O Level

Physics

Session: 1957 June
Type: Question paper
Code: 22

PHYSICS

ORDINARY LEVEL

(THEORETICAL PAPER)

PART I

1. A simple machine is used to lift a load of 90 lb. through a vertical distance of 4 ft. Calculate (*a*) the increase in potential energy of the weight, (*b*) the work done to operate the machine, assuming it to be 70% efficient.

(*a*)

(*b*)

2. State Boyle's law.

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3. What is the freezing-point of water on the Fahrenheit scale? Express, in ° C, a temperature which is 45 degrees below the freezing-point of water on the Fahrenheit scale.

4. A lighted candle stands on a horizontal plane glass mirror. Draw a ray diagram, showing **either** two rays from one point on the flame, **or** one ray from each of two points on the flame, to show how the image is formed.

5. Answer **one** of the parts (*a*), (*b*).

(*a*) A stretched wire has a fundamental frequency of 400 cycles per sec. State the frequencies of any two tuning-forks, other than the one which is in unison with the wire, with which the wire will show resonance.

(*b*) Give an expression for the heat developed in a wire of resistance x ohms when a current of y amp. flows in it for t min.

6. Resistances of 3 ohms and 7 ohms are joined in parallel. Calculate (*a*) their combined resistance, (*b*) the current in the 3 ohm resistance if the potential difference across it is 10·5 volts.

(*a*)

(*b*)

7. State Faraday's laws of electrolysis.

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PHYSICS 53

ORDINARY LEVEL

THEORETICAL PAPER

(*Two and a half hours*)

Answer **all** *the questions in Part I and* **five** *questions from Part II including at least* **one** *question from each of the Sections* A, B, C.

Candidates are advised to spend **not more than half an hour** *answering Part I.*

PART II

Answer **five** *questions, including at least* **one** *from each section.*

SECTION A

1. You are provided with a piece of solid rubber weighing about 20 gm. and having a density of approximately 1·1 gm. per c.c. Describe any **one** method you would use to obtain an accurate value of the density of the rubber. Show how you would calculate the result.

A hollow sealed copper globe weighing 90 gm. contains 800 c.c. of air. It is completely submerged in a tank of water by means of a weightless thread which is attached to the bottom of the tank. Calculate (*a*) the volume of the copper of which the globe is made, (*b*) the tension in the thread.

[Density of the copper = 8·9 gm. per c.c. Density of the air = 1·3 gm. per litre.]

2. Define the *resultant* and the *equilibrant* of two forces acting at a point.

Find, by calculation, or by a scale diagram, the magnitude and direction of the resultant of forces of 5·4 lb.-wt. and 7·2 lb.-wt. acting at right angles. Describe how you would check your answer experimentally.

3. Answer **two** of the parts (*a*), (*b*), (*c*), (*d*).

(*a*) A body of mass 192 lb. rests on a smooth horizontal surface. It is acted on by a horizontal force of 3000 lb.-wt. for 0·100 sec. Calculate (i) the acceleration of the body, (ii) the speed attained by the body. What would have been the acceleration of the body if the coefficient of friction between it and the surface had been 0·50?

(*b*) Describe how you would determine the position of the centre of gravity of a sheet of cardboard of irregular shape.

Two particles, of mass 3 oz. and 8 oz. respectively, are joined by a weightless rod 5½ in. long. Find the position of the centre of gravity of the arrangement.

(*c*) A simple mercury barometer reads 74·5 cm. at a place where a standard barometer reads 75·0 cm. Name any **one** fault in the simple barometer which could have caused the difference in readings. Assuming the fault to be due to the reason you give, describe and explain the effect of tilting the tube of the simple barometer. Calculate the pressure, in the mercury of the simple barometer (with the tube vertical), at a point which is 70·0 cm. above the lower mercury level. Express your answer in **either** gm. wt. per sq. cm. **or** cm. of water.

[Density of mercury = 13·6 gm. per c.c.]

(*d*) Two porous pots *A* and *B* are each half-full of a sugar solution coloured with a soluble dye and each stands, separately, in a vessel of water such that the water and sugar solutions are at the same level. The pores of pot *B* are sealed with a semi-permeable membrane. Describe and explain the changes which take place in these two arrangements, pointing out the parts played by diffusion, by osmosis and by hydrostatic pressure.

Section B

4. Describe how you would determine the latent heat of fusion of ice.

A plastic tray weighing 48 gm. and containing 200 gm. of water at 20° C. is put in a refrigerator which abstracts heat at a uniform rate of 500 calories per minute. Calculate (*a*) the time taken for the tray and water to reach 0° C., (*b*) the *total* time taken to freeze all the water to ice at 0° C.

[Specific heat of the plastic = 0·25; latent heat of fusion of ice = 79·5 cal. per gm.]

