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FOREWORD

This booklet contains reports written by Examiners on the work of candidates in certain papers. **Its contents are primarily for the information of the subject teachers concerned**.

PHYSICS

GCE Ordinary Level

Paper 5054/01
Multiple Choice

Question Number	*Key*	*Question Number*	*Key*
1	**A**	21	**A**
2	**A**	22	**D**
3	**C**	23	**C**
4	**D**	24	**A**
5	**C**	25	**C**
6	**D**	26	**B**
7	**C**	27	**B**
8	**A**	28	**D**
9	**D**	29	**B**
10	**A**	30	**A**
11	**C**	31	**B**
12	**B**	32	**D**
13	**A**	33	**D**
14	**A**	34	**B**
15	**D**	35	**C**
16	**B**	36	**A**
17	**B**	37	**A**
18	**B**	38	**D**
19	**D**	39	**A**
20	**C**	40	**B**

General comments

The mean score for this examination was 26.4 out of 40 (66%) and the standard deviation was 19%.

The responses showed that the candidates were well prepared on the whole syllabus, with no questions causing great difficulty. **Questions 2**, **5** and **20** were answered correctly by most of the candidates.

Comments on specific questions

Two questions are particularly worthy of comment.

Question 15

Almost 50% of the candidates chose **C**, the downward movement, although the higher-scoring candidates chose correctly.

Question 33

There are still a considerable number of candidates who correctly double the frequency but fail to double the amplitude when the speed is doubled.

Paper 5054/02

Structured and Free Response

General comments

The overall impression of the Examiners was that candidates had shown a better standard of explanation in their answers this year and that it was thus easier to award marks for their knowledge of Physics. The detail provided by candidates in answers to ***Section B*** was usually more than adequate and it was encouraging to find that the majority of candidates were able to quote formulae when answering numerical questions. Candidates should be encouraged to write down directly an equation in the form that had been learnt rather than to write down initially a transformation of the equation which may be wrong. A sizeable proportion of candidates were let down by an inability to manipulate equations to give the correct answer.

There were no major variations in performance between questions, although, as always, individual parts of some questions caused more difficulties than others. In particular the mark in **Question 2 (b)** was often not awarded. However, this was only one mark and did not have any significant effect. Candidates were able to choose two questions from three in ***Section B***. **Question 10** was the most popular question and often, but not always, scored slightly higher than the other questions. The difference in performance between the questions in this section was not major. There was a range of difficulty within most questions which allowed the weaker candidates to display some knowledge but was a challenge to the most able.

There were no lined pages on the question paper this year as the questions filled the question booklet.

The time available for the examination appeared to be more than adequate. The vast majority of candidates attempted only two questions from ***Section B*** and made full attempts at all the questions in ***Section A***. Centres should not advise their candidates to attempt all questions from ***Section B***. Candidates are better advised to think carefully about the questions they are to answer in this section, and to plan their answers before starting to write. Where three questions are answered several of them often appear rushed and ill-planned.

Question 9 (c) required an answer to an appropriate numbers of significant figures. In this and most cases answers should be given to two significant figures. In **Question 6 (b)(i)** a large number of candidates calculated the answer as 1/3 A and then gave their answer as 0.3 A, which is a value given to only one significant figure.

Comments on specific questions

Section A

Question 1

(a) Weight was usually stated as the downward force but the upward force, e.g. air resistance was sometimes not clear.

(b) The correct answer for the initial acceleration of a falling object was 9.8 or 10 m/s^2. However, many candidates gave zero as their answer, even though the question goes on to ask why the acceleration then decreases. In explanations on acceleration there was some confusion between speed, acceleration and force, but less than there has often been in the past. Many candidates made a sensible reference to air resistance as the reason for the decrease in acceleration and full answers were obtained by a reference to the increase in air resistance as speed increases. It was encouraging to find many candidates who realised that constant speed is reached when air resistance balances weight, or when the resultant force is zero.

Question 2

(a) Radiation, and the lack of a medium for conduction and convection or the presence of a vacuum in space, were the most usual correct answers. A few candidates merely gave definitions of the three methods of heat transfer without applying their definitions to the question.

(b) This was generally well answered although a lack of precision lost marks when candidates stated that “heat rises” or “molecules expand”, rather than hot air rises, the air expands or the molecules are further apart. Density changes were not always given as the reason for the upward movement of the air.

