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

General comments

The mean score was 21 out of 40 (53%) and the standard deviation was 17%. The general standard was uniform across the paper showing that the syllabus had been well covered, although the candidates seemed less familiar with diverging lenses than with other topics in the 'Light' section. There were high numbers of correct responses to **Questions 26** and **27** but low numbers for **Questions 5**, **25** and **37**.

Comments on specific questions

Question 5

70% of the candidates chose **B**. The wheel is pushing backwards on the road so the frictional force is forwards to stop it spinning.

Question 8

Many of the weaker candidates opted for **C**, the weight of the barrow.

Question 22

With graphs about waves, candidates must take care to check whether they are 'time' or 'space' graphs. Almost 70% chose **B**.

Question 25

Few candidates answered this correctly. The majority opted for **D**, the 'converging' possibility.

Question 35

Many candidates are still forgetting that doubling the generator speed doubles the e.m.f as well as the frequency.

Question 37

Most candidates do not understand what changes affect the electron beam deflection.

Paper 5054/02

Structured and Free Response

General comments

The impression gained by the Examiners was that there *were* strong entries but that weaker candidates found difficulty in understanding the paper. The performance was varied, with some Examiners reporting fewer weaker scripts this year than last year, but other Examiners finding scripts where marks were poor.

Each question has some easier parts but some candidates were not able to show a basic understanding of simple areas of the Physics, for example in drawing a simple circuit to measure the electrical power input to a motor in **Question 9**, or to differentiate between emission and absorption of radiation in **Question 8**. The paper asks for a number of definitions. Quantities and units that candidates should be able to define are specified in the syllabus in the Summary of Key Quantities, Symbols and Units.

Candidates should recognise that the space provided on the question paper should be adequate for an answer. It is not necessary to write a great deal to score high marks; rather the answers produced should be answers to the actual questions. An answer that starts by rewriting the question often leaves too little room for the actual answer and should be discouraged.

Calculation skills continue to be relatively strong, and often candidates scored many more marks for calculation than for explanations where extended prose was necessary. In particular, accounts of experiments or procedures were often poorly described. A proportion of the entry showed clearly in their answers that their lack of command of English was a drawback in answering a Physics paper.

There was little, if any, indication that candidates were limited by time in answering the paper.

Comments on specific questions

Section A

Question 1

(a) There were many acceptable comments on the speed-time graph, e.g. the train was stationary until 20 minutes, travels at a constant speed of 20 m/s or stops after 65 minutes. Many candidates only obtained one of the two marks in this part because they misread values from the graph and quoted, for example, a time of 60 minutes rather than 65 minutes. References to acceleration and deceleration were common, but calculations were not appropriate as the times involved in these parts cannot be found from the graph.

(b) The formula relating speed, distance and time was well known but few candidates obtained the correct value for the distance. The most common error was to fail to convert time in minutes into seconds when using 20 m/s as the speed.

(c) Most candidates were able to draw a horizontal line but many of these lines were drawn at 20 m/s rather than 10 m/s. A considerable number of candidates attempted to draw graphs with positive and negative gradients, perhaps attempting to draw distance-time graphs.

Answer: **(b)** 54 000 m.

Question 2

(a) The great majority of candidates realised that the pressure inside the gas pipe is larger than atmospheric pressure.

(b) Candidates were expected to draw water levels indicating a difference in heights of 30 mm in the two arms of the manometer in Fig. 2.2 and 60 mm in Fig. 2.3. There appeared to be fewer errors in drawing the manometer in Fig. 2.3 where candidates had to appreciate that a liquid with half the density of water rises twice as far. Many candidates did not realise that the width of a manometer tube does not affect the difference in levels that it records.

(c) The difference in water levels in the two manometers is due to the increased pressure exerted by the trapped air. Many candidates realised that the trapped air exerts a pressure but did not recognise that it was higher than the atmospheric pressure exerted on the right hand side of the manometer in Fig. 2.1.

Question 3

(a) Many answers showed an understanding that, at the speed quoted, the resistive and forward forces were equal. There was, however, a significant proportion of answers where there was no clear link between the forward force and the resistive force, or where the runner was stated to fall backwards (or even move backwards) if the resistive force was more than 320 N.

(b) The numerical answers to this question were very well produced but marks were often lost for failing to square "v" in the calculation for kinetic energy or for not giving the answer to 2 or 3 significant figures.

Answers: **(b)(i)** 2100J, **(ii)** 3.5 m.

