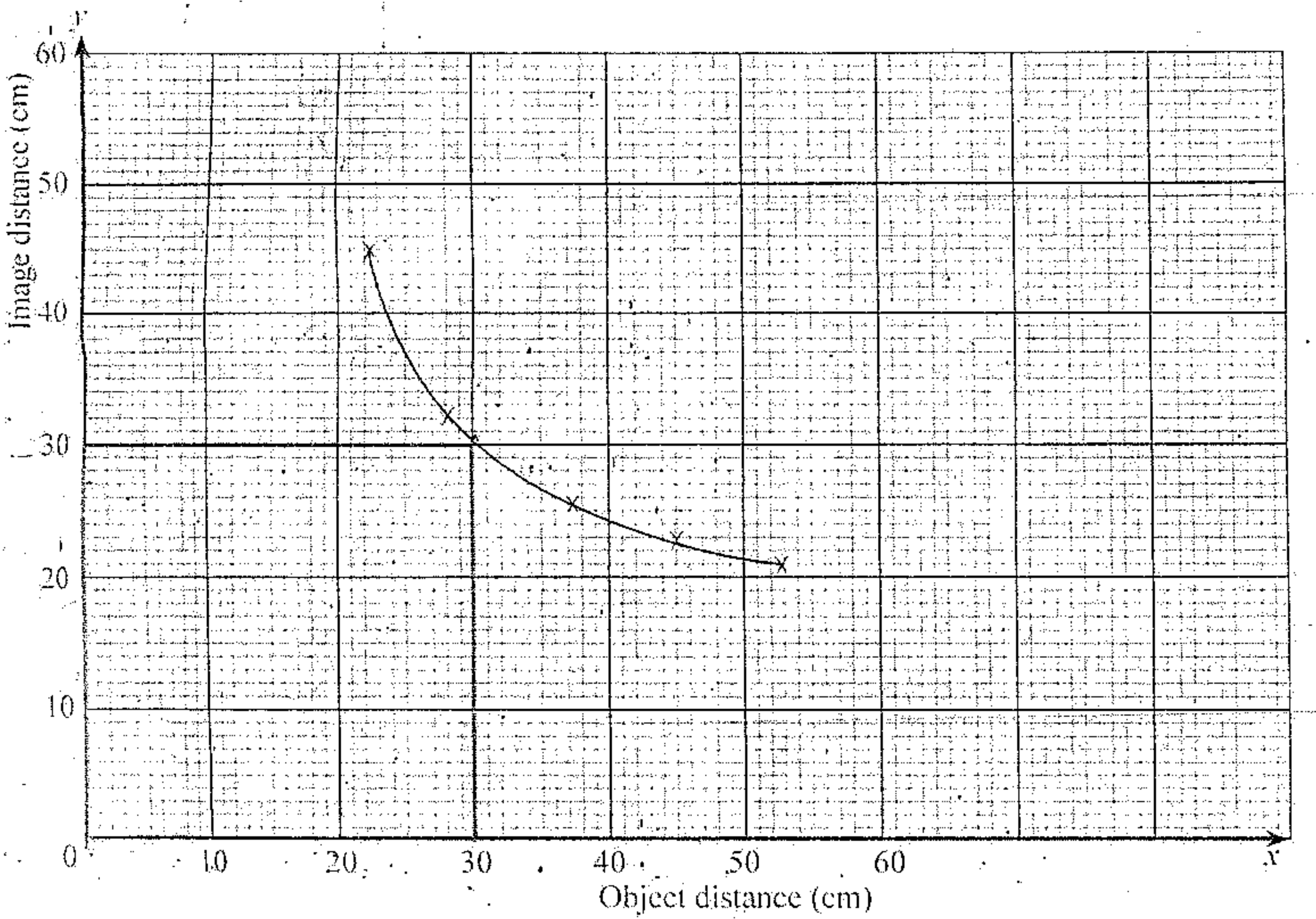
(ii) Incomplete burning or heating of sugar

2. e.

Object distance (cm)	Image distance (cm)
22.5	45
28.0	32
37.5	25
45.0	23
52.5	21

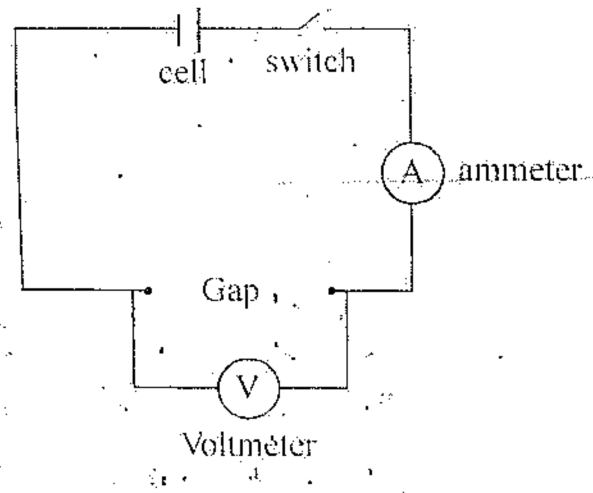
f.

Image distance against Object distance



g. Object distance = 30 cm

3.



The circuit is set as shown in the diagram above. A 100 cm nichrome wire is connected in the gap. The switch is closed to complete the circuit. The ammeter and voltmeter readings are observed and recorded in the table of results. The switch is opened and the nichrome wire is removed.

Following the above procedure; 80 cm, 60 cm, 40 cm and 20 cm lengths of nichrome wire are connected in the gap respectively and their ammeter and voltmeter readings are observed and recorded in the table of results.

The resistance of each length of nichrome wire is calculated and recorded in ohms (Ω) using the formula:

$$\text{Resistance} = \frac{\text{Voltage } (V)}{\text{Current } (I)}$$

Table of results

Length (cm)	Ammeter reading (A)	Voltmeter reading (V)	Resistance (V/I)
100			
80			
60			
40			
20			

Finally, a graph of resistance (Ω) against length (cm) is plotted. From the plotted graph, length of nichrome wire that could be used to make 1.5 Ω resistor is easily determined. This is done by drawing a horizontal line from a point (1.5 Ω) on the y – axis to the graph line and now draw it vertically (downwards) until it touches the x – axis. The point on the x – axis is the length of nichrome wire required.

2007 PAPER II Model Solutions

1.

Initial volume of HCl = 00 ml

Final volume of HCl = 10 ml

Volume of HCl used = 10 ml

k. $HCl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$

l. $\frac{C_1 \times V_1}{n_1} = \frac{C_2 \times V_2}{n_2}$

$$\frac{C_1 \times 10\text{ ml}}{1} = \frac{0.1\text{ M} \times 10\text{ ml}}{1}$$

$$C_1 = 0.1$$

Concentration of HCl is 0.1 M

m. (1) Incorrect reading of the instruments i.e. burette and measuring cylinder.

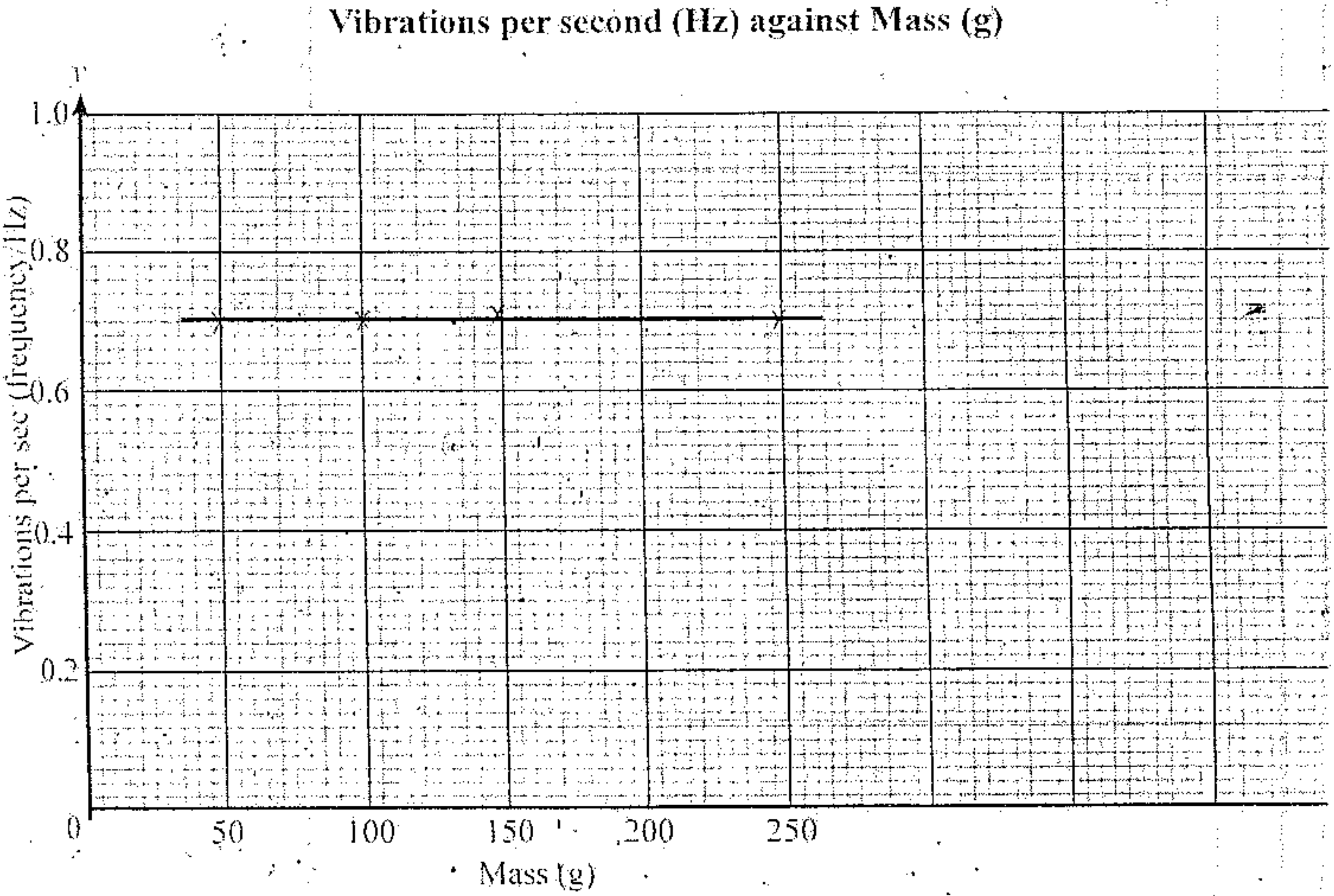
(2) Overshooting of HCl solution from the burette to the conical flask when the colour change takes place i.e. unable to close the burette immediately after observing the colour change.

(3) Use of poorly calibrated instruments or faulty instrument (instrument error).

2. e.