(c) The most direct answer to this part was to explain that the fibre glass traps air which is a bad conductor of heat or to explain the lack of conduction and convection. Although most candidates earned one mark for recognising the decrease in the rate of heat flow they did not give enough explanation of the role of the fibreglass to be convincing. Some candidates confused the fibreglass with glass fibre that conducts light due to internal reflection, even though the question is stated to be about conduction, convection and radiation. References such as “stops cold air entering from outside” or “traps heat” were themselves not enough to earn marks. A large number of candidates stated that air moves in and out of the house through the roof.

Question 3

(a) Although an apparently simple question in which most candidates scored well, marks were lost when candidates did not make clear what actual object expands or what damage would be caused if there were no gaps. For example some candidates suggested that the gaps or a vague “object” expands rather than the railway or bridge.

(b) There were many possible answers to this question where candidates were required to give a further problem caused by thermal expansion and also give its solution. The most obvious answers were that hot water cracks glass (so thin glass is used) or telephone wires expand (so they should be placed high). Answers based on contraction were also accepted as long as it was clear that cooling was involved. Thus telephone wires allowed to sag in summer so that they did not snap in winter were accepted. Good accounts of a further problem due to thermal expansion were quite rare.

Question 4

(a) The definition of speed was well known, although candidates are advised to give such definitions as distance travelled per unit time or in one second, rather than in “a certain time”.

(b) Although most candidates successfully applied the formula relating speed, distance and time they failed to double the distance to the wall.

(c) The best candidates were more than able to calculate the number of claps per minute. Some candidates failed to recognise the simplicity of the question and invented complications which were not intended or present. For example many candidates who had calculated a time of 0.48s between claps then stated that this was the time for two claps and obtained twice as many claps per minute than the correct answer.

Answers: **(b)** 0.48s; **(c)** 123(.75) or 124.

Question 5

(a) The diagram shows a magnetic field produced by the recording head. The tape is magnetised by this magnetic field and the magnetisation in opposite directions is caused by the alternating current responsible for the field in the recording head. As the tape moves faster there is an increase in the length of each section on the tape magnetised in one direction. It was encouraging to find many candidates able to recognise the part that basic principles of electromagnetism play in this process but there were many who failed to state the simple principles or confused the process with electromagnetic induction.

(b) It was necessary in the answer to this section to go beyond the obvious statement that permanent magnetic materials do not lose their magnetism to the realisation that the tape should retain its recorded information after leaving the head for use again. Candidates were generally able to give a suitable magnetic material. Steel was the most often correctly quoted material to be used as a coating on a magnetic tape, but iron oxide and other compounds used on magnetic tapes were also mentioned.

Question 6

(a) This part produced reasonable scores from those candidates able to express themselves logically. Some candidates were not clear due to the confused use of the words current, voltage and resistance. It was only necessary for a candidate to state that the 4V reading is outside the range of the first voltmeter and produces a small reading or is inaccurate on the second voltmeter. Many candidates merely suggested that the voltmeter might be damaged or could not read the 4V without explaining that it is outside the range of the meter.

(b) The majority of candidates were successful with the electrical calculations.

Answers: **(b)(i)** 0.33A, **(ii)** 10V.

Question 7

(a) The production of electrons from the filament was usually appreciated but the influence of the anode in accelerating the electrons was generally unclear, unless the candidate stated that there was an attraction between the positive anode and negative electrons. Most candidates could explain that a vacuum eliminates the possibility of collision between the electrons and molecules in the tube.

(b) The oscillatory movement of the spot on the screen was often understood but not always explained satisfactorily. The explanation merely had to refer to the charge on the deflecting plates repelling or attracting the electrons. The electron-beam tube has only one set of deflecting plates and so a sinusoidal waveform would not be seen. Many candidates gave explanations that suited a cathode-ray oscilloscope rather then the electron tube given in the question.

Question 8

A full range of understanding was shown in the answers to this question. The pie chart was usually interpreted correctly. A correct effect of background radiation could have referred to the addition it causes in any reading or could have referred to a specific effect on health, such as the formation of cancer. Some candidates were too vague and merely stated that radiation “damages health” or “affects readings”. Most candidates realised that cosmic rays come from the Sun, stars or outer space but a large number stated that they came from cosmetics! The definition of nucleon number and the calculations produced a large number of correct results.