5. Answer **two** of the parts (*a*), (*b*), (*c*), (*d*).

(*a*) A flask has a cylindrical neck 8·0 cm. long, of area of cross-section 0·50 sq. cm. The *total* internal capacity is 50·0 c.c. The flask contains air at atmospheric pressure (74 cm. of mercury) at room temperature (17° C.), enclosed by an oil film at the mouth of the flask. Calculate changes in atmospheric pressure and in room temperature which would result in a movement of the oil film to the inner end of the neck of the flask. Consider only the two cases, where, if one of the variables changes, the other remains constant.

(*b*) A ray of green light, travelling in a beaker of liquid, meets the surface of the liquid at an angle of incidence of 44° and emerges into the air. Calculate the angles which the refracted and partially reflected rays make with the surface of the liquid. State, giving your reasons, whether these angles would be greater, less, or unchanged if the incident ray were of red light.

[Refractive index of the liquid for green light = 1·36.]

(*c*) Describe in detail any **one** method for determining the frequency of a tuning-fork whose frequency is approximately 500 cycles per sec. If you consider that another tuning-fork is required, assume that a standard fork of frequency 256 cycles per sec. is the only one available.

(*d*) Draw a labelled diagram of an optical system which can form a pure spectrum on a screen. Show the ray tracks through the prism from any one incident ray when the incident light looks red but is actually a mixture of ultra-violet, red and infra-red. How could the ultra-violet and the infra-red falling on the screen be detected?

6. A simple astronomical telescope consisting of two lenses is used to view a distant chimney, the base of which is on the axis of the telescope. A ray from the top of the chimney to the centre of the object glass (focal length 50 cm.) makes an angle of 10° (an angle whose tangent is 0·18) with the axis. The final image subtends an angle of 45° at the eyelens. Draw a labelled ray diagram, to scale, to explain the action of the telescope; you may show the image to be situated at any position which you consider suitable. From your diagram deduce an approximate value for the focal length of the eyelens. Explain how you obtain this result.

[Squared paper is available for drawing the scale diagram.]

7. Distinguish between the meanings of the terms *conduction* and *radiation* as applied to the loss of energy from a hot body. Describe experiments, **one** in each case, to show the following phenomena:

(*a*) Copper is a better thermal conductor than iron.

(*b*) A rough (or a black) surface is a better radiator than a shiny surface at the same temperature.

Section C

8. Answer **two** of the parts (*a*), (*b*), (*c*), (*d*).

(*a*) Describe simple magnetic tests which would enable you to distinguish between (i) a bar of iron and a bar of steel, (ii) a bar of iron and a bar of aluminium. Give an explanation of the fact that a keeper or bar of iron is usually fitted across the poles of a horse-shoe magnet.

(*b*) Define the terms *declination* (or *variation*), and *dip* as applied to the earth's magnetic field.

Describe how you would find the angle of variation in a laboratory in which the benches have their sides running exactly north–south and east–west.

(*c*) What do you understand by the term *magnetic line of force*?

Draw a diagram to show the magnetic lines of force in a horizontal plane around a vertical wire carrying a current downwards. Mark on your diagram a direction to represent that of the magnetic north and show a possible position of a neutral point (zero horizontal field) due to the interaction of the earth's field and that of the current.

(*d*) Draw a labelled diagram to show the structure of any **one** type of accumulator in a fully charged condition.

An accumulator is labelled "2 volts, 50 ampere-hours, normal charging rate 3 amp." Draw a fully labelled circuit diagram to show how you would re-charge it after discharge, using a 6 volt d.c. supply. Estimate the cost of the re-charge in this circuit if the supply costs 10*d.* per kilowatt-hour.

9. Draw a labelled diagram of any **one** type of ammeter. Explain how the ammeter acts and state, giving reasons, whether it is suitable for use with an alternating current.

An ammeter which reads up to 1·50 amp. has a resistance of 0·05 ohm. Explain how it could be adapted to read up to 7·50 amp.

10. Draw a labelled diagram of a simple type of alternating current generator. Describe and explain the variation of its e.m.f. during one complete revolution of the shaft.

A simple alternating current generator, rotating at 50 revolutions per sec., gives a maximum output of 20 volts. State any **one** way in which a maximum output of 10 volts could be obtained from the generator. [If you consider that additional apparatus is required for this, show how the apparatus should be connected to the terminals of the generator.]