Mass (g)	**Time for 10 complete vibrations (sec)**	**Number of vibrations per second (frequency)**
50	14	0.7
100	14	0.7
150	14	0.7
250	14	0.7

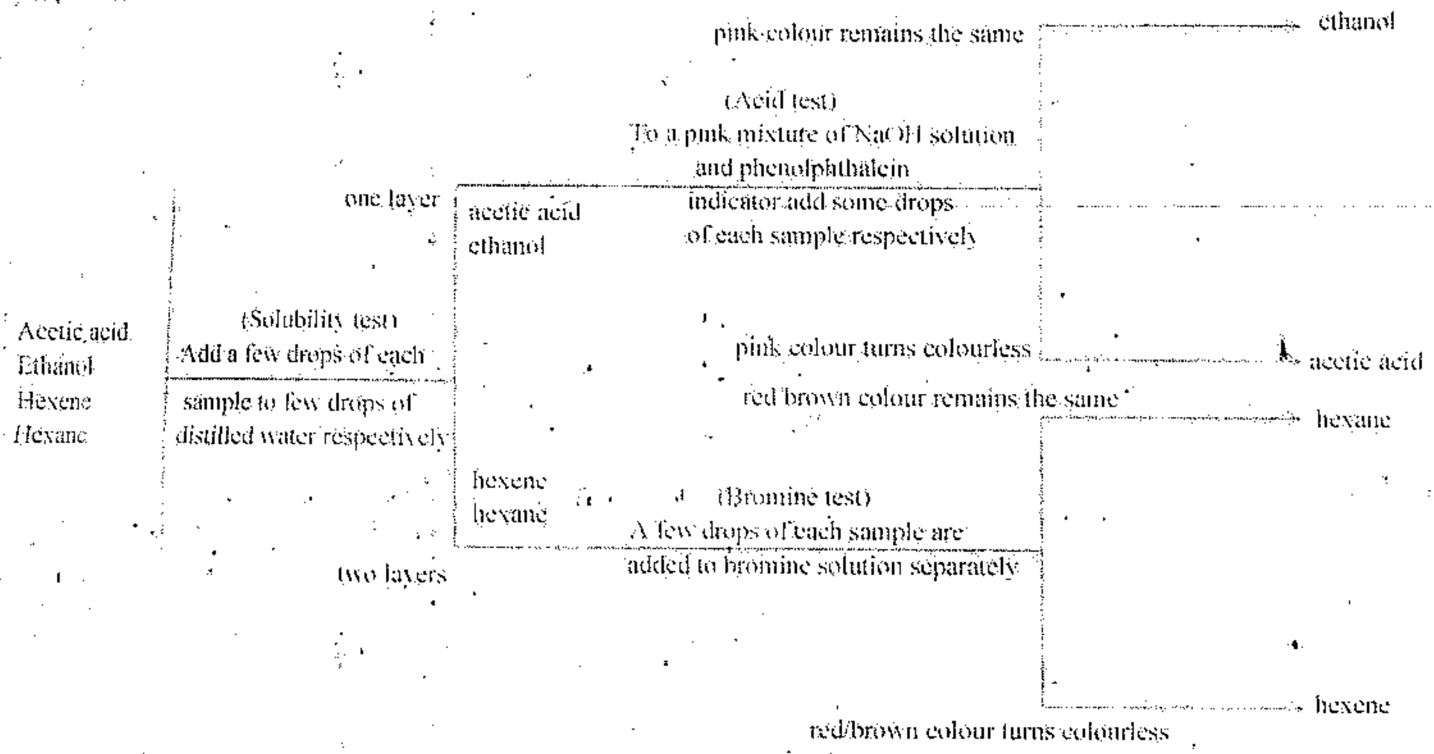
f.



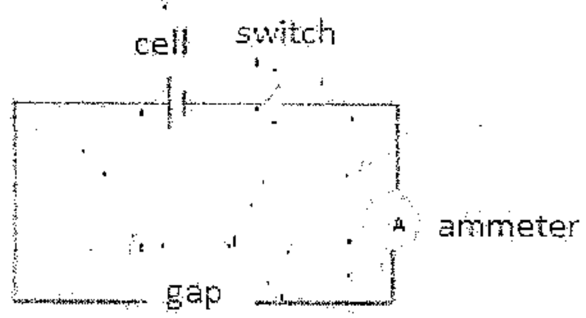
g. Increase in mass does not affect the number of vibrations per second i.e. change in mass does not make change in vibrations per second (frequency).

h. (1) length of string (2) type of string

3.



4.



The circuit is set as shown in the diagram. Firstly, substance **W** is connected in the gap and the switch is closed. The ammeter reading is observed and recorded. The substance is removed and reconnected while reversed. The ammeter reading is checked again.

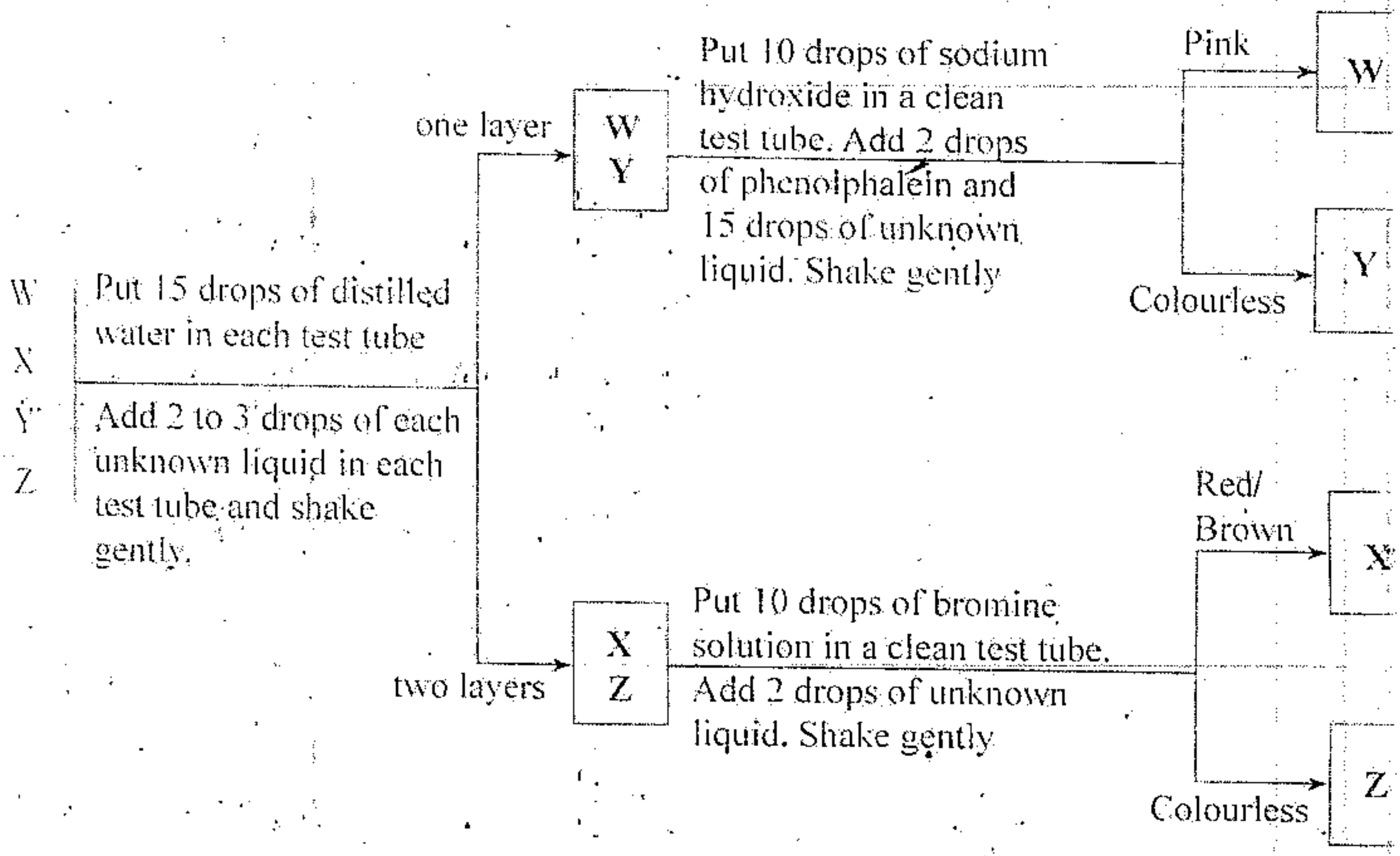
The above procedure is repeated for substances **X** and **Y** respectively.

From the results the three substances could be identified; the one that conducts current in both directions is a resistor, the one that conducts in one direction only is a diode and the one that does not conduct in either direction is an insulator.

Note: An ammeter could be replaced with a bulb in this experiment. Hence, the conclusion will be a substance that conducts in both directions by giving light is a resistor, the one that gives light in one direction only is a diode and the one that does not give light in either direction is an insulator.

2008 PAPER II Model Solutions

1. a.



b. **W:** ethanol

X: hexane

Y: ethanoic acid

Z: cyclohexene

Note: It does not mean that every time one conducts such type of experiments they wi get the above order of results. You are supposed to know the chemical tests and the expected results. Thus, alkanes and alkenes are **insoluble in water** hence they will sho **two layers** when mixed or added to water. Alkenes react with **bromine solution** and th is noticed when **red** or **brown** colour of bromine solution **disappears** (turns **colourles** the moment an alkene is added to bromine solution. This is known as **bromine test.**

It must be also known that small alkanols and carboxylic acids (alkanoic acids) are **solub** in water hence they will show **one layer** when mixed or added to water. Carboxylic acic (alkanoic acids) are easily identified by carrying **acid test**. Acids normally turn the **pin** solution (mixture) of sodium hydroxide (NaOH) solution and phenolphthalein solutic into **colourless**..

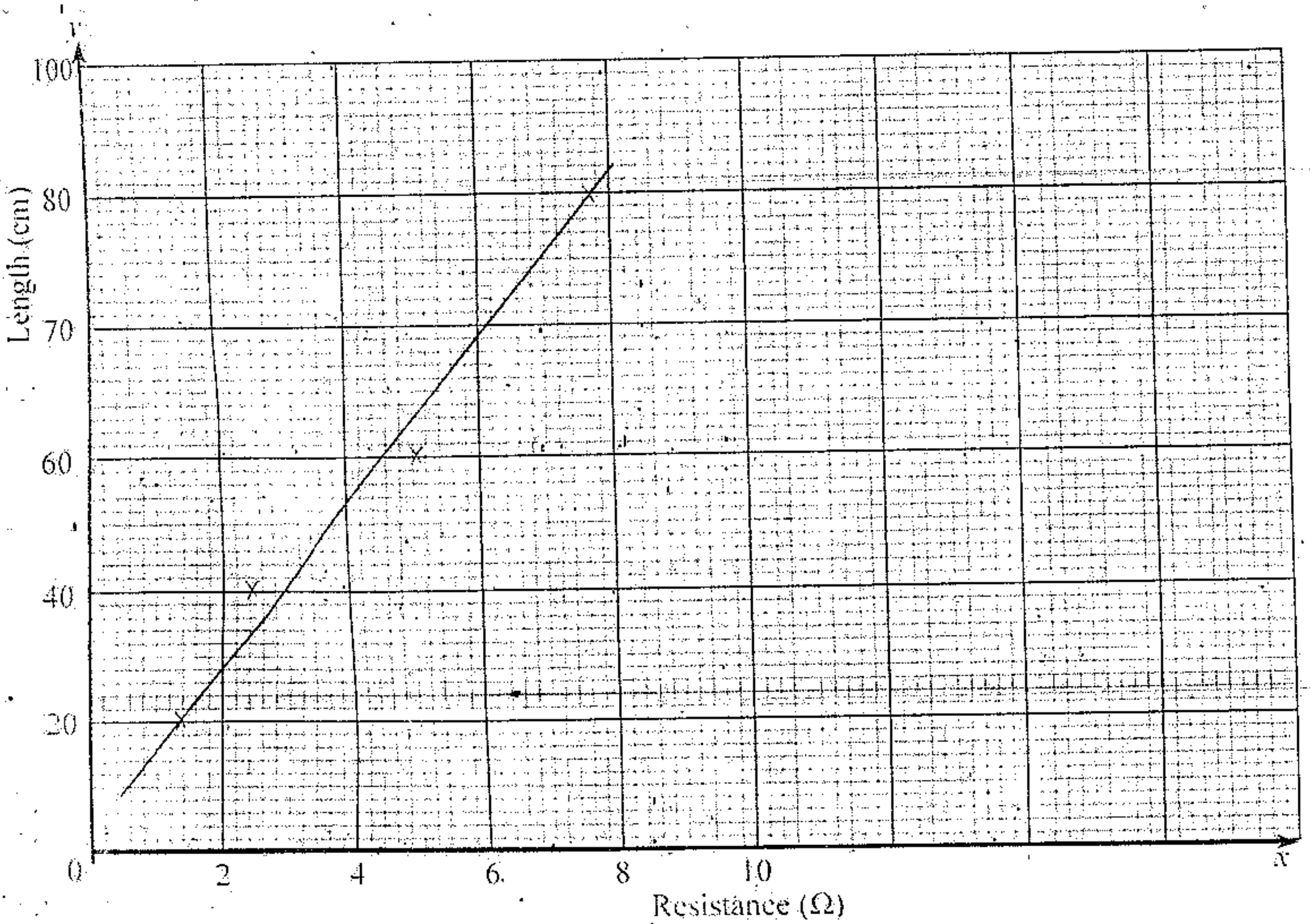
2. e.