Answer: **(e)** 84, 216.

Section B

Question 9

(a) Excellent knowledge was shown of the electromagnetic spectrum, although some candidates placed alpha-particles and ultrasound within the e-m spectrum. When describing why the grill has a layer of shiny material above the heating element, many candidates failed to earn full marks. They merely stated that the shiny material “reflects heat”, which, unless it was clear that they were referring to radiant heat or infra-red, was not accepted. Many candidates did not go on to earn other marks for recognising that the outer cover would remain cool or that heating would be more efficient with the shiny surface.

(b) It was encouraging to read many full accounts of the use of an earth wire. Candidates were more able than usual to explain that an earth connection is present in order to prevent electrocution should the live wire touch the metal case. Most candidates were able to state that the earth prevents an electric shock and is connected to the outer metal case. Weaker candidates stated that the earth wire conducts “excess” current to earth and confused the earth with a fuse.

(c) The formula for power was widely known. The answer was required to an appropriate number of significant figures, in this case two as that was the number of significant figures given in the data to the question. In the last part of this question, the majority of candidates failed to recognise that the current decreases if the voltage halves and thus the power is reduced to less than a half. A significant proportion of the candidates stated that the current doubled to make the power the same.

Answer: **(c)(ii)** 1900W.

Question 10

(a) Descriptions of the measurement of the density of the bar showed a good knowledge of how to use a measuring cylinder, or how to measure the dimensions of the bar, to find volume. The formula for density was very well known. Marks were often not awarded if candidates measured the dimensions of the bar but did not explain how the volume was calculated from the dimensions, or if a "beaker" was used rather than a measuring cylinder. A number of candidates measured the weight of the bar with a spring balance or scales. This was accepted as long as mass was then calculated from the reading of the weight.

(b) Most candidates recognised that the bar was melting between t = 600 and 1000s but a number merely stated that the bar had reached its melting point, which is not what occurs after 600s. Where candidates took the trouble to explain what happens to the molecules initially (an increase in K.E. or an increase in vibration) and then when melting has started (the bonds between molecules break or molecules move freely within the liquid) then high marks were earned.

(c) It was very common that candidates used the time of 600s rather than the temperature rise of 650°C in the formula mass x specific heat capacity x temperature rise to calculate the energy supplied to the bar. As a consequence they only earned a mark for the formula that was used. Many candidates in the last part failed to calculate the energy produced in 400s before applying the formula for latent heat. The units for specific latent heat of fusion were often quoted wrongly. However, there were a large number of complete answers to this part.

Answers: **(b)(iii)** 17 160 J, **(iv)** 400 000 J/kg.

Question 11

(a) Descriptions of energy change are often difficult for candidates as they do not realise that they must describe a transformation of energy from one form to another. A number of candidates merely stated that "the potential energy is high at A and the kinetic energy is high at B", rather than explaining that the potential energy has changed to kinetic energy. Candidates should also realise that in a long sequence of changes they must make clear to the Examiner the sequence they are describing. Thus long chains without explanation, such as "electrical to potential to kinetic to potential" are not clear. Calculations of the initial potential energy were usually correct. There are several methods to calculate the kinetic energy at C. The most frequently used method was to calculate the increase in potential energy from B to C and subtract it from the potential energy at A. A few candidates used complex methods to calculate speed from acceleration. This was accepted, if correct, but was outside the syllabus of the examination and was not necessary.

(b) Although acceleration in a circle has not been examined on this paper for some time, a large proportion of the candidates knew that velocity was a vector and thus had a direction which changes as the direction of the carriage changes. Most candidates also knew that the direction of the force is towards the centre of the circle.

(c) Although almost all candidates knew the formula F = mass x acceleration, a large number incorrectly subtracted the weight to find a resultant force before finding the acceleration.

Answers: **(a)(ii)** 150 000J, **(iii)** 100 000J; **(c)** 6.0 m/s^2.

Paper 5054/03

Practical Test

General comments

Candidates seemed to find the paper rather more difficult than last year's paper. This was particularly the case in **Question 1**. This problem was addressed in the mark scheme so that the overall performance of the paper was similar to that of June 2003.

