CAMBRIDGE
UNIVERSITY PRESS & ASSESSMENT

# O Level

## Physics

Session: 1967 June
Type: Question paper
Code: 530

**530/1**

# PHYSICS

ORDINARY LEVEL

THEORETICAL PAPER

(*Two hours and a half*)

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

(*Mathematical Tables and squared paper are provided.*)

**All** *working must be shown.*

## Part I

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

*Answer* **five** *questions.*

*Answers and working for this part of the paper must be put* **on this sheet.**

**1** A mass of 200 lb. is raised vertically 22 ft. in 6 sec.

Calculate the work done.

Calculate the horse-power expended. [1 h.p. = 550 ft. lb. wt./sec.]

**2** What is a vector quantity? ....................................

Put a tick ✓ against those, in the following list, which are vectors.

Velocity .................. Force ..................

Acceleration ............... Density ..................

**3** Define the temperature 0° on the Celsius (centigrade) scale:

..............................................................................

How many calories of heat are required to heat 80 gm. of a liquid of specific heat 0·43 cal./gm. deg. C. from 0° to 100° C.?

**4** State the energy changes which occur when a moving car is brought to rest by its brakes, and the car is then driven to the top of a hill.

..............................................................................



**5** In Fig. 1 *O* is an object in front of a thick glass mirror silvered on its back surface. *OA* is a ray of light from the object. Show on the diagram the directions of two reflected rays, one due to a reflection at the front of the glass and one due to a reflection at the back.

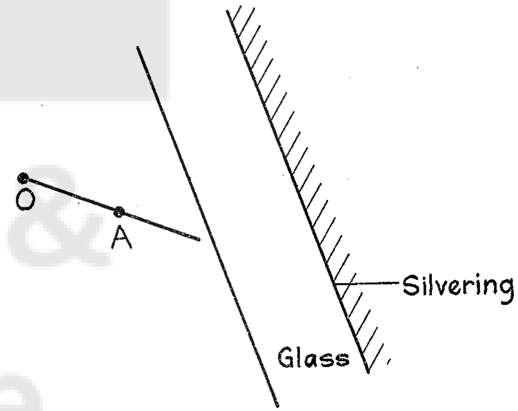


Fig. 1

**6** A current of 3 amp. flows through the resistors *A* and *B* in Fig. 2. Find the energy produced per second

(*a*) in *A* ..............................................................

(*b*) in *B* ..............................................................

(*c*) in *A* if the current is reduced to 2 amp.

.............................................

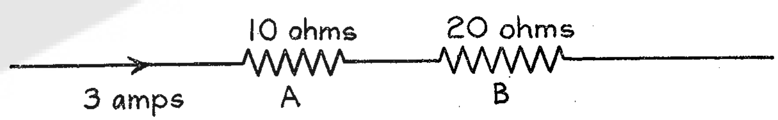


Fig. 2

**7** In Fig. 3 *AB* is a uniform wire 100 cm. long to be used as a potentiometer, fixed to a scale and connected to an accumulator. A voltmeter connected to *A* and *B* reads 2·0 V.

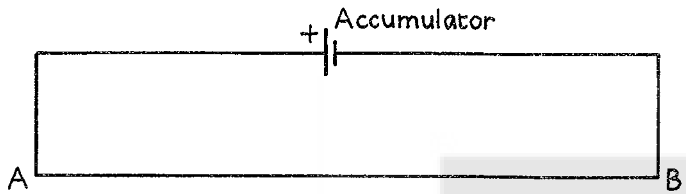


Fig. 3

Show on the diagram how to connect a cell $S$, a galvanometer and a jockey in order to obtain a balance point $C$ on $AB$.

How do you detect the balance point on $AB$?

..........................................................................

What will be the length $AC$ if the E.M.F. of the cell $S$ is 1·5 V.?

..........................................................................

## PART II

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

### SECTION A

**1** Answer **both** parts.

(*a*) A uniform glass tube of narrow bore closed at one end is lowered vertically, with the open end downwards, to the bottom of a lake. The tube is 80 cm. long and the water is found to have risen half-way up the inside of the tube. Find the depth of the lake.