Length (cm)	Ammeter reading (A)	Voltmeter reading (V)	Resistance (V/I)
80	0.3	2.3	7.7
60	0.4	2.0	5
40	0.7	1.7	2.4
20	0.9	1.3	1.4

Caution: These results are not final. Results are dependent on the size of nichrome wire used and the strength of cells.

g.

Length of a wire (cm) against Resistance (Ω)



h. As the length of a nichrome wire increase, its electrical resistance increases as well. There is a direct relationship between length of a wire and its resistance.

3. a. A standard solution is a solution of known molarity (or concentration).

Explanation: A standard solution is a solution containing a precisely known concentration of an element or a substance, a known weight of solute is dissolved to make a specific volume. It is prepared using a standard substance, such as a primary standard.

b.

Volume required = 500 cm^3 = 500/1000 = 0.5 dm^3

Molarity required = 0.2 M = 0.2 mol/dm^3

Relative formula mass (RFM) of NaCl = 23 + 35 = 58 g/mol

Number of moles of NaCl = volume × molarity = 0.5 dm^3 × 0.2 mol/dm^3 = 0.1 mol

Mass of NaCl required = RFM × number of moles = 58 g/mol × 0.1 mol = 5.8 g

Using a triple beam balance (electronic balance) measure an exact mass of 5.8 g of NaCl.Using distilled water the mass is dissolved up to an exact volume of 500 cm^3. The solution prepared is 500 cm^3 of a 0.2 M sodium chloride solution.

4. a Firstly, the stop watch is set at zero (0) second. An observer stands on the other end of a running field with a stop watch in hand. The starting and the finishing lines are clearly marked.

An observer blows the whistle to alert an athlete to start running while at the same time, the stop watch is started. The moment an athlete reaches the finishing line the watch is stopped and the time taken is recorded.

Using a tape measure, the distance between the starting line and finishing line is measured and recorded.

Finally an average speed of an athlete is calculated using ~~the~~ the following formula

$$\textbf{Average speed} = \frac{\text{Distance covered (m)}}{\text{Time taken (s)}}$$

An average speed is expressed in meters per second (m/s).

b. (i) Faulty instrument e.g. stop watch

(ii) Incorrect reading of instruments e.g. stop watch and tape measure

(iii) Poor timing on the part of an observer

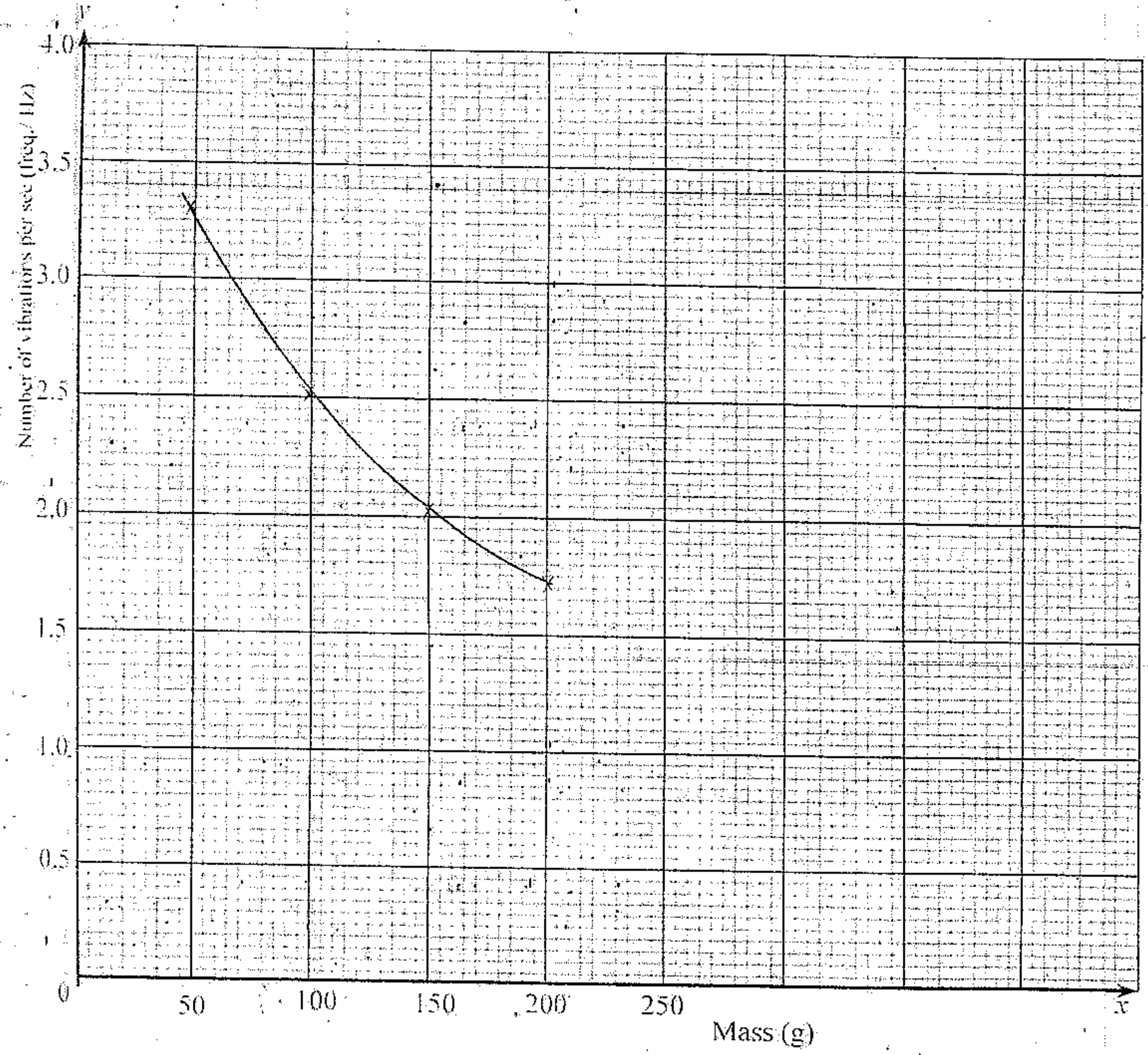
2009 PAPER II Model Solutions

1 e.

Mass (g)	Time for 10 complete vibrations (sec)	Number of vibrations per second (frequency)
50	3	3.3
100	4	2.5
150	5	2.0
200	6	1.7

f.

Number of vibrations per second (Hz) against Mass (g)



g. As mass increases the number of vibrations per second decreases or decreasing mass causes an increase in number of vibrations per second (frequency).

2.

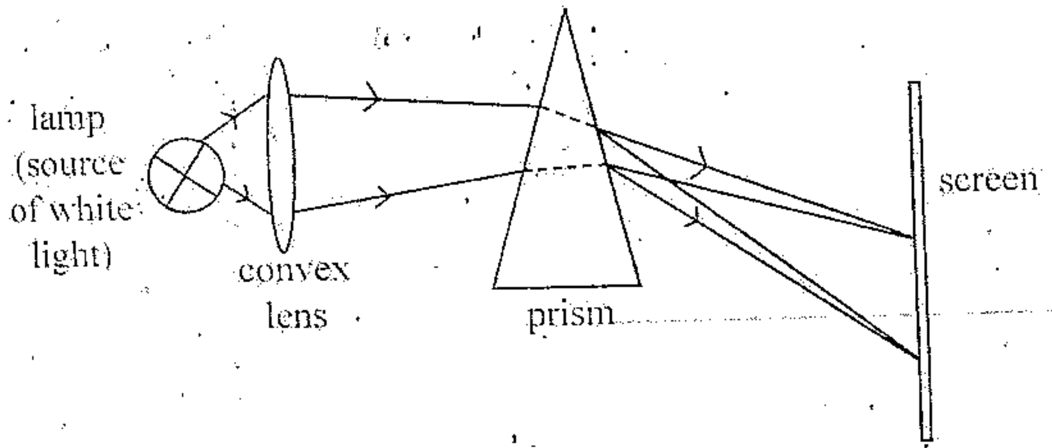
Metals / Solutions	Copper	Zinc	Iron	Magnesium
Copper sulphate		Reaction	Reaction	Reaction

Zinc sulphate	No reaction		No reaction	Reaction
Iron sulphate	No reaction	Reaction		Reaction
Magnesium sulphate	No reaction	No reaction	No reaction	

b. Copper, iron, zinc, magnesium

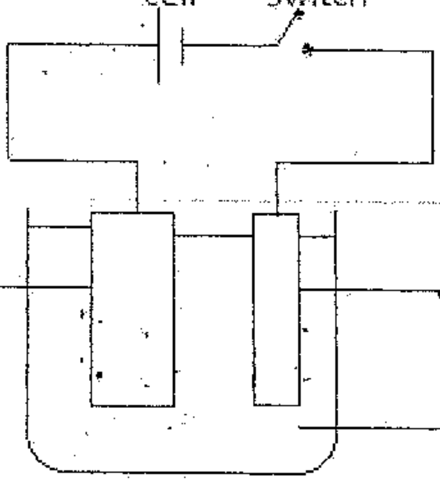
3. a. (i) reflection (ii) refraction (iii) dispersion

b.



An apparatus is arranged as shown in the diagram. The filament of a lamp (bulb) acts as a narrow source of white light. The convex lens converges (brings together) the parallel rays of light on the prism. As the light passes through the prism, the light splits into a range of colours. White light is actually a mixture of colours rather than a single colour, and the prism refracts these different colours by different amounts. The band of colours obtained on the white screen is called a spectrum and the colours are in this order: red, orange, yellow, green, blue, indigo and violet **(ROYGBIV).**

4.



An apparatus is arranged as shown in the diagram. The switch is closed. During th process the impure copper (anode) loses mass because the copper atoms lose electron and become copper ions:

$Cu_{(s)} \rightarrow Cu^{2+}_{(aq)} + 2\hat{e}$

The electrons released at the anode travel around the external circuit to the cathode There, at the cathode, the electrons are passed on the copper ions (from $CuSO_4$ solution and the pure copper is deposited or plated on the cathode. This can be shown by the hal equation:

$Cu^{2+} + 2\hat{e} \rightarrow Cu_{(s)}$

Any impurities fall to the bottom of the cell and collect below the anode.

2010 PAPER II Model Solutions

1. g.

Object distance, U (cm)	Image distance, V (cm)	(U + V) cm
20	60	80
25	37.5	62.5
30	30	60
40	24	64
50	21.5	71.5

U + V (cm) against U (cm)

h.