PHYSICS **54**

ORDINARY LEVEL

PRACTICAL TEST

(Two hours and a quarter)

Do **two** *of the following experiments. You will not be allowed to start work with the apparatus for the first quarter of an hour.*

Candidates are recommended to record their observations as soon as these observations are made. These observations and any arithmetical working of the answers from them should be written on the answer sheets; scrap paper should not be used. The record may be in pencil provided it is sufficiently neat to be intelligible. A fair copy is **not** *wanted.*

A full account of the method of carrying out the experiments with a detailed description of the apparatus is **not** *required. Candidates should note any special precautions they have taken, and it must be clear (by diagrams or otherwise) exactly what the readings mean and how they were obtained. The theory of the experiments is* **not** *required.*

Mathematical Tables and squared paper are provided.

1. You are provided with a metre rule which has a clip attached near the 100 cm. end, and which has a label giving the combined weight. Record this weight.

Do not move the clip from its position.

Balance the rule and clip on a fulcrum and record the scale mark g corresponding to the position of the centre of gravity.

Hang a 100 gm. weight from the 2 cm. mark of the rule, and balance the arrangement on a fulcrum as shown in Fig. 1. Measure the distance x between the fulcrum and the point of attachment of the weight. Record this value, and also the scale-mark s from which the weight was hung.

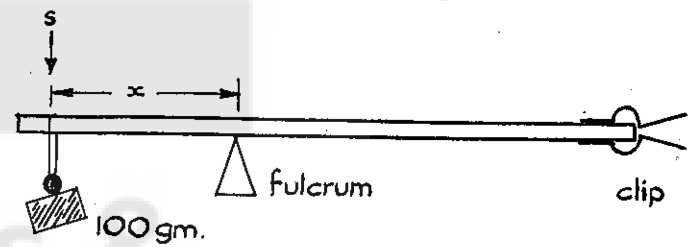

Fig. 1.

Then repeat the experiment with the 100 gm. weight hung from the 5 cm., 10 cm., 20 cm., 30 cm., 40 cm. and 50 cm. marks.

Plot a graph of s against x, commencing both scales from the origin or 0, 0 mark. From your graph, deduce

(i) the value of s_0, where s_0 = value of s, when $x=0$;

(ii) the value of x_0, where x_0 = value of x, when $s=0$. Hence find the value of

$$\frac{x_0}{s_0-x_0}.$$

2. Measure the diameter of the given metal rod with a screw gauge and also by the following optical method.

Mount the rod and a screen so that they are 100 cm. apart. Place the given convex lens (focal length 10 cm.) between them, illuminate the rod with a lamp and move the lens to such a position that it forms a magnified image of the rod on the screen. Measure the width w of the image, in mm., and the distance v of the image from the centre of the lens, in cm.

Repeat the observations with the rod and screen separated by distances of 90 cm., 80 cm., 70 cm. and 60 cm.

Plot a graph of w against v, commencing both scales from the origin or 0, 0 mark. From your graph, deduce the value of (*a*) w_{60}, where w_{60} = value of w, when $v=60$ cm.; (*b*) w_{20}, where w_{20} = value of w, when $v=20$ cm. Calculate the diameter d of the rod from the formula $d=\frac{w_{60}-w_{20}}{4}$.

Record the value of d found by using a screw gauge. State, giving your reason, which of the two results you consider to be the more accurate.

Draw a diagram of the arrangement of apparatus in the optical experiment, and state how you measured the distance v.

3. Heat the given test-tube and its contents ("hypo" crystals) in a bath of boiling water to melt the "hypo" and to bring it to a temperature of about 100° C.; this will take about 5 minutes.

Weigh the given calorimeter, together with the crystals of "hypo" which it contains; record the weight w_1. Add 90 c.c. of paraffin and re-weigh. Hence find the weight w_2 of paraffin added. Take the temperature θ_1 of the paraffin, and then pour the molten "hypo" from the test-tube into the calorimeter of paraffin. Stir the paraffin, and take its temperature θ at regular intervals for a period of 5 minutes. Then re-weigh the calorimeter and contents to find the weight w_3 of "hypo" added.

Plot a graph of the temperature θ of the paraffin against time. From the graph, find the highest temperature θ_2 reached by the paraffin.

Calculate the heat H received by the calorimeter and paraffin, using the equation

$$H=(0{\cdot}1w_1+0{\cdot}5w_2)\,(\theta_2-\theta_1).$$

Hence find the value of $H \div w_3$, the heat received from each gram of the molten "hypo".

4. Connect, in series, an accumulator, switch, potentiometer and the given length of bare wire labelled **R** as shown in Fig. 2. Then connect a dry cell, galvanometer and crocodile-clip as shown in Fig. 2, with the crocodile-clip connected to the zero end of the potentiometer. Move the jockey to find the balance-point on the wire, i.e. the point at which the galvanometer gives no deflection. Measure and record the balance-length l.