The tube is dried and a thread of mercury 15 cm. long introduced to enclose some dry air. When the tube is held vertically with the open end downwards, the length of the air column is 45 cm. What will be the length of the air column when the tube is turned upside down?

[Atmospheric pressure = 75 cm. of mercury; specific gravity of mercury = 13·6.]



(*b*) A ladder is 20 ft. long and weighs 100 lb. Its centre of gravity is 8 ft. from one end. Two men carry the ladder, one man at each end. Draw a diagram to show the forces exerted by the men on the ladder, and calculate the magnitude of each force.

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

(*a*) A car starts from rest with uniform acceleration. The speed after 10 sec. is 80 ft./sec. and remains constant for 20 sec. The car is then brought to rest with uniform retardation in a further 16 sec.

Draw the graph of speed against time.

Indicate the area on the graph which corresponds to the distance covered with uniform speed. Find the distance travelled in coming to rest with uniform retardation, and the total distance covered by the car.

What was the initial acceleration of the car?

(*b*) A small amount of water placed on the flat surface of a wax block forms into drops, but the same water placed on a clean glass surface spreads into a thin film. Give an explanation of this effect in terms of the forces between molecules.

Why is it that a needle may float on clean water but sinks when some detergent (wetting agent) is added to the water?

(*c*) How would you construct a simple hydrometer from a drinking straw? Why is a more sensitive hydrometer heavier and made with a long thin stem? A hydrometer weighs 20 gm. and the area of cross-section of the stem is 0·5 sq. cm. Where on the stem will the 0·9 graduation mark be in relation to the 1·0 mark?

**3** What is meant by *friction*? Illustrate your answer by reference to the effect of a steadily increasing horizontal force applied to a block of wood at rest on a rough horizontal table.

Discuss the frictional forces between the tyres of a motor car and the ground when the car (*a*) starts from rest, (*b*) skids in the forward direction.

## Section B

**4** Define *coefficient of linear expansion.*

Describe briefly two experiments, one to demonstrate the expansion of a solid when heated, and the other to demonstrate that two different metals possess different coefficients of expansion.

Draw a diagram of a useful device which involves the expansion of two different metals and indicate how the device works. Make clear which metal has the greater coefficient of expansion.

Calculate the expansion of 15 m. of copper pipe when heated from 5° C. to 60° C., if the coefficient of linear expansion of copper is 0·000017 per deg. C.

**5** State two pieces of evidence which suggest that light travels in straight lines.

Describe carefully a laboratory experiment to produce further evidence of this property of light, and indicate the accuracy with which your experiment establishes this result.

Draw a ray diagram to illustrate an eclipse of the moon. Describe the appearance of the moon, observed without a telescope, during the period of the eclipse.

**6** Explain the difference between the actions of a converging and a diverging lens on a parallel beam of light.

Draw labelled ray diagrams to show how a converging lens can produce (*a*) a real magnified image, (*b*) a virtual magnified image. Which of these two diagrams applies to the formation of an image by a projection lantern? Give one reason for your answer.



A lens of focal length 25 cm. projects an image of an object, which is 2·5 cm. high, on to a screen placed 150 cm. from the lens. Find by calculation or by scale drawing the height of the image.

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

(*a*) What is meant by *boiling point* and by *saturated vapour pressure*?

Describe briefly the information which may be obtained by using the wet and dry-bulb hygrometer.

(*b*) What is the essential difference between infra-red and ultra-violet radiation?

Describe how you would detect each type of radiation in the laboratory.

(*c*) Make clear the terms *frequency* and *wavelength* with reference to a sound wave.

A tuning fork is vibrated near an instrument, e.g. a microphone connected to an oscilloscope, which depicts the wave form of the sound. Show clearly, by means of labelled diagrams, the changes observed in the wave form when (*a*) the fork is replaced by one of twice the frequency, (*b*) the fork emits a louder note; indicate clearly the important features of these changes.

## Section C

**8** Describe an experiment to investigate the form of the magnetic field around a solenoid laid on a table and carrying a current. Draw a diagram of the lines of force of the field.