Question 4

(a) The normal should be drawn from the point where ray **1** touches the bubble towards the centre of the bubble. Often candidates incorrectly drew a normal that was parallel to the long edge of the examination paper. They then found difficulty in labelling an angle of incidence which should not be inside the air bubble.

(b) Many candidates did not realise that ray **1** was totally internally reflected and drew a refracted ray inside the air bubble. A significant proportion of candidates incorrectly drew the continuation of ray **2** as a refracted ray bending downwards (towards, rather than away from, the normal) as it enters the air bubble but almost all candidates drew ray **3** correctly with no deviation on entering the air bubble.

(c) The definition in **(i)** was poorly answered. Too often a vague expression such as "refractive index measures the bending of a light ray" was given rather than correct definitions in terms of the speed of light in vacuo and in water or in terms of the sine of the angles of incidence and refraction. Although candidates quoted the formula correctly, some failed to use sines correctly in their calculation. The refractive index should be greater than 1 but as the value was given for the angle of incidence in the slower medium an answer of 0.75 was accepted, as well as 1.33.

Answer: **(c)(ii)** 1.33.

Question 5

(a) Few candidates failed to earn a mark for drawing or describing the vertical movement of the hand and many candidates stated that the hand must make one complete movement in 0.25 s or 4 movements in one second. A significant minority of answers were definitions of a frequency of 4 Hz and were not related to the movement of the hand.

(b) Where the formula was known there was little difficulty in obtaining full marks.

(c) Doubling of the wavelength is achieved by halving the frequency, although stretching the spring to achieve a doubling of the speed was also accepted as an answer.

Answer: **(b)** 0.2 m.

Question 6

(a) The question refers to the movement of electrons in the sphere. Many candidates described the movement of positive and negative charges rather than the movement of electrons. Although candidates were able to draw the correct charges on the sphere, they failed to score full marks when they suggested that positive charges move towards the rod, that there were positive electrons, or when they failed to explain why repulsion of like charges caused the electrons to move. Candidates appeared to want to quote attraction as though a rule has to be used in full, whether relevant or not.

(b)(c) Some candidates failed to draw the correct diagrams in which the charge on the sphere next to the earth wire was not present, and on Fig. 6.4 had spread over the sphere.

(d) A large number of possible insulators were accepted. Wood was accepted, although it is not a useful insulator in electrostatic situations as most wood, for example, when held in the hand will discharge a charged gold-leaf electroscope.

Question 7

(a) Transformer **B** is a step-down transformer. The majority of candidates explained that this was to step down or reduce the voltage. Weaker candidates suggested that voltage or current would be merely altered.

(b) Drawing of transformers was often disappointing. Coils drawn often did not have clear ends (and it was thus not clear that there were even two separate coils), were drawn without a core or did not show a secondary coil with fewer turns than the primary coil. Labelling of the coils and of the soft-iron core was the exception, even though the question clearly asks for a labelled diagram.

(c) Only some candidates stated in **(i)** that there is less electrical power loss from cables if high voltage is used, and only a very few stated clearly that this is because the electrical current is lower. Weaker candidates suggested that the decrease in current at high voltage was due to an increase in resistance of the cables, and lost credit. Very strong candidates explained the relationship $P = I^2R$, between power loss, current and resistance either in **(i)** or **(ii)**. Although many answers clearly suggested that resistance decreases with an increase in the thickness of the cables, only the stronger candidates backed this up with a sound explanation. There was often confusion between area of cross-section, surface area and thickness.

Section B

Question 8

(a)(i) This was well answered with medium ability candidates clearly describing the vibration of the copper molecules and the transfer of energy from molecule to molecule.

(ii) This part was less well answered as candidates failed to answer the question. They were asked to describe how boiling and condensation causes a transfer of energy but instead gave descriptions of the whole transfer process rather than stating that boiling requires energy and condensation releases this energy.

(iii) This was the least well answered, with vague statements that "copper is a good conductor", "there is a convection current", or "black absorbs better". A small number of the strongest candidates were able to state that the movement of the alcohol vapour, molecules or liquid is fast down the tube, particularly as the large pressure difference mentioned in the question is likely to cause a rapid movement from the high to the low pressure ends of the tube.

(b) The definition was known by many candidates, although some failed to state that specific latent heat is the energy needed to change the state of 1 kg of the liquid. Weaker candidates did not state that specific latent heat was a quantity of heat or energy at all, or confused the definition with specific heat capacity by mentioning a change in temperature. In **(ii)** and **(iii)** the calculation was generally answered well, with some confusing between the mass of alcohol and the mass of water in equating the thermal energy lost by the alcohol in condensing with the thermal energy gained by the water.