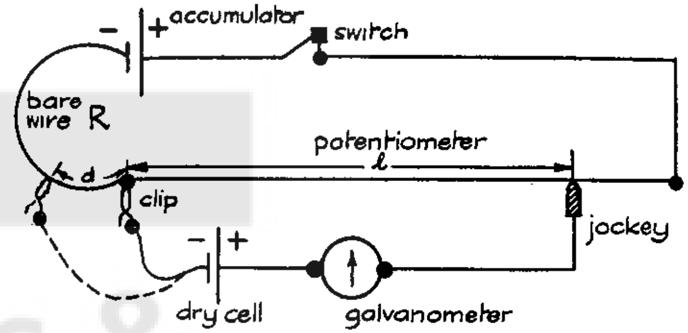

Fig. 2.

Then move the crocodile-clip to make contact with a point on the bare wire about one-fifth of the way along it, as shown by the dotted lines in Fig. 2. Measure and record the length marked d, and also the corresponding balance-length (measured from the zero end of the potentiometer).

Repeat the experiment for other positions of the crocodile-clip to give, in all, five readings of l. Tabulate your values of d and l, including the one where $d=0$.

Plot a graph of l against d. From your graph deduce the average value of d which makes l decrease by 10 cm.

C

ORDINARY LEVEL

PRACTICAL PHYSICS INSTRUCTIONS

PAPER 54. JULY 1957

Instructions for preparing apparatus

In order to assist the laboratory staff in making preparations for the examination, the Chief of the Physics Staff may study the question paper on Monday, 1 July. It is to be re-sealed with the other copies as soon as practicable.

N.B. The candidates will be instructed not to write out a detailed description of the apparatus; instead, the Supervisor or teacher responsible is asked to send up (on the form provided) a *brief* description of the apparatus supplied, mentioning any points which are likely to be of importance to the Examiner in marking the answers. This form is also to be used for reporting any assistance given to candidates under the regulation explained overleaf; it should be signed by the Supervisor and by the person responsible for preparing the apparatus.

In addition to the usual equipment of a physics laboratory, each candidate will require the following:

Apparatus required:

1. Metre rule with a bulldog clip attached near the 100 cm. mark, and carrying a label stating the total weight of clip and metre rule. Knife-edge or fulcrum and means of supporting it above bench level. Cotton or thread. 100 gm. weight.

2. Short rod such as a blanket pin or a thick gramophone needle; if the latter is used its point should be broken off or embedded in plasticine. Means of supporting the rod; lamp for illuminating the rod. Screen to which can be attached a millimetre scale (a paper scale is suitable); drawing pins or rubber bands for the attachment of the scale to the screen. Convex lens (focal length 10 cm.) and holder. (The focal length of the lens can be in the range 9·5 cm.–10·5 cm.) Metre rule. Screw gauge (one gauge to about six candidates should be sufficient).

3. Copper calorimeter (not lagged), capacity 100–150 c.c. but up to 250 c.c. will do; the calorimeter is to have in it 3 crystals of photographic "hypo", about 0·1 in. long. Thermometer (to 100° C. in degrees). Paraffin oil (any one of the proprietary brands of burning paraffin), about 100 c.c. per candidate. 100 c.c. measuring cylinder. Test-tube containing 10 gm. photographic "hypo" (to nearest 0·2 gm.). Holder for handling the test-tube when the test-tube is hot—a strip of stiff paper would do. Water bath for heating the test-tube; the bath and its heater

should be set up ready for use and with the water in it already hot. Balance and box of weights. Clock or watch reading to nearest 5 sec. Stirrer.

4. Potentiometer, 2-volt accumulator, switch, dry cell, centre-zero galvanometer, jockey, crocodile-clip with wire attached, connecting wire. The polarity of the cells is to be clearly marked.

A length (25–50 cm.) of bare resistance wire labelled **R** such that, when it is included in series in the accumulator circuit of the potentiometer, the balance length for the dry cell is nearly equal to the length of the potentiometer wire; its resistance is therefore likely to be in the range 0·25–0·30 of the resistance of the potentiometer. $\frac{1}{2}$-metre rule.

Special information required from the Supervisor

Question 1. None.

Question 2. Focal length of lens.

Question 3. None.

Question 4. (*a*) The resistance per metre of the potentiometer wire.

(*b*) The resistance per metre of the bare resistance wire.

Instructions for Practical Physics Supervisor

A. The first $\frac{1}{4}$ hour of the $2\frac{1}{4}$ hours allowed for the examination is to enable candidates to read the questions, choose which they will do, and plan out their work. During this period they should be allowed to inspect the apparatus, but they must not start work with it.

B. *Assistance to Candidates.* The purpose of the Practical Physics test is to find out whether the candidates can carry out simple practical work themselves. The Examiners are aware that a candidate may sometimes be unable to show his practical ability through failure to understand some point in the theory of the experiment. If an Examiner were present in the laboratory, he would be prepared to give such a candidate a hint to enable him to get on with the experiment. In order to overcome this difficulty, the Supervisor is asked to co-operate with the

Examiners to the extent of being ready to give (or allow the Physics teacher to give) a hint to a candidate who is unable to proceed.