Candidates had difficulty gaining marks on the following sections of questions:

- **1 (d)** discussion of the likely cause of uncertainty in the measurements.
- **3 (d)** when determining the gains and losses in thermal energy candidates were confused as to which masses or temperature changes to use.
- **4 (d)** candidates clearly had difficulty obtaining focused enlarged and diminished images of the object. In most cases the maximum mark for the table of results was 3 out of 5.
- **4 (e)** because the graph involved $1/D$ and $(d/D)^2$ there were a number of difficulties with scales and labelling of the axes.

The above 4 points were scored rarely. In contrast, performance on the electrical question was considerably better than in previous years, with many candidates scoring full marks for the question.

Comments on specific questions

Section A

Question 1

(a)(b)(c) It was disappointing to see so few candidates repeating their measurements of the time for 10 oscillations. Good candidates obtained correct values for T_1 and T_2. Weaker candidates did not obtain good values for one or more of the following reasons:

- candidates did not distinguish between *t* and *T*.
- some candidates calculated the frequency rather than the period.
- the stopwatch was misread i.e. 14.50 seconds was read as 0.1456 seconds.
- times were recorded to the nearest second.

(d) Very few candidates discussed the uncertainty in their measurements. The best candidates realised that there would be an error in the measurement of the time for 10 oscillations because of their reaction time but there was no indication of the size of this quantity.

(e) Ideally the conclusion would have been that within the limits of experimental error the values of the periods for the 100 g mass and the 300 g mass would have been the same. As candidates did not determine the uncertainty quantitatively this was a difficult mark to score. Examiners therefore allowed any sensible conclusion that could be deduced from the candidates' results.

Question 2

(a) The majority of candidates produced a good diagram of the circuit that had been set up by the Supervisor. Candidates who lost the mark mainly had difficulty with the connections to the voltmeter. Those candidates who did not show the leads that came off the voltmeter to be connected to the lengths of wire, drew a circuit that had the voltmeter in series with the circuit and lost the mark. Similarly there were a number of candidates who drew voltmeters with 4 terminals.

(b)(c)(d) Generally the results in parts **(b)** and **(d)** were good. The majority of candidates obtained good values for the current, potential difference and resistance. A number of candidates tested the thicker wire before the thinner wire so that their results were interchanged. A number of candidates misread the ammeter giving currents that were a factor of 10 greater than they should have been.

(e) As with **Question 1**, any sensible conclusion based on the candidate's results was allowed. As a result the majority of candidates gained the final mark. As this was a Practical Paper candidates were allowed to say that the resistance was inversely proportional to the diameter rather than the cross-sectional area i.e. they had drawn a reasonable conclusion from their results.

Question 3

(a)(b) Most candidates obtained sensible values for the temperature of the water before and after the ice was added. Good candidates interpolated between the divisions on the thermometer so that the temperatures were recorded to better than 1˚C.

Calculations involving the mass of ice proved more difficult for candidates. Since candidates were provided with a 5 ml teaspoon and were instructed to use a heaped spoonful of ice, Examiners expected the mass of melted ice to be approximately 10 g. However, much larger values were obtained by some candidates. These values were allowed providing they produced a comparable increase in the fall in temperature.

(c) Most candidates correctly determined the change in the thermal energy of the ice as it melted. Some candidates did not know the unit of energy.

(d) In the calculation to find the gain in the thermal energy of the cold water formed from the melted ice the majority of candidates gave an incorrect answer. There were several reasons for this;

- the total mass of water and melted ice was used rather than the mass of melted ice.
- the fall in temperature of the warm water was used rather than the rise in temperature of the melted ice from 0˚C to the final temperature of the mixture.
- incorrect units were given for the change in the thermal energy.

Similar problems arose in the calculation of the loss of thermal energy of the water that had been initially at room temperature. Generally the change in temperature was correct but the other problems that arose are listed below:

- the mass of the melted ice was used rather than the 100 g mass of water.
- the mass of water and melted ice combined was used.
- incorrect units were given for the change in the thermal energy.

(e) Because of the problems in part **(d)** candidates could not make a sensible comment at this point. Because this experiment takes place below room temperature the problem here is the gain in thermal energy from the surroundings rather than the loss of thermal energy to the surroundings. The thermal energy gained by the ice as it melts and then rises in temperature to the final temperature of the mixture is greater than the loss in thermal energy of the water at room temperature. Only one or two candidates reached this conclusion.