(c) There are many possible experimental procedures that may be used to show that black surfaces absorb more infra-red radiation than white. The most common was to use metal plates with a cork attached on the rear surface with wax and exposed to radiation from a heater. Many accounts were not real experiments, as there was no physical measurement, e.g. a person "feels hotter" in the sun under a black, rather than a white, umbrella. Many sources of infra-red radiation were clearly inappropriate, e.g. radioactive sources.

(ii) Many accounts were identical to **(i)** and there was no clear understanding of the emission of radiation. The most common correct methods were to measure, with a thermopile, the radiation from black and white faces of a metal tank containing hot water or to compare the rate of heating from identical hot objects. When describing experiments the apparatus described should be sufficient to make the measurement, e.g. a thermometer should be drawn or mentioned when it is stated that hot water in a black can cools faster than the same water in a white can.

Answers: **(b)(ii)** 2100 J, **(iii)** 10ºC.

Question 9

(a) Answers to this part were often made more complicated by candidates who suggested that the current in the coil will not reverse, when there is in fact no current at all in the coil since there is a short circuit. In **(ii)** candidates had merely to explain that the brushes may not be in contact with the rings and thus no current can flow. Weaker candidates confused the construction of the motor and suggested that the coil could not touch the split-rings.

(b)(i) The answers here were disappointing. Vague references to "turning effect" were common rather than a definition of moment as the product of the force and the perpendicular distance from the line of action of the force.

(ii) Candidates often halved the distance and then failed to double the resultant moment to find the total moment on both sides of the coil, or doubled the moment without halving the distance given in the question. Candidates with strong understanding of moments were able to draw a graph with a repeating shape and a moment that is always positive or negative. Weaker candidates did not realise that the moment always acts in the same direction and merely drew a sine wave. It was disappointing that many candidates failed to mark clearly any time for one oscillation of the coil.

(c) Many candidates failed to answer this comparatively easy part of the question. They had only to realise that electrical power is the product of current and voltage and to measure these two quantities in **(i)**. In the circuits drawn in **(ii)**, the motor was often drawn as a resistor, which would have been acceptable, had it been labelled as a motor. Voltmeters were sometimes omitted or drawn in series rather than in parallel with the motor.

Answer: **(b)(ii)** 0.195 Nm.

Question 10

(a) The number of protons was nearly always quoted correctly, as it is given directly in the question, and the number of neutrons and electrons usually quoted correctly, but the largest omission was to fail to describe the arrangement of the protons and neutrons inside the nucleus and the electrons as being in orbits outside the nucleus. The number of electrons in any particular shell was not required. Answers for the proton and neutron numbers of the xenon nucleus were disappointing.

(b) There are many possible differences that may be quoted between beta particles and gamma rays. Weaker candidates tended to suggest the gamma rays are "stronger" without suggesting that they can penetrate a particular material further, or no comparison was made between beta particles and gamma rays. Some suggestions, although clearly describing a difference used wrong data, such as beta particles are stopped by paper or were vague by stating that beta particles are stopped by aluminium and gamma rays by lead, without specifying the thickness involved. Where there are many possible differences to be described candidates should realise that incorrect comparisons will lose marks and they should give differences that they are sure of and that quote sensible values, where appropriate.

(c) The answers to **(i)** were disappointing. Many candidates sensibly suggested that it takes time for the radioactive iodine to travel through the bloodstream, but fewer suggested that decay is random and many merely referred to "background radiation", which is not relevant. Many suggested that the amount of iodine had actually decayed during the time of the observations, even through the count rate is seen as increasing towards 18 minutes and the half-life is stated to be 8 days. The numerical answers in this section were well answered. It was encouraging to find a large proportion of candidates able to apply proportionality in an unusual situation. Weaker candidates found difficulty in calculating the average value of the four readings in **(ii)**.

(d) The most often quoted precaution take was that the doctor should wear a lead-lined suit or use lead-lined gloves. A "radioactive suit" is not sensible. Many candidates gave suggestions such as "wear a mask or coat" but these were not considered sensible suggestions for a Physics examination.

Answers: **(c)(ii)** 38.5 per second, **(iii)** 7480 cm^3, **(iv)** 10 per second.