The following regulations must be strictly adhered to:

(i) No hint may be announced to the candidates as a whole.

(ii) A candidate, who is unable to proceed and requires assistance, must come up to the Supervisor and state his or her difficulty. Candidates should be told that the Examiners will be informed of any assistance given in this way.

(iii) A note must be made, on the Form for Report on Apparatus Supplied, of any assistance given to any candidate, with the name and index number of the candidate.

It is suggested that the following announcement be made to the candidates:

"The Examiners do not want you to waste your time through inability to proceed with the experiment. Any candidate, therefore, who is unable to get on with his experiment after he has spent 15 minutes at it, may come to me and ask for help. I shall report to the Examiners any help given in this way, and some marks may be lost for the help given."

PHYSICS **55**

ORDINARY LEVEL

ALTERNATIVE TO PRACTICAL

(One hour and a half)

Answer **two** *questions.*

Mathematical tables and squared paper are provided.

A good quality ruler in centimetres and a protractor in degrees will be required.

Question 1

Fig. 1, which is drawn **one-fifth** actual size, represents a U-tube with one closed limb in which some dry air is enclosed by mercury. At the commencement of the experiment, the levels

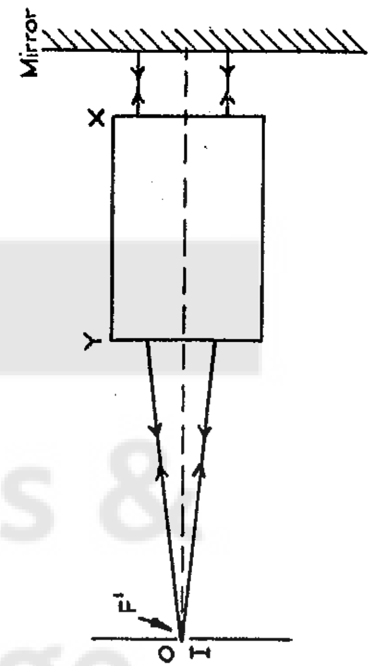

Fig. 3 (b).

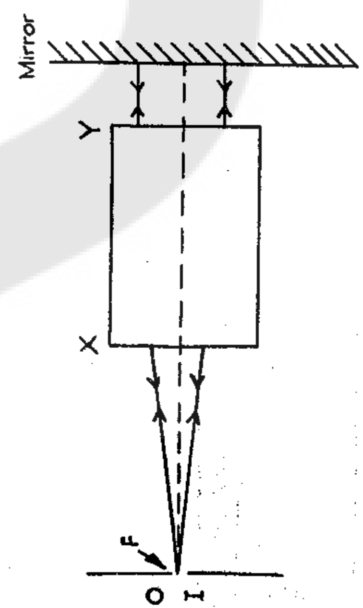

Fig. 3 (a).

Scale diagrams one-half actual size.

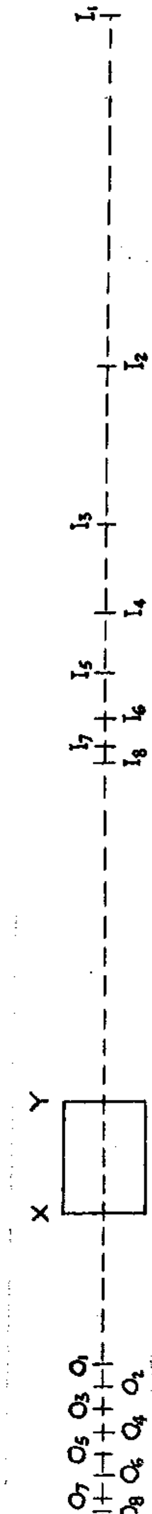

Fig. 5. Scale diagram one-quarter actual size.

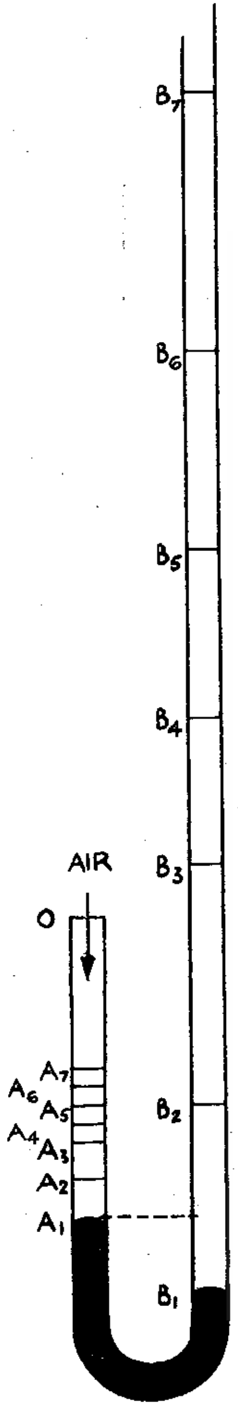

Fig 1. Diagram is one-fifth actual size.