Suggest two ways of modifying the experiment in order to obtain a stronger magnetic field.

A small cylinder of iron is placed co-axially with the solenoid so that one end of the cylinder is just inside the solenoid. Explain briefly what happens when a current through the solenoid is switched on, if (*a*) the current is direct, (*b*) the current is alternating.

The solenoid alone is then connected directly to a sensitive centre-zero galvanometer. What is observed when a cylindrical magnet is pushed into the solenoid and then withdrawn?

9 State Ohm's law, and define *resistance*.

When a direct current electric motor is in use, the current flowing through the armature is not proportional to the applied potential difference. Give the reason for this.

A filament of resistance 3 ohms is designed to carry a current of 2 amps. The only battery available is a 12 V. accumulator of internal resistance 0·6 ohm. Draw the circuit you would use in order to supply the filament, and calculate the value of the additional resistor required. Show an ammeter in your circuit for checking the value of the current.

10 Describe a simple cell and indicate the source of the electrical energy which it produces.

Indicate the disadvantages of the simple cell and describe how they are reduced in a modern 'dry cell'. Why is a modern dry cell unable to maintain a steady current over a long period?

A zinc plate is the anode of a voltameter. Find the decrease in the mass of the zinc when a current of 0·5 amp. flows for 2 hr.

[Electrochemical equivalent of zinc is 0·00034 gm./coulomb.]

**530/2**

## PHYSICS PRACTICAL A

ORDINARY LEVEL

*(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 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 Determine the volume $V$ and the density $d$ of the glass of the given test-tube. Use the following method, in which lengths are to be measured in cm. and volumes in ml. or c.c.

(*a*) Determine the external circumference $C$ by wrapping some wire round the tube. You are provided with some thin wire for the purpose, and some plasticine to hold the wire in place. The mean of at least **three** results is required for $C$.

Hence calculate the external area of cross-section $A$ from the approximate formula

$$A = \frac{8C^2}{100}.$$

(*b*) Pour a little water into the tube. Then determine the volume $v$ in a measured length $x$ of the cylindrical part of the tube, by pouring in more water from a measuring cylinder.

Hence calculate the internal area of cross-section $a$ from the formula

$$a = \frac{v}{x}.$$

The mean of at least **two** results is required for $a$.

(*c*) Measure the length $l$ of the tube and calculate the volume $V$ of the glass. It will be sufficiently accurate to use the formula

$$V = l(A-a).$$

(*d*) Weigh the tube to find its mass $M$. It will be sufficiently accurate to weigh the tube to the nearest 0·1 gm.

(*e*) Calculate the density $d$ of the glass from the formula

$$d = \frac{M}{V}.$$

**2** Determine the thermal capacity $c$ of 90 ml. (c.c.) of the liquid **L** by the following method.

Put 90 ml. (c.c.) of the liquid into the given lagged calorimeter, and heat the 100 gm. brass weight in boiling water for two or three minutes. Remove the brass weight from the water, shake off surplus water, and hold the weight in the air for about 10 sec. before transferring the weight to the calorimeter to find the resulting rise in temperature $r$; during the 10 sec. wait you should check the initial temperature of the liquid.

Repeat the experiment to give in all at least **five** observations of $r$. Do not change the liquid which is in the calorimeter; the object of the experiment is to determine $r$ for different initial temperatures. At the end of the experiment, record the boiling point of the water.

Tabulate: Initial temperature $\theta$, final temperature, and $r$. Plot a graph with $\theta$ and $r$ as axes, commencing both scales at the origin and making the $\theta$ scale range to 100° C. Draw the best straight line to fit the plotted points and continue it to cut both axes.

Hence deduce

(*a*) $r_0$, the rise in temperature when $\theta = 0$,

(*b*) $\theta_0$, the temperature corresponding to $r = 0$.

Calculate $c$ from the formula

$$c = \frac{9\theta_0}{r_0} - t,$$

where $t$ is the total thermal capacity of the brass weight and



the calorimeter. The value of $t$ is given on the outside of the calorimeter.