Paper 5054/03

Practical Test

General comments

Generally speaking the paper was a similar standard to the paper set in November 2003 and the performance of candidates was comparable. Candidates generally performed well on **Question 4** despite the fact that it may have seemed slightly more difficult than the previous year as it involved the calculation of a gradient rather than reading the maximum point off a graph. Many of the candidates used all possible series combinations, it was particularly pleasing to see that all these combinations were included, even by the less able candidates. In **Question 4** it was rare to see a mark of less than 10 out of 15. **Questions 1** to **3** provided better differentiation with a wide range of marks being scored.

Comments on specific questions

Section A

Question 1

(a) Examiners only gave credit for the Newton meter reading if it was given to 0.01 N which is the precision of the Newton meter. A large number of candidates who gave the value as 0.8 N therefore lost the mark.

(b) As Examiners only required one measurement to be to the nearest mm and the unit to be shown on only one occasion, the majority of candidates gained the mark in this section.

(c) To check that the heights measured were vertical it was necessary to check that the metre rule was vertical. This could have been done by aligning the metre rule with a vertical feature such as the vertical frame of a door or a window or by the use of a set square between the bench and the rule. Quite a number of candidates who showed the set square and the rule, did not show the bench and hence lost the mark.

(d) Most candidates gained credit for the correct calculation of cos θ. Very weak candidates confused the cosine of the angle with the actual angle. Most candidates went on to correctly calculate the weight but the value had to be within a range of the Supervisor's value so that the mark was not always scored. A number of candidates used an incorrect unit for the weight, incorrect units included both g and kg.

Question 2

(a)(b) Generally the temperatures recorded by candidates were correct. Better candidates interpolated between the divisions of the thermometer and recorded temperatures to better than 1ºC. Some of the weaker candidates used the unit of temperature as º rather than ºC.

(c) These calculations proved difficult for some candidates. Popular sources of error included:

- The use of the incorrect mass. Popular incorrect masses that were used included 1 g and 100 g. The latter mass presumably being the total mass of water rather than the mass of the individual volumes that were mixed.
- The use of an incorrect unit. The most popular error was the unit of specific heat capacity rather than the unit of energy.
- The use of incorrect temperature differences e.g. when the heat lost by the hot water was calculated the difference in temperature between the hot water and room temperature was used rather than the difference between the hot water and the final temperature.

(d) Most of the more able candidates found that the heat lost by the hot water was greater than the heat gained by the cold water. The reason for the discrepancy being that some heat was lost to the surroundings. However, occasionally the results showed that the heat gained by the cold water was greater than the heat lost by the hot water. This could not be explained by heat lost to the surroundings. In this case candidates would need to talk about heat gained by the cold water from the hot beaker. Generally this explanation was not given, in such circumstances most candidates still referred, incorrectly, to the heat lost to the surroundings. Note that the question asked the candidates to explain the discrepancy, thus those candidates who simply stated that the heat lost was greater than the heat gained did not receive any credit.

Question 3

(a)(b) Good candidates obtained a correct value for the focal length of the lens. The value was quoted to the nearest mm and a unit was given with the answer.

(c) In order to find the distance from the centre of the lens, the thickness of the lens should have been measured and half of this value should then have been subtracted from the height of the pin above the plane mirror. Candidates were confused here. A number found the height above the middle of the top of the lens by locating the centre of the lens from half of the diameter and then measuring the vertical height above this point.

(d) Good candidates found a correct value for the second height when the water was added between the lens and the mirror. However, the weaker candidates were unable to obtain this position.

(e) The best diagram to draw to show the shape of the water was a cross section through the lens. Such a diagram would have clearly shown that the shape of the water was that of a plano concave lens and candidates would then have been able to deduce that the water lens was diverging. Other candidates deduced the diverging nature of the lens by realising that the water had increased the focal length of the combination and must therefore be diverging.

Section B

Question 4

(a) The most able candidates had no difficulty with the circuit diagram. There were several errors that were made by the weaker candidates, these included:

- Not leaving a gap between A and B, this would effectively lead to a short circuit of the power supply and was not given any credit.
- Not showing the leads A and B, in many cases this made it look as though the voltmeter was in a series circuit and again lead to the loss of 2 marks.
- In some cases the Supervisor had not concealed the unknown resistor. This led to some candidates thinking that the voltmeter was only connected across the unknown resistor and not the power supply.
- A converse problem arose when both unknown and known resistors were shown but the voltmeter was only connected across the power supply.