Section B

Question 4

(b)(c) Most candidates obtained good values for *d* and *D* in this section of the experiment. A small number quoted values to the nearest cm rather than the nearest mm and a small number omitted units.

(d) The other values proved more problematical. Despite the fact that candidates were instructed to use a range of *D* between 0.650 m and 1.000 m, a large number of candidates used a narrower range for their results. The results of some candidates did not make sense. Such candidates could not have had clearly focused images on the screen. Good candidates correctly calculated $1/D$ and $(d/D)^2$ although weaker candidates quoted values to 1 significant figure and used cm rather than m despite the guidance in the question paper.

(e) Graph plotting was poor. Even good candidates wished to start the graph at 0,0. This was not the most sensible point to start. $1/D$ values range from 1.00 to 1.54 m^{-1} so that it would have been better to start this axis at 1.00 m^{-1}. Very weak candidates attempted to produce a $1/D$ axis by labelling the axis 1/60, 1/70, 1/80 etc. This was obviously not acceptable.

(f) Most candidates attempted to use a large triangle to determine the gradient of the graph even when the points occupied a very small area of the page. Many candidates ignored the negative sign of the gradient and Examiners decided not to penalise this omission. Only the very good candidates obtained an acceptable value for the focal length of the lens.

Paper 5054/04
Alternative to Practical

General comments

The candidate's marks were in the range 29 –0. Generally the candidates appeared to be well prepared for the paper. The scripts were neat, easy to follow and well presented. The use of English was very good.

Centres are reminded that the best preparation for this paper is a Physics practical course giving experience using a wide variety of apparatus.

Comments on specific questions

Question 1

(a) The Examiners were expecting to see two straight – thin lines, representing two rays from the point **X** to the screen. One ray drawn to touch the upper point of the aperture and the second ray touching the lower point of the aperture. A similar pair of rays was expected from the point **Y**. Although most of the candidates drew the diagram correctly some candidates drew unexpected features. These unexpected features included:- a lens across the aperture, diffracted rays on the right of the aperture, rays from **X** and **Y** incident upon the card and then reflected to the left of the diagram and a large number of parallel lines from points between **X** and **Y** through the hole and to the screen. An arrowhead identifies a ray on a diagram, the Examiners expected to see at least one arrowhead on a ray drawn in the candidate's diagram.

(b)(i) Answers in the range 54 to 56 mm were accepted for the diameter of the area illuminated by every point on the source XY, a correct unit was also required. Many gave values near 10.2 mm which includes the partially illuminated ring around the bright central circle of diameter 55 mm.

Question 2

(a) A series circuit diagram using circuit symbols was required. "Historic" symbols were accepted, however attempts at pictorial representation did not gain marks. As well as using unusual symbols many candidates showed additional electrical components. These components were penalised if they affected the function of a series circuit e.g., a voltmeter in series with the rest of the apparatus.

(b) A positive sign was required on the power supply and on the ammeter. There were careless errors and omissions in the responses. The direction of the current (given in the diagram) is helpful in deciding the polarities. The direction of the conventional current is from the +ve terminal of the power supply. The terminal of the ammeter, which the conventional current is approaching, is +ve. (The current then passes through the ammeter from the +ve to the –ve terminal.)

(c) Although the most common, but wrong, answer was that the "current was reversed". There were some very clear correct answers ranging from "there is no current in circuit" to "the diode is in reversed bias and so the current is very small".

(d) This was well understood with good answers which included "the lamp acts as a current indicator" and "the lamp acts as a resistor and limits the current".

Question 3

(a) The candidates were required to describe how they would measure the length shown as l on the left hand side of Fig. 3.1. They were expected to use the 300 mm rule illustrated in Fig. 3.2. Any method that, (1) used the rule placed alongside and close to the thermometer, (2) subtracted the rule reading at the beginning of the mercury thread from the rule reading at the meniscus of the mercury thread and (3) stated how the readings could be made accurate, scored three marks. A large number of the candidates explained how they would have determined the length from 0°C to 25°C. Such candidates did not score full marks for this part. Those candidates who drew a diagram usually scored at least two out of the three marks.