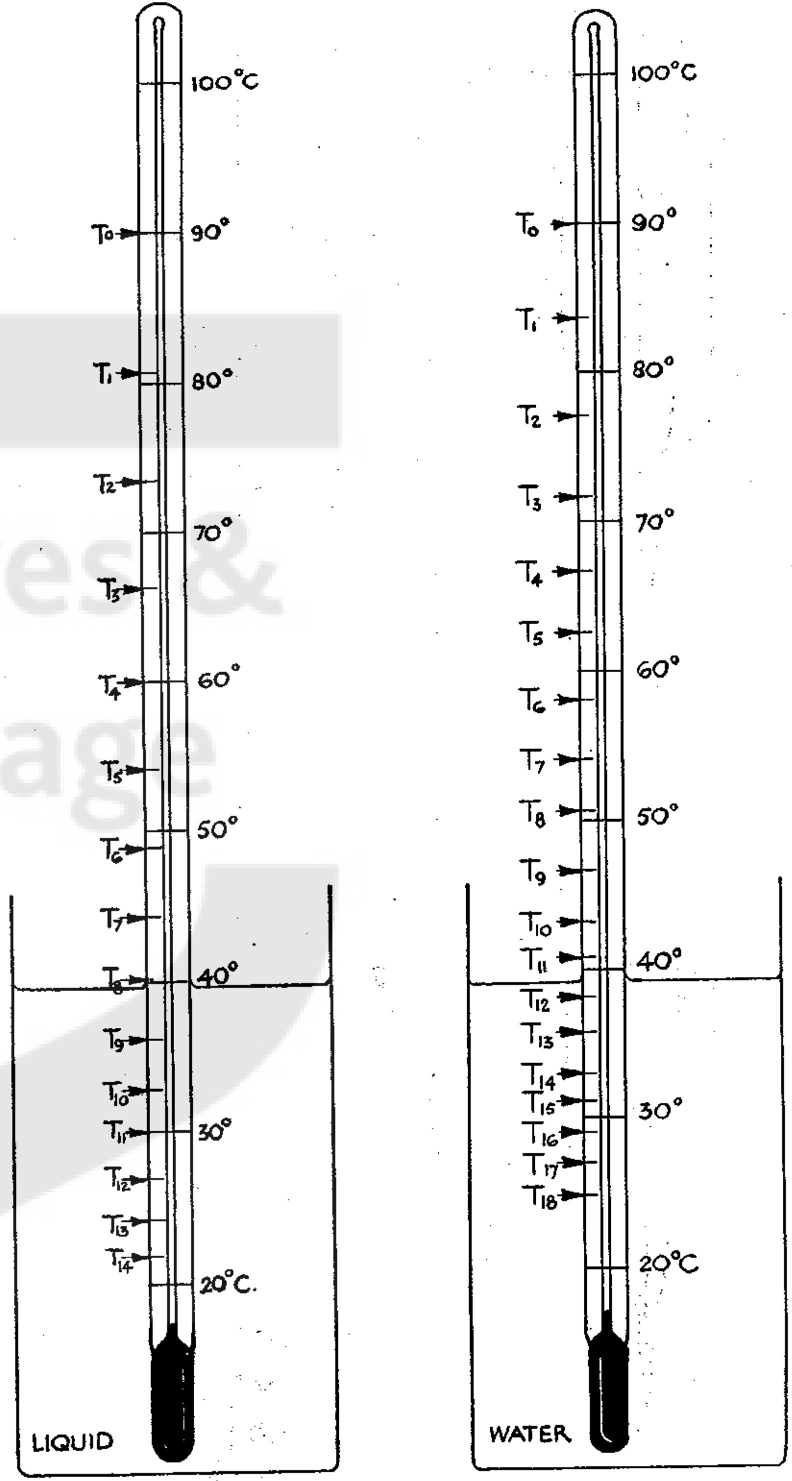

Fig. 2.

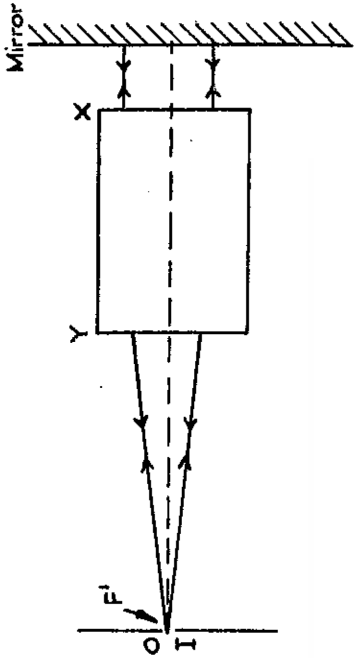

Fig. 3 (b).