(b) There were essentially three problems that arose with the preliminary readings:

- Occasionally voltmeter readings were quoted to the nearest volt rather than to at least 0.1 V e.g. 3 V.
- Readings were sometimes out by a factor of 10 e.g. currents were quoted as 2.2 A rather than 0.22 A.
- The wrong unit was sometimes given e.g. 220 A rather than 220 mA.

(c) The major problem in this part was the omission of all the possible values of resistance. By using the 15, 18 and 22 Ω resistors in suitable series combinations it was possible to obtain values of resistance of 33, 37, 40 and 55 Ω. It was pleasing to see that a large number of candidates did use all seven possible combinations of resistor. A small number of candidates used parallel combinations but these produced a small range of values.

(d) Graph plotting was generally good. The most frequent mark to be lost was that for scale. It was not necessary to start the graph at the origin because the lowest current reading was frequently in the region of 0.08 A and the lowest voltage reading was in the region of 3.5 V. Only the best candidates gained the scale mark, most lost the mark because the plotted data occupied less than half the page in either one or both directions.

(e) Generally candidates did not draw very good smooth curves through their points. Candidates should realise that points do not have to be joined dot to dot in such circumstances. Drawing a tangent at the point of greatest slope also proved difficult. Most candidates drew a tangent somewhere in the middle of the curve rather than in the region of greatest slope. Examiners were quite generous in their interpretation of the region of greatest slope and allowed tangents to be drawn close to this region. Most candidates scored full marks for the gradient calculations. A large triangle was used and the sides of the triangle were read correctly leading to a correct value of the gradient.

(f) Virtually all candidates realised that the gradient of the graph was negative and that this led to a positive value for the internal resistance.

Paper 5054/04
Alternative to Practical

General comments

The marks gained by the candidates covered the full range available, namely 0 marks to 30 marks. It is difficult to understand why a candidate, having attended a Physics practical course, did not manage to score any mark. **Question 1**, which had no complicated Physics or Mathematical task involved, proved to be a challenge to many candidates. In contrast many of the answers to **Question 5** parts **(b)** and **(c)**, both of which contained testing material, were often correctly and clearly answered. The standard of ray diagrams drawn to answer **Question 4**, was very variable. The quality of the diagrams ranged from excellent to very poor.

The inadequacies, noted above, could well be attributed to lack of practice.

Comments on specific questions

Question 1

The Examiners expected that the method chosen by most of the candidates would be based upon the following *outline*:

- Wind many turns, *N*, of the wire around the rule. Wind the turns so that adjacent turns touch but do not overlap. Keep the wire in place on the rule by using a little plasticine. Determine the length, *l*, of rule occupied by the *N* turns. The diameter of the wire, *d*, is determined from the relation $d = l/N$. Accuracy is improved by using a large number of turns so that the length *l* is several centimetres. To avoid parallax errors when measuring the length *l*, keep the line of sight perpendicular to the reading on the rule. The length of wire used is greater than *l*, the diameter *d* is likely to vary along the length of wire. So the method is an average value for a long length of wire.

Some candidates used methods that were similar, in principle, to method the above.

The Examiners therefore accepted methods *based* on the following outlines:

- Measuring the length *l*, ***on*** the reel, and counting *N* the number of turns involved. The length *l*, is parallel to the axis of the reel. The method would be similar to the *outline* given above. It was considered important to avoid including the end-stops at the top and bottom of the reel.
- Measuring the diameter of one *turn* of wire taken from the reel. The basic method being as follows: – one turn of wire is identified, on the reel. The length of this wire is *C*, the *circumference of one turn* of the wire, on the reel. The diameter, *D*, of this *turn* is given by $D = C/\pi$. Using more than one turn was required for full marks. The Examiners were aware that this is not a method to determine the diameter, *d*, of the wire. However, some candidates misread the question at the point, at the end of the stem, 'for the average diameter of the wire *on the reel*'.
- Measuring the length, *l*, occupied by several (*N*) short lengths of wire placed across the scale of the rule. The pieces are placed so that one side is adjacent to the next piece of wire. *Methods using only* ***one*** *piece of wire were not accepted since* **Question 1**, *gave the approximate diameter of the wire as 0.8 mm.*

Each answer was expected to cover points raised in the part questions **(a)** to **(e)**.

There were *many* poor answers. The following are examples of *popular* but *wrong* answers:

- Answers in which the rule was used to measure a length, *l*, of the wire, repeated (say) five times. Then $d = l/5$.
- Answers in which the plasticine was used as a pendulum bob on a length of wire. The candidates then just said "from the results determine the diameter of the wire".
- Answers in which candidates confused *diameter* with *radius* (this was common in good answers).
- Answers in which candidates confused *diameter* with *circumference*.