**3** Arrange the given test-tube to stand vertically, mouth downwards, on a sheet of squared paper as shown in Fig. 1, i.e. with its centre $C$ 1 in. from the top and left-hand edges. Place the given small lamp with its filament above $L$, 6 in. from $C$. On the line $AB$ (2 in. from $CD$) set up a pin $P$ vertically, such that $AP = 0{\cdot}60$ in. In the direction $CP$ you will see two reflected images of the lamp filament. Use another pin to make pinpricks in the paper to show the directions of the light, passing through $P$, which comes from each of these images in turn. Also track the pairs of rays when $AP$ is 1·20 in., 1·80 in. and 2·40 in.

Remove the test-tube, join the pinpricks to show the directions of the pairs of rays, and measure the separation $S$ of the rays along the line $LM$ (see Fig. 1).

Plot the graph of $S$ against $AP$. From it deduce the value of $S$ when $AP = 2{\cdot}00$ in.

[Hand in your traces with your script.]

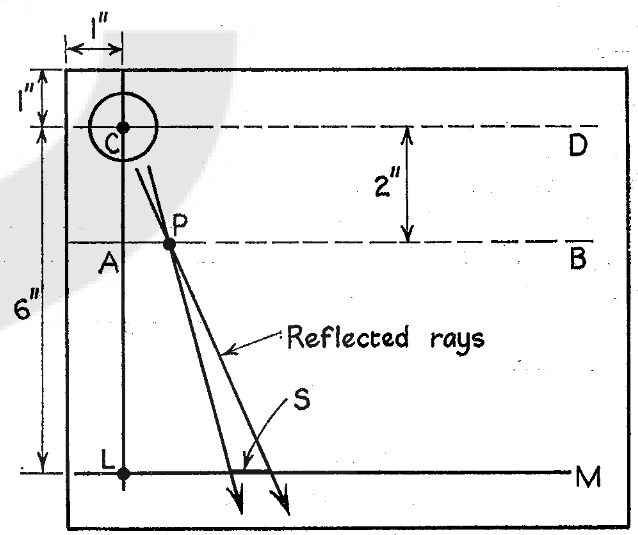


Fig. 1

**4** You are provided with two resistance wires of equal length labelled **A** and **B**. Compare the resistance per unit length of these by the following method.

Connect the given cell or battery, the given current-meter and the wire **A** in series; observe the scale reading $a$ of the meter. Repeat the process for wire **B** and observe the scale reading $b$. Then connect wire **A** and wire **B** in series in the circuit, and observe the scale reading $c$.

Repeat the experiment using shorter lengths of **A** and **B** in the circuit, but make the lengths of the two wires the same in each case; you need not cut the wires to do this. **Four** sets of readings are required; they should be tabulated as shown below, each column being headed by the corresponding length $l$ of wire used.

| | $l=$ | $l=$ | $l=$ | $l=$ |
|---|---|---|---|---|
| $a$ | | | | |
| $b$ | | | | |
| $c$ | | | | |
| $b-c$ | | | | |

Plot the corresponding values of $a$ ($y$-axis) and $b$ ($x$-axis). On the same axes plot the corresponding values of $c$ ($y$-axis) and $b - c$ ($x$-axis). Commence both scales at the origin.

Draw the best straight line, through the origin, to fit all the plotted points. Determine the slope of this line, which gives the ratio of the resistance per unit length of the two wires.

Record the resistance of the current-meter, which is given on a label on the meter.

**530/3**

## PHYSICS

ORDINARY LEVEL

ALTERNATIVE-TO-PRACTICAL



(*One hour and a half*)

*Answer* **two** *questions.*

*Mathematical tables and squared paper are provided.*

*Candidates should provide themselves with a* **good quality** *ruler, with metric scale graduations; inch scales must* **not** *be used. A protractor and a set square will also be required. Candidates should show clearly how any deductions from graphs have been made.*

*Figures* 2, 4, 5(*a*), 5(*b*), 7, 8 *and* 10 *are printed on a detachable sheet, which is to be handed in with your answer papers.*