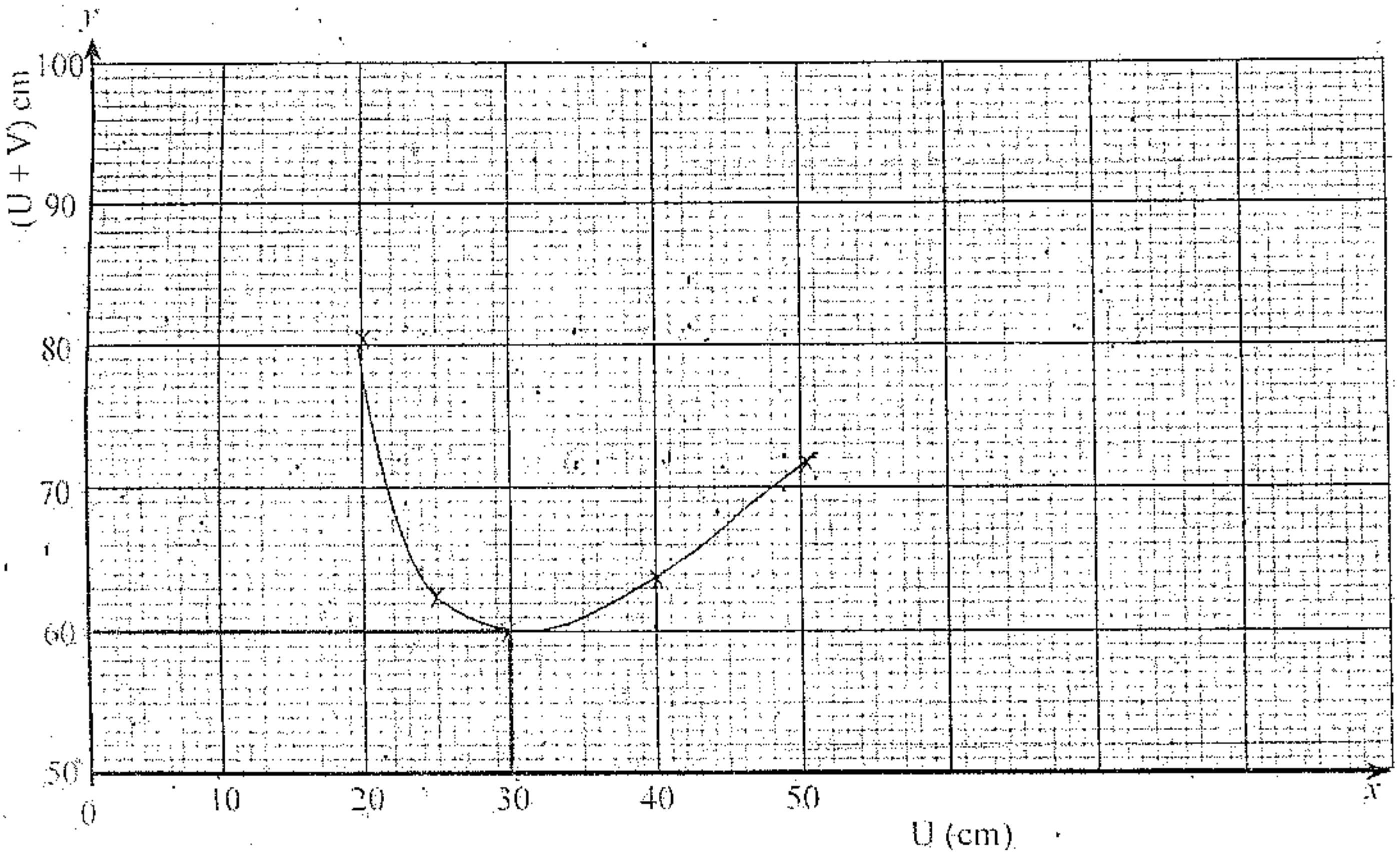


Table of results

i. U at minimum point of the graph = 30 cm

Focal length of the lens = $\frac{U}{2} = \frac{30\ cm}{2} = 15$ cm

2. e.

Solution	Initial Temperature (^0C)	Final Temperature (^0C)	Temperature change (final temperature – initial temperature) (^0C)
Ammonium Chloride (NH_4Cl)	26	22	- 4
Sodium hydroxide (NaOH)	26	40	14

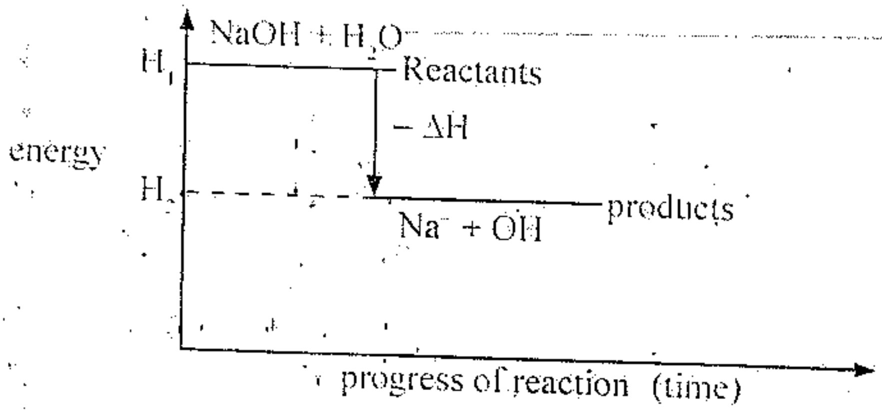
f.

Ammonium chloride: endothermic reaction

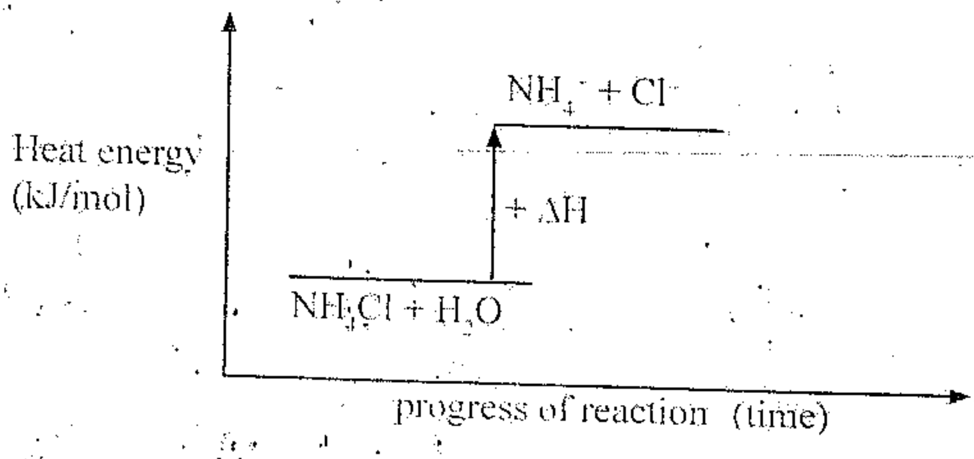
Sodium hydroxide: exothermic reaction

g.

Exothermic reaction



Endothermic reaction

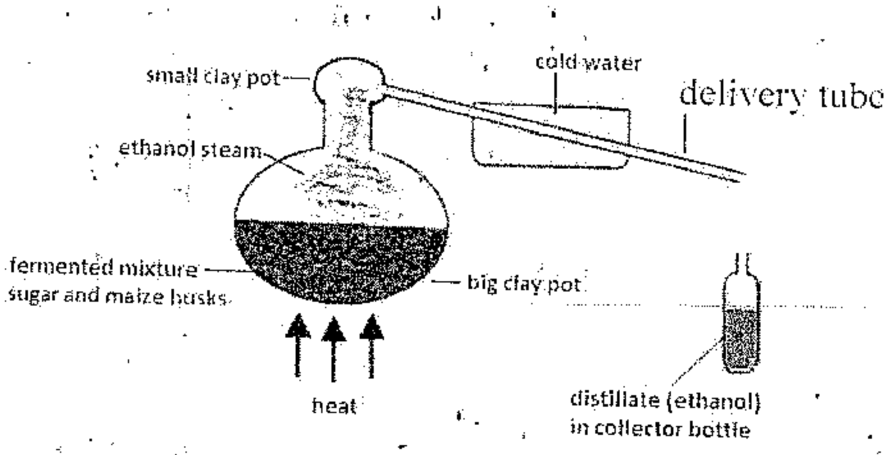


h. Faulty instrument and inaccurate measurement (poor observation)

3. a. It is cheap because the raw materials are locally available and easily accessible.

   b. In local method, sugar, maize husks, warm water are mixed and left to stand for at least three days for the mixture to ferment. After fermentation, the ethanol produced is separated from the mixture using distillation method.

   The following diagram shows how ethanol is separated from its mixture in local way of producing ethanol:



The fermented mixture of sugar and maize husks is heated in a big clay pot until boiling takes place. Since ethanol has lower boiling point than water, it boils off first. Ethanol vapour rises and moves through the delivery tube and passes over the cold water (condenser) where it condenses to liquid ethanol. Pure ethanol (kachasu) is collected as distillate in the collecting bottle.

Note: At sea level, pure ethanol boils at 78°C and pure water boils at 100°C.

4. a.

A: frictional force (fluid resistance)

B: upthrust

C: weight (gravitational force)

b.

The apparatus is set as shown in the diagrams above. The heights of the liquids in both jars are measured and recorded. The stop watch is set at zero. In the first jar containing water, the ball is released at the same time the stop watch is started. As soon as the ball hits the bottom the watch is stopped and the time taken is recorded.

The above procedure is followed, now using the jar containing oil.

The speed of the ball (both in water and oil) is calculated using the formula:

$$\text{Speed} = \frac{\text{Distance (height) in cm}}{\text{Time in seconds}}$$. The speed is calculated in cm/s.

In conclusion, the two speeds are compared to establish if really resistance of a media affects the speed of an object falling through the media.

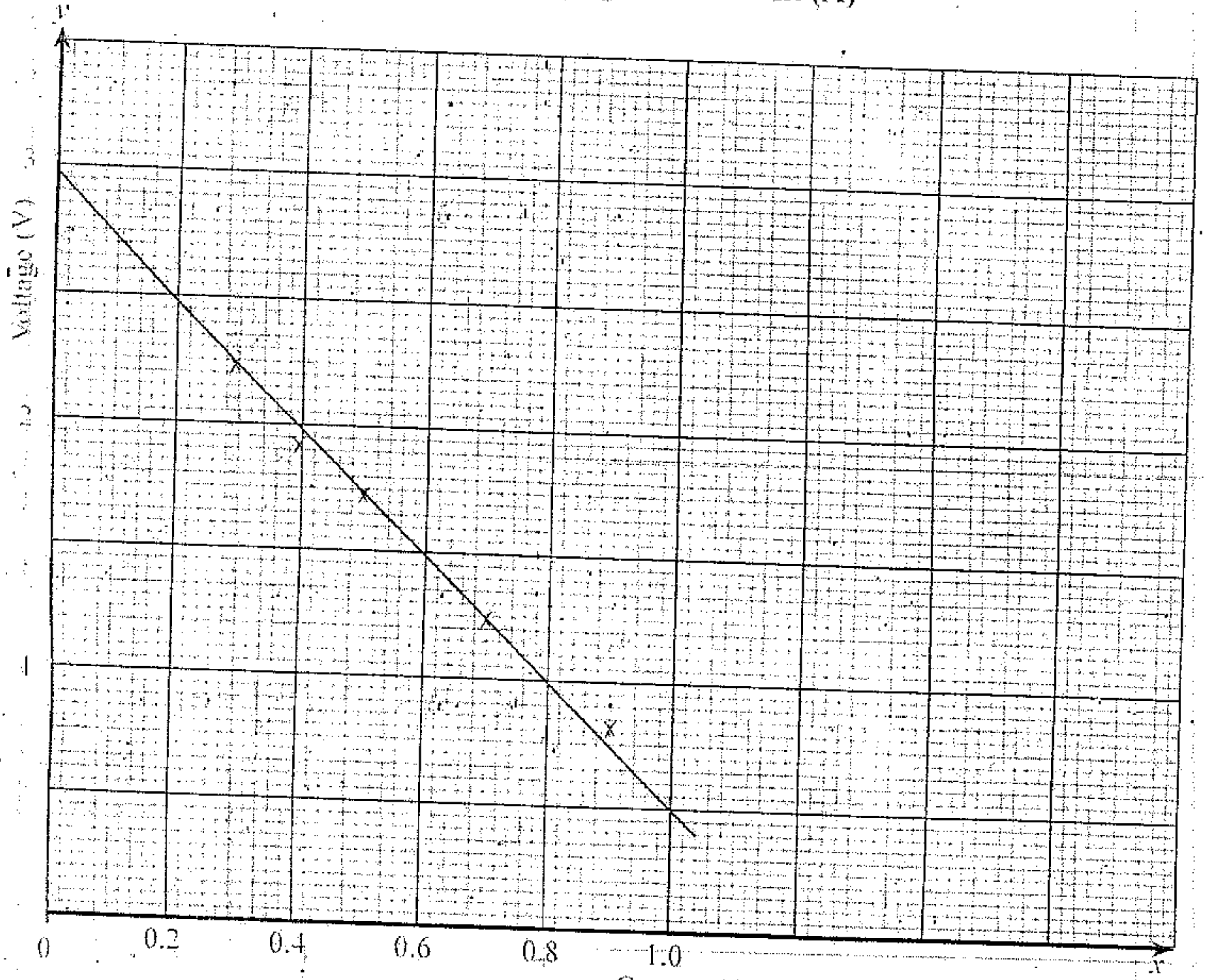
2011 PAPER II Model Solutions

1. h:

Ammeter reading (A)	0.9	0.7	0.5	0.4	0.3
Voltmeter reading (V)	0.8	1.2	1.7	1.9	2.2

j.