Several of the marks, in the mark scheme, could be scored from appropriate well-labelled diagram.

The Examiners report that many of the candidates confused mm with cm or m.

The Examiners also reported that many of the candidates did not appreciate the significance of the information that the diameter of the wire was about 0.8 mm.

A considerable number of the candidates did not attempt this question.

Question 2

(a) The question is about resistance $R = V/I$, and temperature θ. The required table needed at least four columns, one for each of θ, V, I, and R. Enough space was required for five separate attempts at the experiment. Many candidates failed to respond correctly to the instruction 'in which all the required readings may be recorded'. The unit was required for each of the physical quantities given in the table. These units were often omitted from the candidates' headings/column of results. Many candidates scored low marks because they failed to include θ in the table and also omitted to include any units in the headings.

(b)(c) Most of the candidates scored two marks out of the three marks available. The points listed below indicates the responses the Examiners accepted:

- **1.** and **2.**: Any two from the following list: wait for temperature equilibrium/stir the oil/place the thermometer near to the thermistor/reference to length of thermometer immersed/tap electrical meters having pointers/good electrical connections/how parallax was avoided/etc.
- And for part **(c)**: One suggestion from: oil has a higher resistance between input leads/water less/oil less volatile/water evaporates/specific heat capacity low/large range of temperature is possible.

Question 3

(a) Although a high proportion of the candidates gave 0°C, many of the other candidates gave a range of temperatures between 1°C and 16°C. Some actually gave the range. They had not understood how to design this experiment. The required value for θ was 0 (°C was not required for the mark). An explanation involving the melting point of ice was required for the second mark.

(b)(i) The Examiners required a line on the diagram showing the liquid acetophenone level just within the thickness of the ice. Although the level chosen by the majority of the candidates was correct, there were some disappointing positions chosen. Full test-tubes, nearly empty test-tubes and even *vertical* lines in the tube were chosen to represent the liquid level.

(ii) It was unusual for the answers given by the candidates to include *two* good reasons for the choice of amount of liquid acetophenone. The Examiners looked for answers to **1.**, that dealt with the equilibrium of the temperature or effective cooling of the liquid and in **2.**, that consider the accuracy of temperature measurement or the reduction of the time of the experiment.

(c) Probably less than 50% of the candidates gave 14°C, the correct answer. The wrong answers ranged from below 10°C to 29°C. Quite often a time value was given instead of a temperature. A unit was required for this answer.

Question 4

Although there were some neatly drawn diagrams, the responses contained errors showing that candidates do not understand the representation of optics by ray diagrams.

- Some incident rays did not start from the object at O; many rays changed direction at the point P_2.
- (The angle between the incident ray and the emergent ray was generally correct. The Examiners accepted the correct small angle and the correct large angle (viz., 42° and 138 ° +/–1°). There were, however, some wildly different values.
- The refracted ray, through the glass, was often omitted or incorrectly located.
- The position for the eye, to be labelled E, was on the emergent ray and 25 cm (along the rays) away from O. Surprisingly the position for E *ranged over the whole page*. Even at the bottom of page 9 behind and close to the object was chosen for the position of E.
- The position for *i* the incident angle was often incorrect. The most frequent mistake was *between* the incident ray and the prism.
- Although most diagrams were neat a few were drawn free hand. Did these candidates have a rule?
- A small, but noticeable, number of the candidates drew a large number of incorrect lines over the diagram.

Question 5

(a) The general standard of graphical work continues to be high. The Examiners commented on the good choice of scales, clear labelling and accurate plotting. There were however, some unsuitable and awkward scales chosen.

The Examiners looked for a graph line that was a good fit to the plotted points and that was smooth and thin.

(b) Quite a challenge for most of the candidates but there were some excellent answers. The two labels restricted the field of view of the lens. The *length* of rule seen between the labels is *w.* A *small* value for *w means* that the image is *enlarged*, that is, it is *magnified*. In the table 21 mm is the *smallest* value for *w*, so the magnification is the *greatest.* The Examiners were encouraged that about 50% of the candidates managed to give a clear answer to this part question.

(c) The answer is related to the argument given in **(b)** above. It follows from the table that *w* decreases with increase of *u.* Therefore, the *magnification of the image* increases as *u* increases.