### Question 1

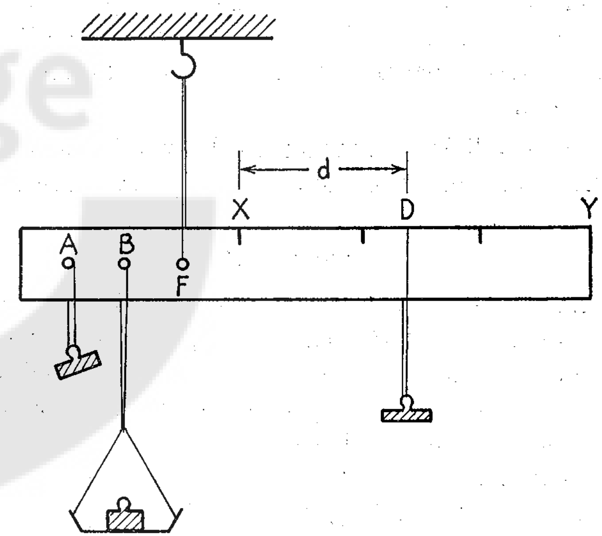


Fig. 1

**1** Fig. 1 shows a Steelyard balance, supported so that the beam is free to move in a vertical plane about the point $F$. The beam balances horizontally with a weight attached at $A$ and the empty scale pan hung from $B$.

A weight is placed on the scale pan and another weight (the rider) is hung from $D$. The rider is moved along the scale $XY$ until the beam is again horizontal. A series of positions of the rider $D_1$, $D_2$, $D_3$, etc. corresponding to weights of 25, 50, 75, 95, 120 and 135 gm. on the scale pan, are shown in Fig. 2, which is drawn to a scale of *one-half full size.*

Measure and record the distances $d_1$, $d_2$, $d_3$, etc. of $D_1$, $D_2$, $D_3$, etc. from the zero of the scale.

Plot the graph of $d$ against the weight on the scale pan.

From the graph deduce:

(i) (*a*) the largest, (*b*) the smallest load which will give a reading of the rider on the scale $XY$;

(ii) the weight which balances the beam when $d$ is 22·8 cm. Given that this is the weight of 12 pennies, deduce the number of pennies which need to be taken from the scale pan to achieve a balance when the rider is moved 7·0 cm. nearer to $X$.

State **two** different changes which could be made to the steelyard to increase the maximum weight it can measure.

## Question 2

**2** Fig. 3 shows an apparatus for observing the expansion of a liquid over a period of time. Initially, at time $T_1$, the liquid is at room temperature and reaches the height $H_1$ in the tube. The flask is then completely immersed in a water bath at 65° C. The subsequent heights of the liquid $H_2$, $H_3$, $H_4$, etc. shown in Fig. 4 correspond to the times $T_2$, $T_3$, $T_4$, etc. shown in Fig. 5(*a*) and Fig. 5(*b*), which indicate respectively the first and second revolutions of the hand.

Measure and record the values of $T$ and the values of $h$, which are the distances of $H_1$, $H_2$, $H_3$, etc. from the zero of the scale.

Plot the graph of $h$ against $T$.



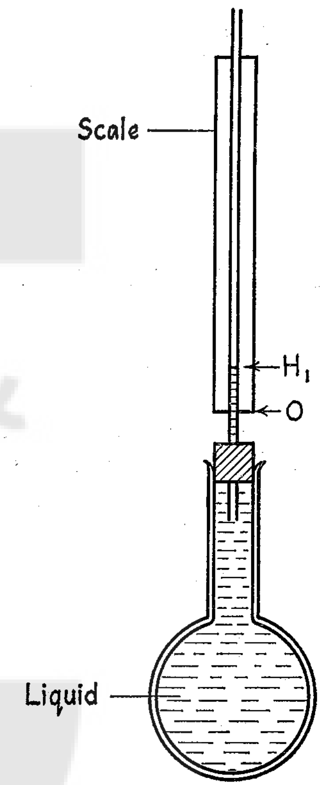


Fig. 3

From the graph deduce:

(i) the time when the liquid, after heating, again reaches the height $H_1$;

(ii) the rate of increase of height in cm. per second after 50 sec. of heating.