Voltage (V) against Current (A)



k. Voltage = 2.95V

l. The voltage found in (k) is the electromotive force (emf) of the cell.

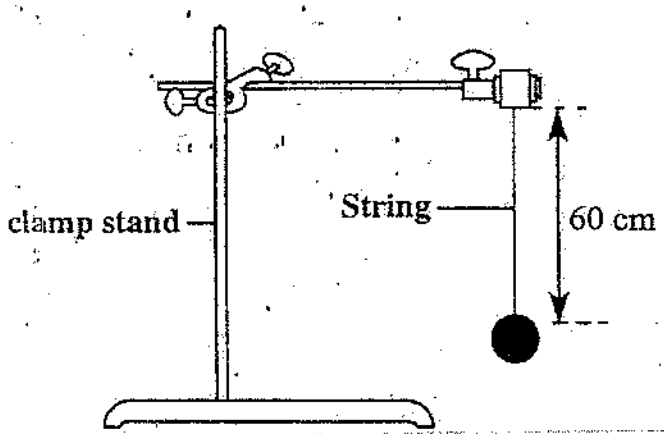
2.

Test	Substance X	Substance Y	Substance Z
Add 2 drops of unknown substance to 15 drops of distilled water in a test tube.	One layer	Two layers	One layer
Add 2 drops of unknown substance to 15 drops of bromine solution in a test tube	Remains red/brown	Turns red/brown to colourless(red/brown colour disappears)	Remains red/ brown
To 15 drops of dilute NaOH in a test tube add 2 drops of phenolphthalein indicator. Now add 2 drops of unknown substance.	Turns pink colour to colourless (pink colour disappears)	Remains pink	Remains pink

X: carboxylic acid (alkanoic acid) **Y**: alkene **Z**: alkanol

In answering this question, it is assumed that the confidential instructions indicated that substances **X**, **Y** and **Z** are organic compounds from the families of carboxylic acid (alkanoic acid), alkene and alkanol respectively.

3.



An apparatus is set as shown in the diagram. The stop-clock is set to zero reading. With a string length of 60 cm, the pendulum mass is pulled aside about 10cm (or any sizeable distance) and released. The stop-clock is started as soon as the mass is released. Count 10 complete vibrations (oscillations) and stop the clock and record the time taken. The experiment is repeated using different lengths of string of 45 cm, 30cm and 15 cm respectively. In each case the frequency is calculated using the formula:

$$\text{Frequency} = \frac{\text{No. of complete vibrations (oscillations)}}{\text{Time taken}}$$

The results are tabulated as shown in the following table and a graph of frequency against length is plotted in order to deduce the relation between the two variables.

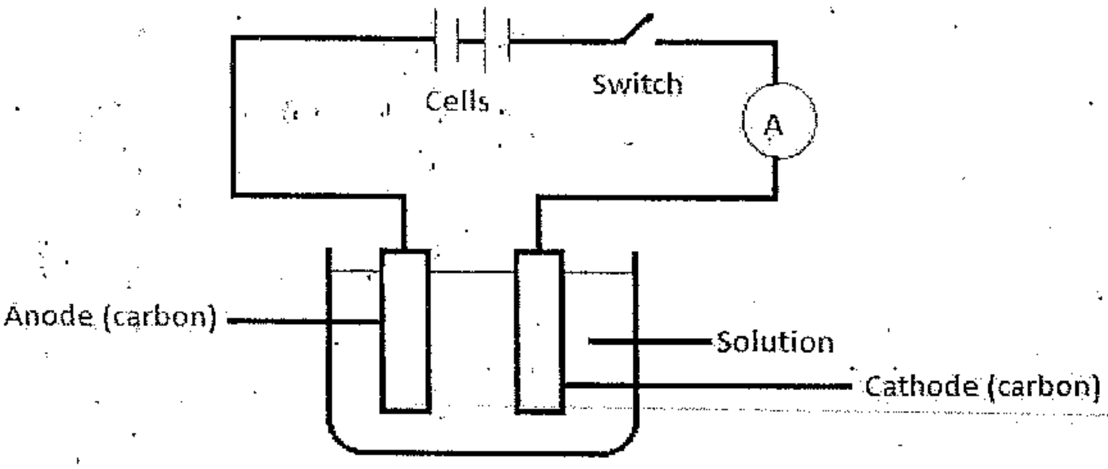
Length of string (cm)	**Time taken for 10 complete oscillations (sec)**	**Frequency (Hz)**
60		
45		
30		
15		

Finally it can be noted from the graph that the frequency of a vibrating pendulum increases with decrease in length of string.

Note: As a candidate you are not only confined to use the above lengths but you can as well use any sizeable (reasonable) lengths.

4. a. A strong acid is the one ionises completely when dissolved in water and releases a lot of protons (hydrogen ions) whereas a weak acid partially ionises when dissolved in water and releases a few protons.

b.



An apparatus is set as shown in the diagram. One of the acids is put in the beaker (container) and the switch is closed. The ammeter reading is observed and recorded. The switch is opened. Then the acid is removed and replaced with the remaining one. Once again, the switch is closed and the reading of the ammeter is noted.

It can be concluded from the results that an acid that gives higher ammeter reading is a strong acid and the one that gives a smaller ammeter reading is a weak acid. This comes from the fact that a strong acid releases more protons (hydrogen ions) hence it conducts more than a weak acid.

Note: An ammeter could be replaced with a bulb and the conclusion is a strong acid will give brighter light than a weak acid – an indication that a strong acid conducts more current than a weak acid.

The following factors must be kept constant: concentration of the two acids, distance between electrodes, the depth of electrodes and number of cells.

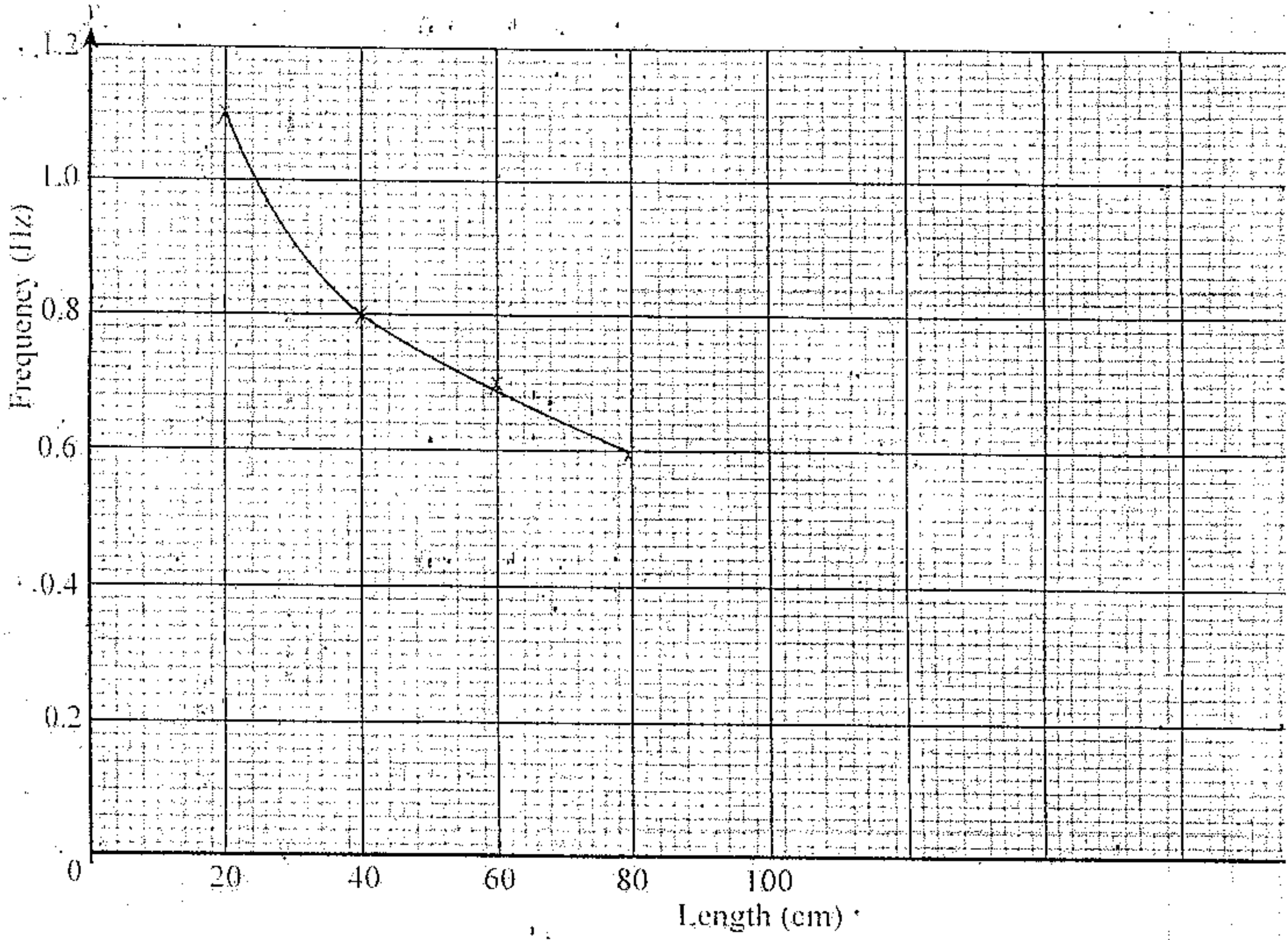
2012 PAPER II Model Solutions

1 e.

Length of pendulum (cm)	Time for 10 vibrations (s)	Frequency $\left(\frac{\text{Number of vibrations}}{\text{Time (s)}}\right)$
80	18	0.6
60	15	0.7
40	13	0.8
20	9	1.1

f.

Frequency (Hz) against Length (cm)



g. As the length of a pendulum increases its frequency decreases (thus, frequen increases with decreasing length of a pendulum).

2. f.

Initial volume of acid (ml)	Final volume of acid (ml)	Volume of acid used (m
00	10	10

g. $CH_3COOH_{(aq)} + NaOH_{(aq)} \rightarrow CH_3COONa_{(aq)} + H_2O_{(l)}$

h. $$\frac{C_1 \times V_1}{n_1} = \frac{C_2 \times V_2}{n_2}$$

$$\frac{C_1 \times 10 \text{ ml}}{1} = \frac{0.1 \text{ M} \times 10 \text{ ml}}{1}$$

$$C_i = \frac{0.1\ M \times 10\ ml}{10\ ml}$$

$C_i = 0.1$ M

Concentration of ethanoic acid is 0.1 M

i. 1. By making sure that the tap of the burette is immediately closed soon after the colour change i.e. this will reduce an error as a result of overshooting.