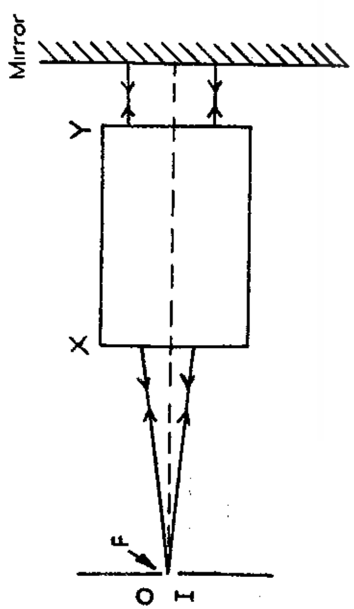

Fig. 3 (a).

Scale diagrams one-half actual size.

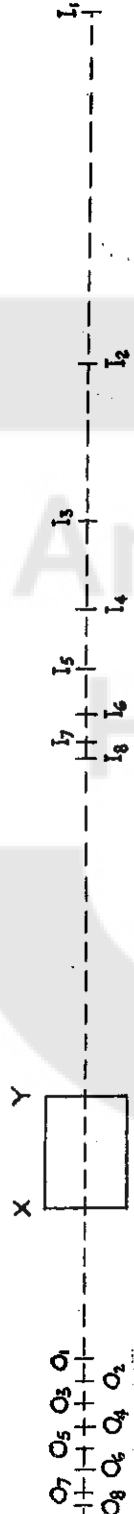

Fig. 5. Scale diagram one-quarter actual size.

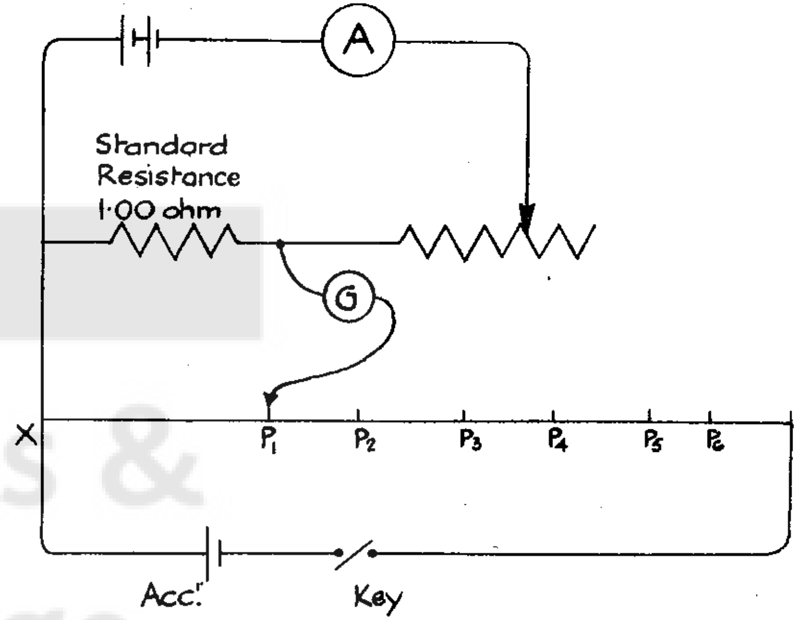

Fig. 6. Diagram is one-tenth actual size.

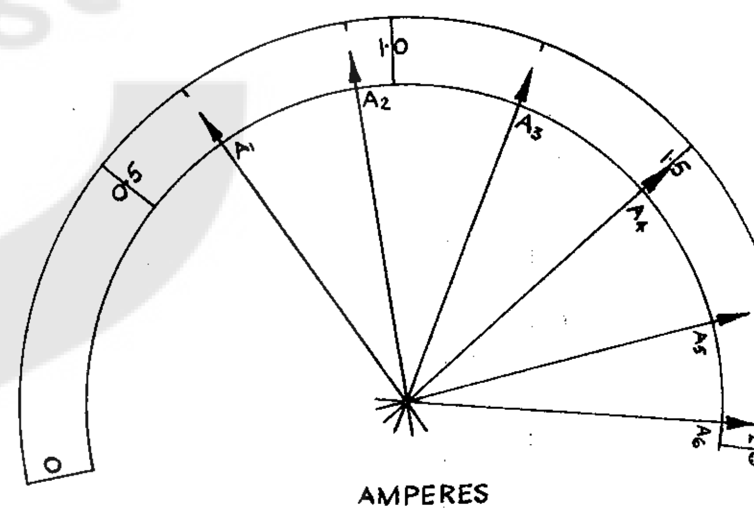

Fig. 7.