Explain why the height of the liquid first falls before rising up the tube.

## Question 3

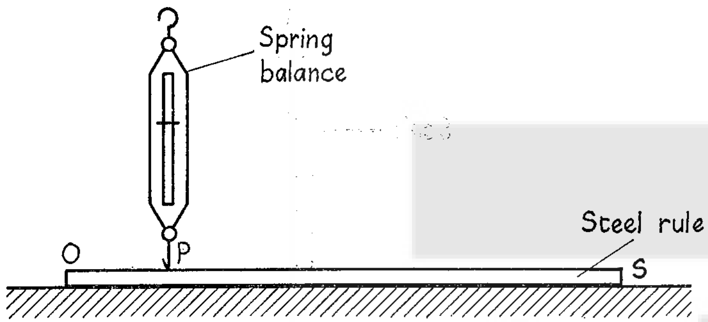


Fig. 6

**3** A magnetised steel ruler is fixed horizontally to the bench as shown in Fig. 6. The iron hook of a spring balance is lowered on to the ruler at various points $P$ and at each point the balance is gently raised. Readings on the spring balance are taken when the hook is just released from the ruler.

Record:

(i) the distances $p$ of the points $P_1$, $P_2$, $P_3$, etc., measured from the zero of the scale shown in Fig. 7, which is drawn to a scale of *one-half full size*.

(ii) the corresponding readings on the spring balance $F_1$, $F_2$, $F_3$, etc., shown in Fig. 8.

Plot the graph of $p$ against $F$ using the longer length of the graph paper for the $p$-axis.

Draw a straight line from a point on the $F$-axis across the graph paper so as to touch the graph at the two points where the readings of the spring balance are largest. You should find that this line is approximately parallel to the $p$-axis.

Record from the graph the value of $p$ at these two points.

Also deduce from the graph the values of $p$ when $F$ is a half of the largest recorded value of the spring balance readings.



## Question 4

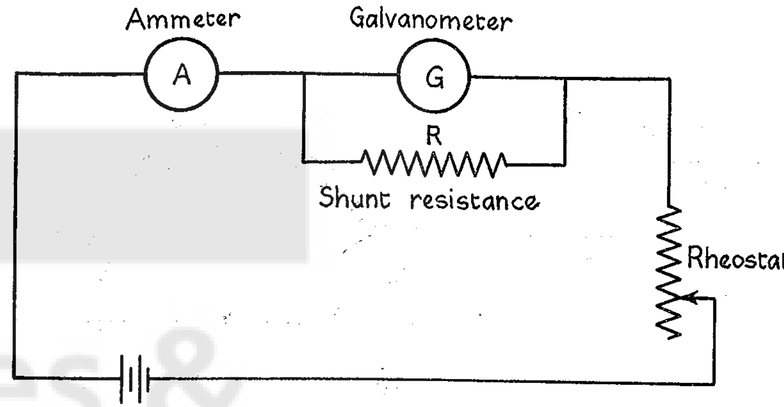


Fig. 9

**4** The circuit in Fig. 9 consists of a battery, a rheostat, a galvanometer $G$ and an ammeter $A$; a shunt resistance $R$ is connected across the galvanometer. Current readings $I$ are taken on the ammeter for a series of values of shunt resistance $R$, the rheostat being adjusted for each observation so that the reading on the galvanometer is a full-scale deflection.

When values of $R$ are 20, 10, 5, 2, 1 and 0·8 ohms, the corresponding readings of current $I$ on the ammeter are shown at $I_1$, $I_2$, $I_3$, etc., in Fig. 10. (N.B. the current increases as the resistance values decrease.)

Measure the values of $I$ and tabulate $I$, $R$ and $1/R$ (the reciprocal of $R$).

Plot the graph of $I$ against $1/R$.

From the graph deduce:

(i) the shunt resistance required when a current of 2·5 amp. passes through the ammeter;

(ii) the slope of the graph;

(iii) the current passing through the galvanometer throughout the experiment after the rheostat has been correctly adjusted.