2. By making sure that the correct readings of the burette and measuring cylinder are taken i.e. ensuring proper position of the level of the eye and the meniscus of the solutions.

3. By making sure that the materials are thoroughly cleaned before use i.e. rinsing the glass ware with distilled water thoroughly.

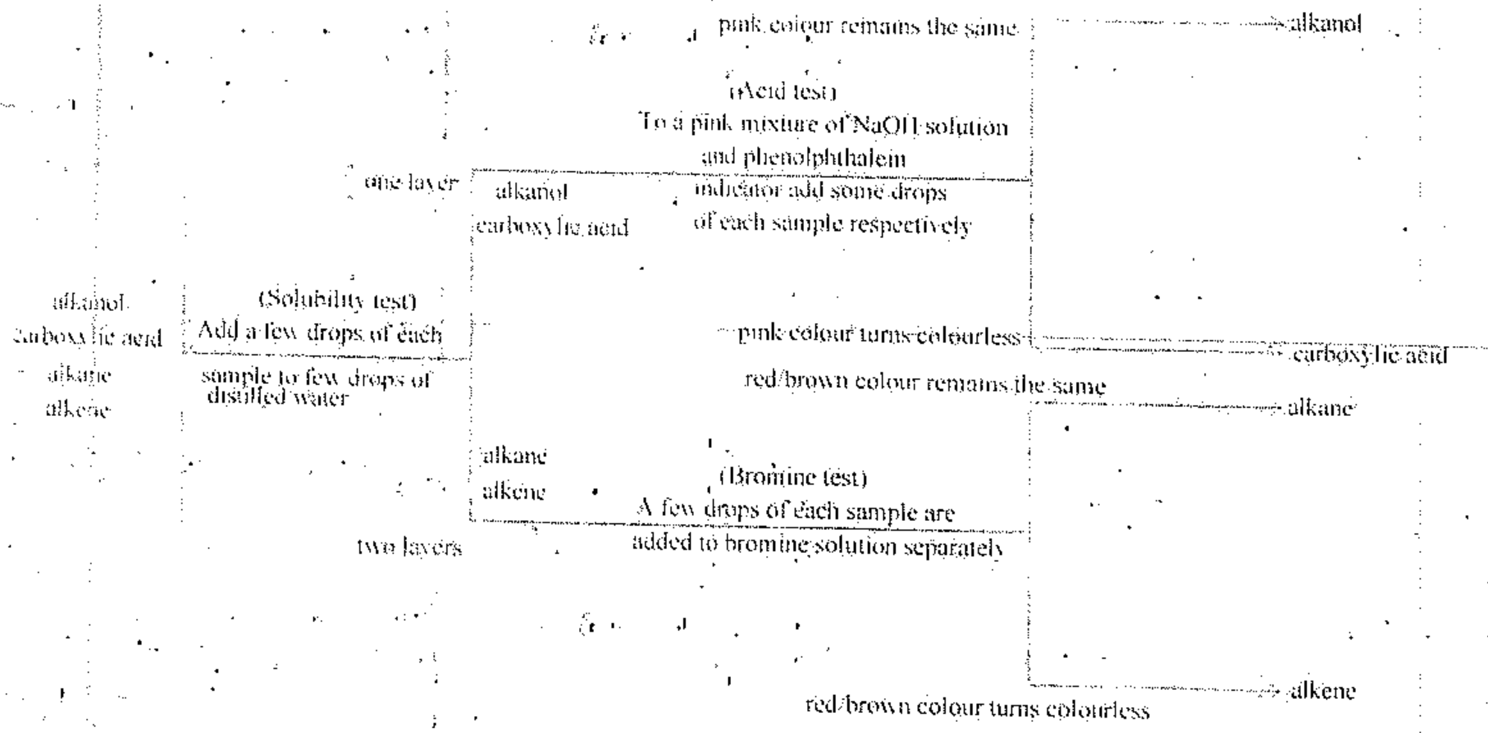
4. By adding ethanoic acid drop by drop from the burette.

3. Firstly, solubility test is carried out. Each of four samples is added to distilled water respectively and the results will show that: an alkanol and a carboxylic acid give one layer (soluble) while an alkane and an alkene show two layers (insoluble).

Secondly, bromine test is carried out to identify an alkene from an alkane. A few drops of each sample are added to bromine solution separately. A sample of an alkene will turn red or brown bromine solution to colourless unlike an alkane which will not change the colour of bromine solution.

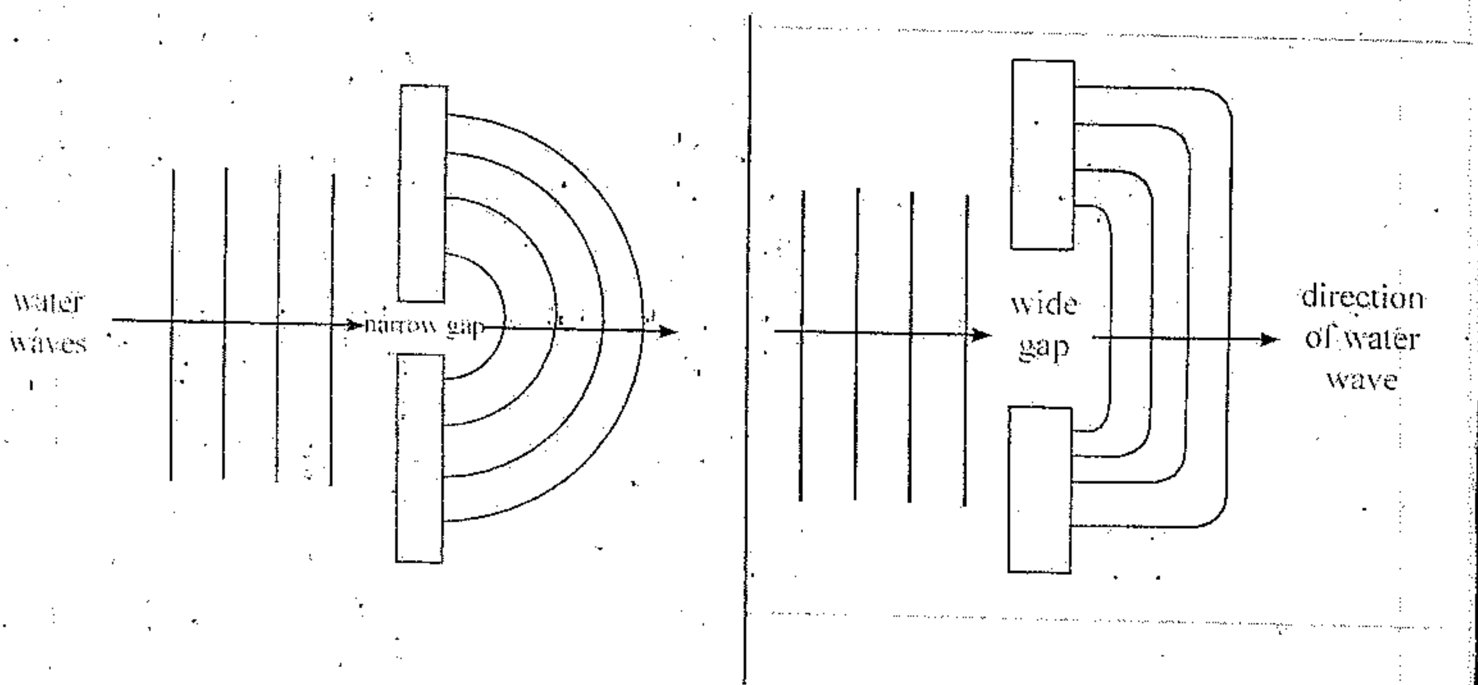
Finally, an acid test is conducted to distinguish a carboxylic acid from an alkanol. A sample of each of the two is added to a pink or purple mixture of phenolphthalein indicator and sodium hydroxide solution respectively. A sample that turns pink or purple colour to colourless is an acid (carboxylic acid) and the other one must be an alkanol.

Note: This question could also be answered by constructing a flow diagram.



4. a. (i) reflection (ii) refraction and (iii) diffraction (iv) interference

b.



Something is observed when two obstacles with a narrow gap between them in the path of plain water waves. Waves passing through the gap spread out in all directions and the wave fronts produced are circular. This is an example of an effect known as diffraction – the bending of waves as they pass around obstacles.

Diffraction is only significant if the size of the gap is comparable with the wavelength of the waves i.e. if the gap is narrow as shown in the first diagram. The second diagram shows what happens when plain water waves pass through a much wider opening (gap). The waves continue in their original direction and the wave fronts remain straight. Some diffraction does occur at the edges of the wave "beam", but the effect is slight. In other words, some spreading occurs but it is less obvious.

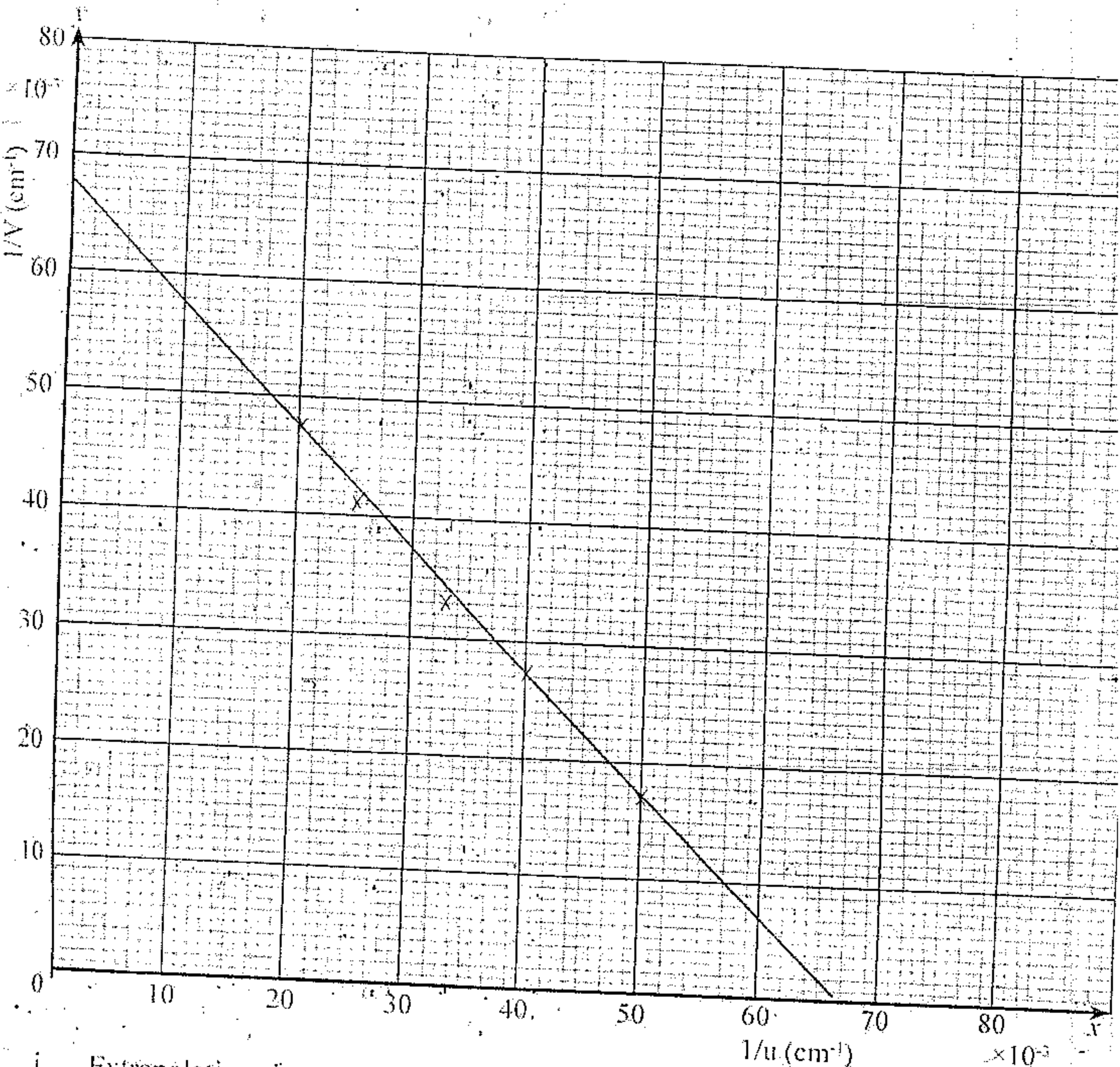
2013 PAPER II Model Solutions

1. g.