(b)(i) Most candidates gave an acceptable answer for each value. The Examiners accepted the following ranges, l_0 in the range 5.8 to 5.6 cm and l_{100} in the range 22.8 to 22.6 cm; a unit was not required to score the mark.

(ii) The candidates were required to show a clear and correct calculation of $\Delta l/100$. An error carried forward (from **(b)(i)**) was allowed and no unit was required. Some candidates chose graphical values using different values for $\Delta l/\Delta\theta$. The Examiners accepted these alternatives. Many of those candidates who chose to use different graph values selected the points (5.6, 0) and (5.8, 2), such a small change in θ is not a good choice, many of this group of candidates made an error by reading the θ value as 1°C and not 2°C.

(iii) The graph of Fig. 3.1 is a straight line. There is a linear variation between l and θ. The equation to the line is $l = 0.172\theta + 5.6$, many candidates gave this equation, others said $\Delta l = k\ \Delta\theta$ such answers scored the mark. The Examiners were disappointed to note that the majority of the candidates said, "l was directly proportional to θ". Others said "l increases with θ", making no reference to the linear relation. The last two answers did not score the mark. Many of the candidates did not appear to understand: the differences between a "linear relation" and one that is "directly proportional"; that "l increases with θ" is not necessarily a "linear relation".

Question 4

(a) Well-labelled diagrams can be used to give most of the information required by this question. The best of the written answers were very good. The question was set out in three parts **(i)**, **(ii)** and **(iii)**. Candidates who used this format did not forget to include an answer to each question. Some candidates wanted to add the metal pieces one at a time recording the displaced volume each time. There were some excellent descriptive accounts and some informative and well labelled diagrams.

(i) The initial volume of water in the cylinder should be between 40 cm^3 and 60 cm^3. It should then be possible: to displace the water by 40 cm^3 but; not let the water displace beyond the upper limit of 100 cm^3 on the cylinder scale. The Examiners required either as part of the answer to **(a)(i)**. A fairly common mistake was to suggest using 70 cm^3 of water for the initial volume.

The Examiners were please to note that there were some very clear answers to **(a)(i)**.

(ii) The relation $V_{metal} = (V_{max} - V_{initial})$ was well understood and used. Some candidates reversed the values used in the subtraction. Candidates should pay attention to correct mathematical procedures.

(iii) Most of the candidates gave one or more of many good practical points. E.g., "take the volume reading at the bottom of the meniscus" or "repeat the experiment and take an average" or "ensure that the line of sight is perpendicular to the cylinder scale when taking a reading" or "add the pieces of metal carefully so as not to splash the water out of the cylinder" or "tap the cylinder so as to release any air trapped by the pieces of metal".

(b) A lot of guesses were made for the answer. The answer was that "the scale on the cylinder is calibrated to give a correct reading when the liquid is at 20°C".

(c) Most of the candidates understood that the water on the metal pieces would increase the volume for the metal obtained by this experiment. Some candidates misread the question and answered the different question "How would you dry the metal pieces?".

Question 5

(a) There are four features to good graphical work.

(1) *Correct axes*, labelled together with units, using a scale that cannot be doubled and that is not awkward to use.

(2) *Correct plotting* of graph points.

(3) *Good line judgement* with respect to the graph points.

(4) *Quality of line drawing*, a neat, smooth and thin line should be drawn.

Generally the graphical work was very good, however there are candidates who have yet to reach the high standard of students graph plotting and drawing.

(b)(i) One of two changes will “raise” the (inverted) image and so remove the bottom of the image (of the object) from the top of the screen, namely:-

(1) *Lower the object or*

(2) *Lower the screen.*

The best ray to use on the diagram is a ray from the top of the object through the centre of the lens. This ray passes straight through to meet the screen. Any other ray is converged by the lens to form an image on the screen.

(ii) To obtain a full image on the screen the object, lens and the image (screen) must be parallel with each other and the centre of each item on the same horizontal axis.

There were some excellent answers to part **(b)**. These were usually, but not always, on high scoring scripts. Some of the diagrams were most impressive showing, although not required, a ray from the bottom of the object missing the screen.

The Examiners hope that, when using a converging lens, candidates receive training in how to arrange the equipment in order to obtain an image on a screen.