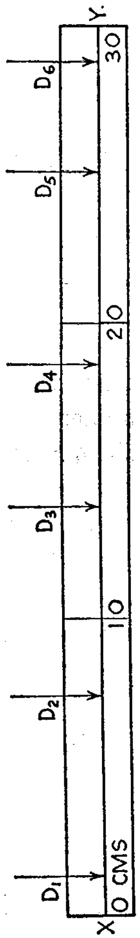

Fig. 2

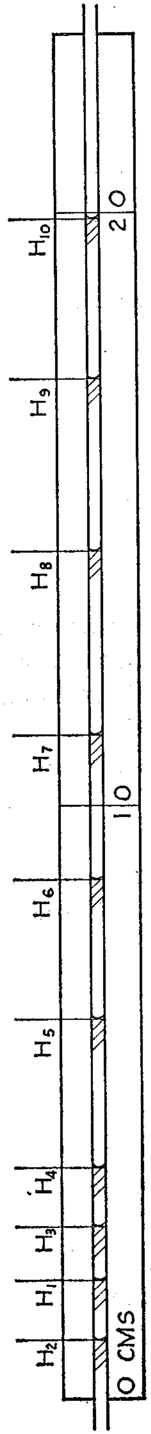

Fig. 4

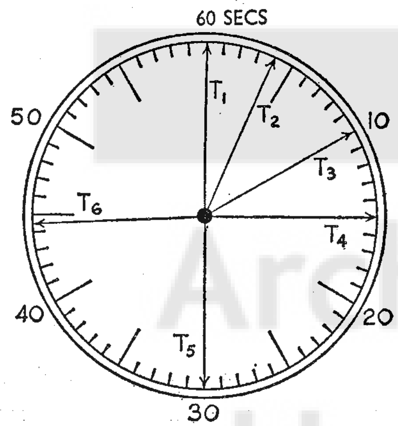

Fig. 5(a)

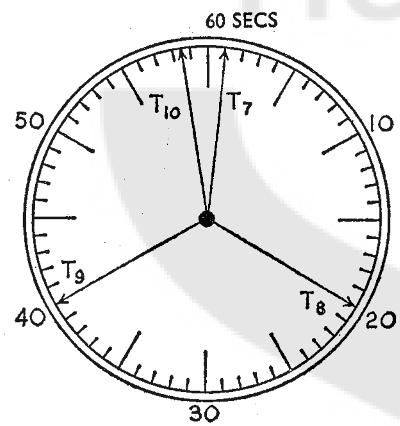

Fig. 5(b)