Object distance, u (cm)	**Image distance, v (cm)**	**1/v**	**1/u**
50	21.4	0.047	0.02
40	24	0.041	0.025
30	30	0.033	0.033
25	37.5	0.027	0.04
20	60	0.017	0.05

h.

1/V (cm^{-1}) against 1/U (cm^{-1})



i. Extrapolating the graph to y – axis. 1/v = 0.067; at this point focal length (f) = image distance (v)

1/v = 0.067; v = 14.9

Therefore, f = v = 14.9 cm

or

1/u = 0.067

u = 14.9

Therefore f = u = 14.9 cm

2. e.

Metal	Copper sulphate solution	Aluminium sulphate solution	Iron sulphate solution
Copper	No reaction	No reaction	No reaction
Aluminium	Reddish-brown coating	No reaction	Silvery-gray coating
Iron	Reddish-brown coating	No reaction	No reaction

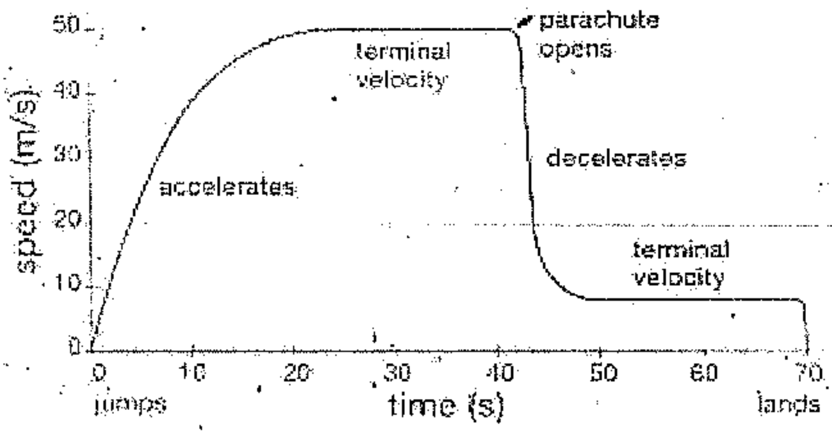
f. Al

Fe

Cu

g. Aluminium (Al) is the strongest reducing agent because it readily loses electrons and is easily oxidised in a chemical reaction as compared to iron and copper.

3.



Before the parachute opens:

1. When the skydiver jumps out of the plane s/he **accelerates** due to the force of **gravity** pulling them down.
2. As s/he speeds up the upward force **air resistance** increases. S/he carries on accelerating as long as the air resistance is less than their **weight**.
3. Eventually, s/he reaches their **terminal speed (velocity)** when the air resistance and weight become **equal**. The forces are said to be **balanced**.

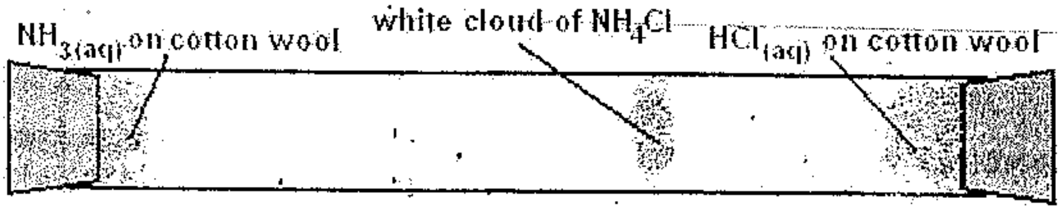
After the parachute opens:

4. When the canopy opens it has a large **surface area** which increases the **air resistance**.

This **unbalances** the forces and causes the parachutist to **slow down**.

5. As the parachutist slows down, their air resistance gets **less** until eventually it **equ** the downward force of gravity on them (their weight). Once again the two for **balance** and they fall at **terminal speed.** This time it is a much **slower** termi speed than before and they land safely on the ground.

4.



The apparatus is set as shown in the diagram above. One piece of cotton wool is soal in concentrated ammonia solution and another is soaked in concentrated hydrochl acid and these are put at opposite ends of a dry glass tube. The HCl and NH_3 ga diffuse in tube, Gases diffuse at different rates. The speed of diffusion depends on speed of its molecules and is greater for lighter molecules. Then after a few minute white cloud of ammonium chloride appears. This shows the position at which the t gases meet and react. The white cloud forms in the position shown because the ammo particles are lighter than the hydrogen chloride particles (released from the hydrochl acid) and so move faster. Generally, lighter particles move faster than heavier ones given temperature.

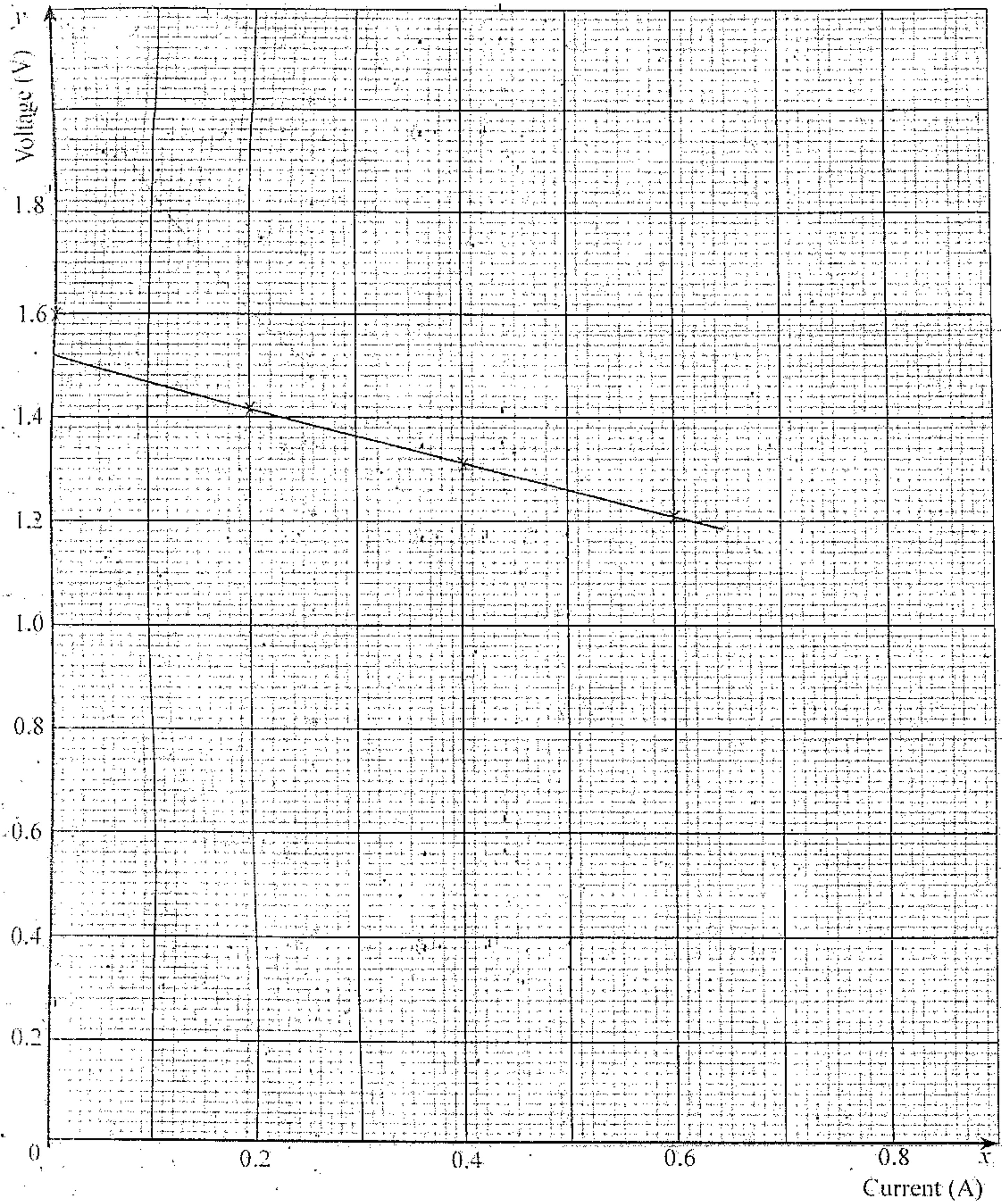
2014 PAPER II Model Solutions

1. g.

Current (A)	Voltage across cell (V)	"Lost voltage" (V)
0	1.6	0
0.2	1.4	0.2
0.4	1.3	0.3
0.6	1.2	0.4

h.

Voltage (V) against Current (A)



i. In a circuit, a battery provides the difference in potential between two terminals by doing work against the electric field, to give electrons potential energy. Once these charges get this potential energy, they naturally do work to get to their neut positions by changing this potential energy to kinetic energy which drives curr through the circuit. But since **electrons travel through a medium they lose so of this energy as heat due to collision with atoms or molecules.** A measure the energy lost/expended between two points in a circuit is known as potential d (voltage loss). The drop in potential increases with resistance. Due to the law energy, the sum of all voltage drops must equal the applied voltage: hence th will be a greater voltage drop across a load in a circuit if the total resistance of circuit is lower.

2. c.

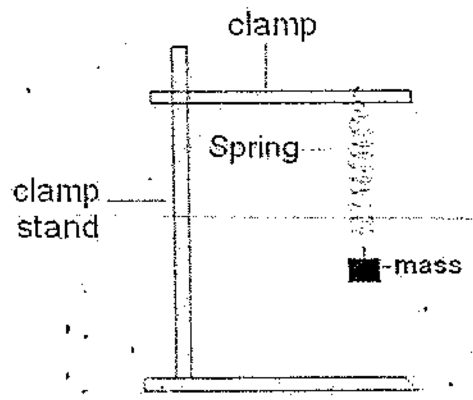
Metal	Initial colour	Final colour
Iron nail	Silver-grey	Reddish brown
Copper foil	Brown	Brown (slightly light brown)

d. The electrons lost by copper foil (dipped in $CuSO_4$ solution) travel through external circuit to the cathode (nail). The ions present in the solution are C (aq) (positive ions) and SO_4^{-2} (aq) (negative ions). The positive Cu^{+2} (aq) ions attracted to the cathode where they gain electrons to form copper atoms. The cop atoms form a reddish brown coating on the iron nail. The reduction half-equat that takes place at the cathode is:

Cu^{+2} (aq) + 2e → Cu (s)

e. Using an anode made of the plating metal has the advantage of replacing the i of copper (Cu^{+2}) that have been converted to solid copper on the surface of object.

3. a.



Set the apparatus as shown in the diagram above. The stop watch is set to zero. Ha mass of 50 g, gently pull down the mass and release it. Start the stop-watch as so the mass is released. Count 10 complete oscillations and stop the watch and record the time taken.

The above procedure is repeated using different masses of 100 g, 150 g, 200 g and 250 g respectively. The frequency for each mass is calculated (in Hertz) and recorded in the table of results.