A_1B_1 of the mercury in the two limbs are as shown. When more mercury is poured into the right-hand limb, the levels are A_2B_2. By pouring in mercury, the levels are found to be A_3B_3, A_4B_4, etc. Determine from the diagram the volumes of the air (measured in cm. of tube) under the different pressure conditions. The temperature is kept constant throughout.

Tabulate the readings as shown:

Volume of gas, OA (cm. of tube)	Excess pressure of air $= AB = p$ (cm. of mercury)	$\frac{1}{\text{Volume}}$

Plot the graph of $\frac{1}{\text{volume}}$ against excess pressure p. The scales should cover the range 0–0·1 for $\frac{1}{\text{volume}}$ and -80 to $+80$ cm. for p. Draw the best straight line through the points and find the value of p when $\frac{1}{\text{volume}} = 0$.

Question 2

Equal volumes of water and liquid are allowed to cool under exactly similar conditions and their temperatures are recorded every minute. These temperature readings are shown on the thermometers represented in Fig. 2 and the numbers correspond to the successive minute intervals. Read the temperatures from the diagram and tabulate as shown:

Time (min.)	Temperature of water	Temperature of liquid

Plot the two cooling curves, i.e. temperature against time, on the same axes. From the graph read off the time taken for each liquid to cool from 70° C. to 30° C. Assuming that both liquids lose heat at the same rate and that the density of the liquid is

1·25 gm. per c.c., calculate an approximate value for the specific heat of the liquid from the following formula. (The heat given out by the calorimeter is neglected.)

$$\frac{m_1 s_1 (70-30)}{t_1} = \frac{m_2 s_2 (70-30)}{t_2},$$

where m_1 and m_2 are the masses of the water and of the liquid, s_1 and s_2 are the specific heats of the water and of the liquid, t_1 and t_2 are the times taken by the water and by the liquid to cool from 70° C. to 30° C.

Question 3

The box XY contains a convex lens. The position of one focal point F is found by the method shown in Fig. 3 (a). The light from the object O passes through the lens on to the plane mirror and is made to return along the same path by adjusting the position of XY.

The other focal point F' is found by turning XY round and using the same method, Fig. 3 (b).

The lens is now used to produce a real image I of the object O by the method illustrated in Fig. 4.

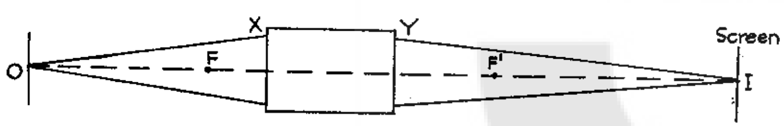

Fig. 4.

Fig. 5 shows eight pairs of positions of O and I, viz, O_1, I_1; O_2, I_2; etc.

Mark on Fig. 5 the exact positions of F and F' found from Fig. 3 (a) and 3 (b). (Note that the Figs. 3 (a), 3 (b) and 5 are not drawn to the same scale.)

Measure, in cm., the distances O_1F, O_2F, etc., and I_1F', I_2F', etc.

Tabulate the readings:

OF	IF'	$\frac{1}{OF}$

Obtain the reciprocals $\frac{1}{OF}$ from tables. [These reciprocals should be expressed as decimals and not as fractions.]

Plot the graph of IF' against $\frac{1}{OF}$, starting both scales from zero. Find the slope of this straight line graph.

Question 4

The ammeter A shown in the circuit Fig. 6 is to be checked. The true value of the current is obtained by finding the potential difference across the standard resistance.

It can be taken that the potential difference across each cm. of the potentiometer wire is 0·0208 volts.

The potential difference across the standard 1 ohm is measured on the potentiometer and a series of readings obtained by varying the current in the main circuit with the rheostat.

The potential differences across the standard 1 ohm for six values of the current A_1, A_2, etc., are represented by the distances XP_1, XP_2, etc., on the potentiometer. Determine these distances which are drawn to scale in Fig. 6. XY is 100 cm. The corresponding readings of the ammeter are shown in Fig. 7.

Complete the following table of readings:

Reading of ammeter. Fig. 7 (amp.)	Distance XP (cm.)	p.d. across XP $=0{\cdot}0208 \times XP$ (volts)	True current in circuit $= \frac{\text{p.d. across } XP}{1{\cdot}00}$ (amp.)

Plot the graph of reading of ammeter against true value of current and from it find the error in the meter reading at 1 ampere.

[Use a protractor to obtain the readings from Fig. 7.]