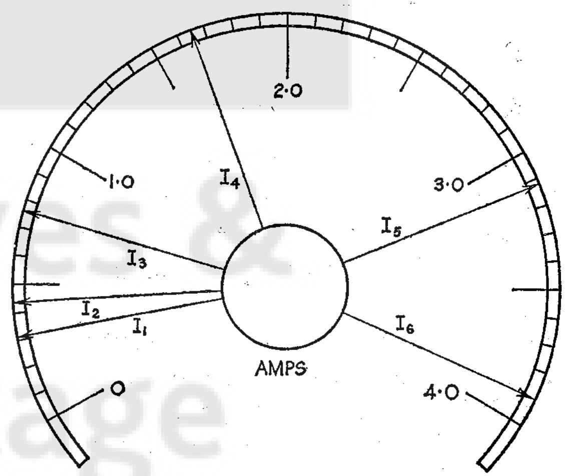

Fig. 10

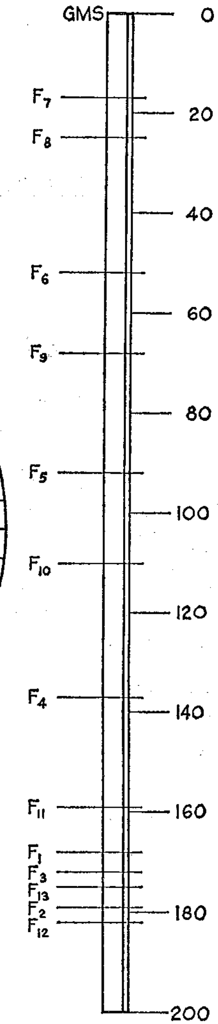

Fig. 8

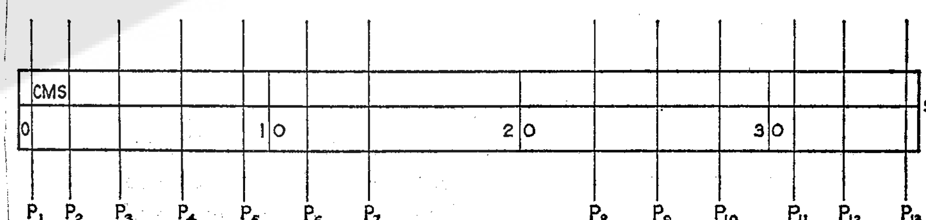

Fig. 7

**C (A)**

ORDINARY LEVEL

## PHYSICS INSTRUCTIONS

## PRACTICAL A

PAPER 530/2

### 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 eight working days before the paper is worked. 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 attached) 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 apparatus listed overleaf. If a candidate breaks any of the apparatus, or loses any of the material supplied, the matter should be rectified and a note made in the report.

*Apparatus required.*

**1** Thick-walled test-tube (6 in. × 1 in.) preferably without a flange. Retort stand and clamp. 100 ml. measuring cylinder. Beaker containing water. Balance, for weighing the tube to the nearest 0·1 gm. Metre rule. Hand lens. About 1 metre of



thin wire (s.w.g. about 40). Small pellet of plasticine (about 1 c.c. will be enough). Millimetre scale, 15 cm. or more.

**2** Supply of kerosene (paraffin oil) labelled **L**; each candidate will need about 100 ml.; the liquid should be provided at 5–10 deg.C. below room temperature. 100 ml. measuring cylinder. 100 gm. brass weight with about 30 cm. of wire (s.w.g. about 28) firmly attached. Lagged calorimeter (capacity 100 ml. or more). Candidates will be required to know a quantity $t$, where $t$ is the total thermal capacity of the calorimeter and the brass weight in cal./deg.C.; this information, to the nearest whole number, should be indicated on the outside jacket of the calorimeter; the thermal capacity of the brass weight is to be reckoned as 9 cal./deg.C.

Water bath and means of heating it; the water should be nearly at boiling point, ready for the candidate's use. Thermometer, to 100° C., calibrated in degrees or half-degrees.

**3** Drawing board. Sheet of squared paper (tenth-inch squares), size 10 in. × 8 in. Pins or sellotape for fixing the paper to the board. Test-tube (6 in. × 1 in.), preferably thin-walled. Retort stand and clamp; alternatively, a lump of plasticine. Set square. 2 pins (minimum length $1\frac{1}{2}$ in.) for tracing rays of light.

Electric lamp, and supply for lighting it. The lamp should have a small or a straight filament and there should be means for holding it with its filament two or three cm. above the drawing board. An electric torch bulb (e.g. in a miniature Edison-screw holder) is particularly suitable; if a larger bulb (e.g. headlamp bulb) is used, candidates should be instructed to mount it with the filament vertical.

**4** Cell or battery, preferably an accumulator (acid or alkaline type). If a dry cell or a dry battery is supplied, candidates should be warned not to allow current to flow from it for longer than is necessary.

Meter to register currents up to 1 amp.; its scale need not register amperes and a suitably shunted milliammeter will do; candidates will be asked to deal only with its scale reading. The meter should be given a label to show its approximate resistance; 1 s.f. will suffice.

Two equal lengths of resistance wire both bare, both of the same or nearly the same resistivity (s.w.g. 26 and 28, or 24 and 26, or 28 and 30); the thicker one labelled **A**, the thinner one labelled **B**. The lengths are determined by the fact that when the wire **A** is connected to the cell or battery the current should be about 0·7 of the current which the meter can take. Metre rule. Plug key or switch. Connecting wires.

## 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, 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. You can ask me for any additional apparatus which you think would improve the accuracy of your experiments, and you should say, on your script, how you use any such apparatus supplied.'