Frequency = $\frac{Number\ of\ complete\ oscillations}{Time\ taken\ (s)}$

Table of results

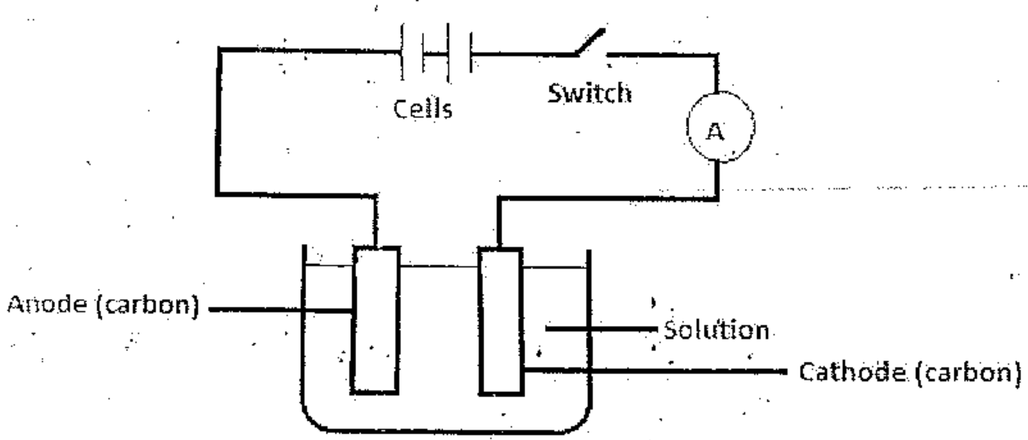
Mass (g)	Time taken to complete 10 oscillations (s)	Frequency (Hz)
50		
100		
150		
200		
250		

Finally, a graph of frequency against mass is plotted. From the graph, the relationship between frequency and mass can be established based on the shape.

Note: Practically, as the mass hung on the spring increases the frequency decreases.

b. Inaccurate reading of the stop watch and poor timing when counting number of complete of oscillations.

4.



The apparatus is set as shown in the diagram above. Two solutions of sugar and sodium chloride are prepared.

Sugar solution is put in the beaker (container) and the switch is closed. The ammeter reading is observed and recorded. The switch is opened.

Then, the sugar solution is removed and replaced with sodium chloride solution. Once again: the switch is closed and the reading of the ammeter is noted.

Table of results

Substance	Ammeter reading (A)	Remarks (conductor or non-conductor)
Sugar solution		
Sodium chloride solution		

It can be concluded from the results that a solution that conducts is prepared from an ionic compound and the one that doesn't conduct is prepared from a molecular compound. This comes from the fact that ionic compounds releases "free" ions when dissolved in water (or when in molten state) hence they conduct current. Molecular compounds do not form ions when dissolved hence they do not conduct current.

Note: An ammeter could be replaced with a small bulb and the conclusion is that a solution made from an ionic compound conducts current and will light the bulb whereas the one prepared from a molecular compound does not conduct electricity and no light is observed from the bulb.

2015 PAPER II Model Solutions

1. c.

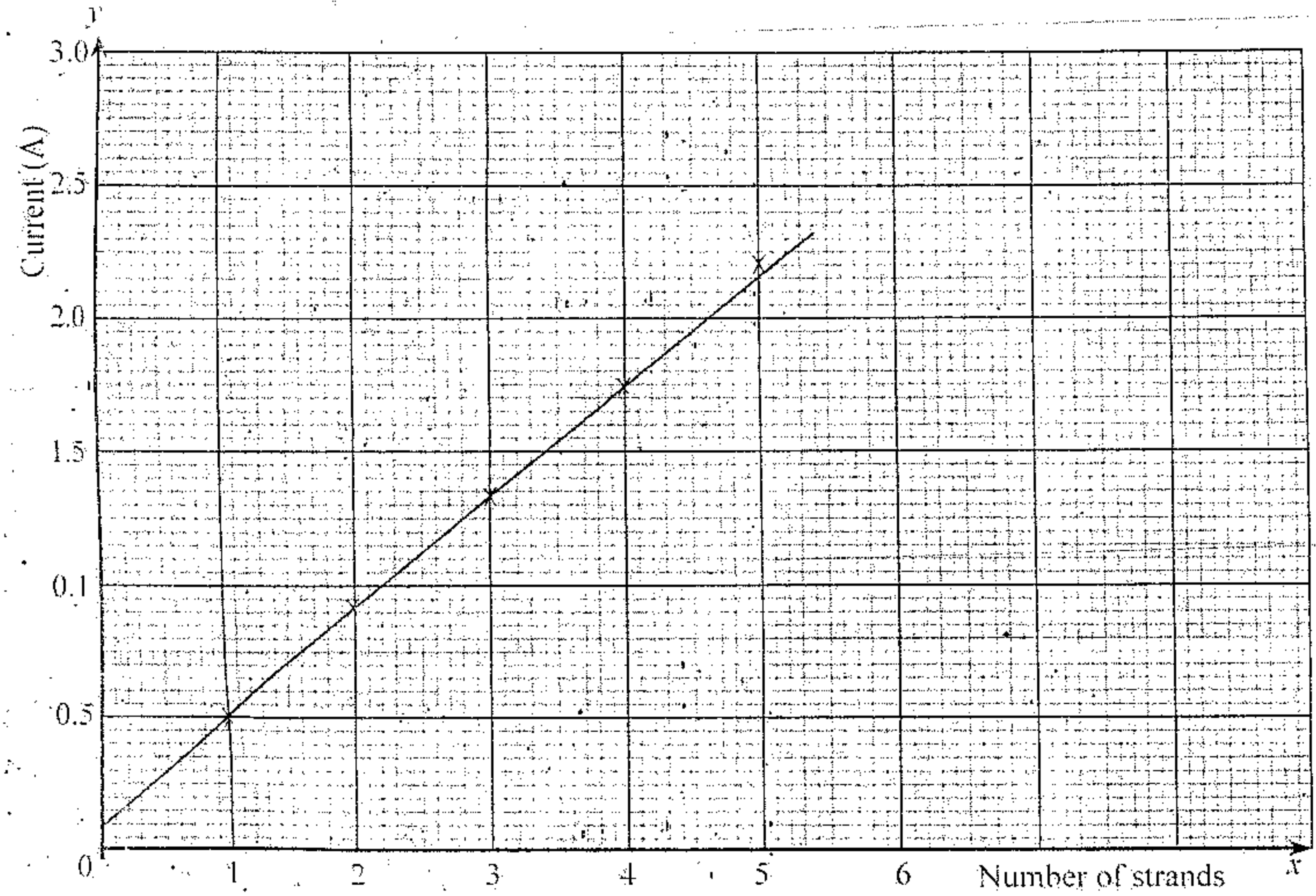
Table of results

Number of strands	Current (A)
1	0,5
2	0,9
3	1,3
4	1,7

5	2.2

f.

Current (A) against Number of strands



g. The graph shows that as the number of strands increases the amount of current flowing also increases (direct relationship). This is the case because increasing number of strands makes the thickness (cross-section area) to increase resulting into decreasing electrical resistance. As a result much current flows more easily in thicker wire (more strands) than in thinner wire (less strands).

g. In this question, you expect liquids that are ionic to conduct current and give light and those that are covalent normally do not conduct current hence no light will be observed.

Liquid	Observation
J	Light
K	No light

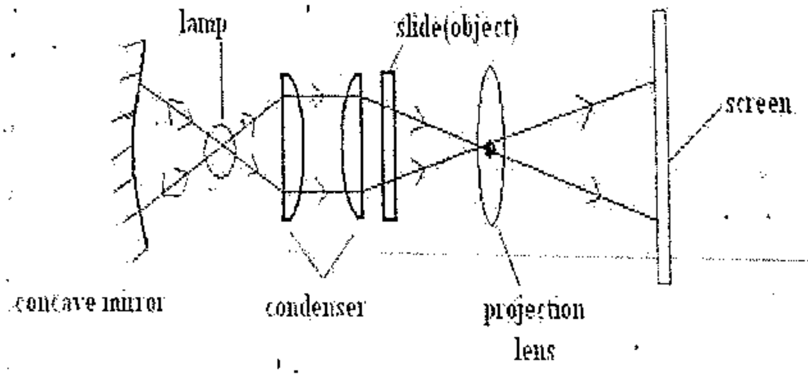
L	Light
M	No light
N	No light
O	No light

The different liquids that were provided were: sodium chloride solution (J), sugar solution (K), copper sulphate solution (L), cooking oil (M), ethanol (N) and distilled water (O).

h. Ionic: J and L

Covalent: K, M, N and O

3.



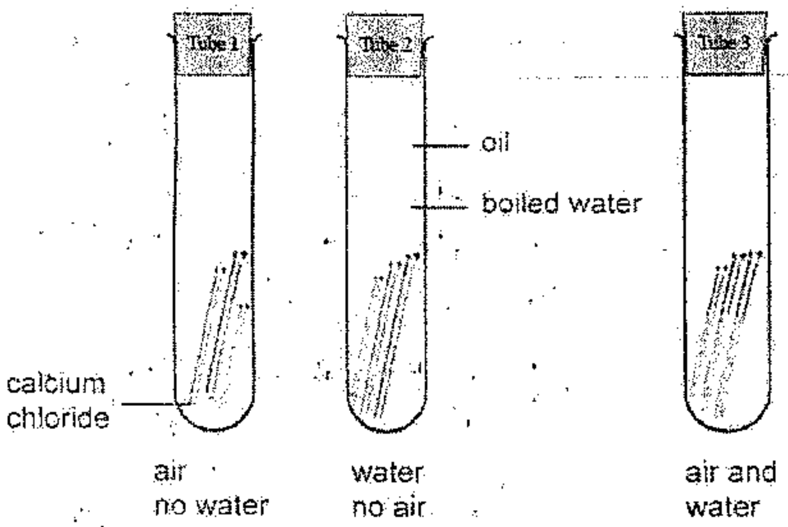
A projector forms a real image on a screen of a slide in a slide projector. The imag larger than the slide and is further away from the lens. It is usually so highly magn that very strong but even illumination of the slide is needed if the image is also t bright. This is achieved by directing light from a small but powerful lamp on to 'object' by means of a concave mirror and a condenser lens system.

In a projector the object (**slide** or **film**) must be inverted to give an upright image must be between 2F and F from the projection lens.

The **projection lens** is a lens of long focal length and its function is to produce a focus magnified, real and upright image (when object is inverted) on the screen.

The **lamp** (light bulb) is used to illuminate the object (slide or film). But much light the lamp is lost because some rays do not strike and light up the object. The light that are directed away from the object are therefore reflected back towards the obje the **concave mirror**.

In order to concentrate the light from the lamp upon the object, a pair of convergin lenses of short focal length called **condenser** is used. The function of the **condens** is to converge and condense (concentrate) as much light as possible onto the objec (slide) so as to illuminate it very well.



g. Place three iron nails in a test tube (1) with some white dry calcium chloride solid. The top of the test tube plugged with some cotton wool. Calcium chloride absorbs water vapour from the air and so the air is dry – water is not present.

h. Place three iron nails in a stoppered test tube (2) of boiled water with a layer of oil on top of the water. The water is boiled for about 15 minutes to drive off all the dissolved oxygen. The oil prevents oxygen from the air dissolving in the water.

i. Three nails are placed in an open test tube (3) containing some water.

j. Allow the tubes to stand in a beaker or test tube rack for a few days and examine for rusting.

k. Expected results: Rusting only occurs in tube 3: no rusting without water or without oxygen.

l. Conclusion: Water and oxygen are together needed for rusting.

n summary;

Tube 1: No rusting, $CaCl_2$ being a drying agent makes the tube to have no water. There is only one essential requirement which is oxygen (from the air).

Tube 2: No rusting, in boiled water dissolved oxygen is removed and the layer of oil prevents air from dissolving in the water. As such water alone cannot make rust on the iron nails.

Tube 3: Rusting is observed on the iron nails since oxygen (from the air) and water are available.