PHYSICS

Paper 5054/01
Multiple Choice

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

General comments

The number of candidates for the November 2007 examination was 9663. The mean score was 22.8 out of 40 (57%) with a standard deviation of 7.4.

The results showed that all areas of the syllabus had been covered well, but the understanding of electrical safety and the applications of electromagnetic radiations caused some problems. Candidates found **Questions 7** and **17** to be the easiest to answer.

Comments on Individual Questions

Question 5

Similar numbers chose B (correct), C and D. The higher-scoring candidates chose correctly.

Question 22

Although the greatest number of candidates chose the correct option (D), the statistics suggest that it was guesswork. A large number opted for A; perhaps they are not linking infra-red radiation with heat radiation.

Question 24

Many of the better candidates chose D instead of B.

Question 30

Half of the candidates opted for D. This would have been correct if the ammeter had not been in one arm of the parallel combination.

Question 32

A large number of candidates, including the better ones, chose A. Either they read only the first half of the option or they did not understand how a fuse operates.

PHYSICS

Paper 5054/02

Structured and Free Response

General comments

The Examiners are of the opinion that the performance the candidates in this session, was very much in line with that which has been achieved in the most recent examination sessions. The overwhelming majority of the candidates answered some questions correctly whilst making errors in others. Consequently, they finally obtained a mark somewhere in the middle of the range. The actual mark obtained was, of course, an indication of the breadth and depth of the understanding of the particular topics which this year's questions examined and of the candidate's ability to express this on paper. It did, however, seem that rather fewer candidates than usual scored the very highest marks possible. This, on the other hand, seems to have been more than balanced by a slight but noticeable and significant rise in the numbers who produced performances which were very creditable and decent but which did not quite reach the highest standards throughout the paper. At the other end of the mark range, there was a further decrease in the fraction of candidates who scored very few marks at all and many of the candidates whose scores did fit into this band of marks, left significant sections of the question paper blank and only attempted a few parts of the questions in ***Section B***. There was a slight increase in the number of candidates who infringed the paper rubric by answering three questions in ***Section B***. In this session, a further opportunity for this arose in **Question 8** where the **OR** section tested material from ***Section 25*** of the syllabus which is, of course, optional. A very small (but larger than usual) number of candidates omitted to answer **Question 8** at all and as a consequence scored none of the marks available. It is possible that some of these were unable to decide which section to answer and then forgot to return to the question at the end of the examination.

Almost all candidates produced answers which indicated that the question had been properly understood and the answers given revealed that the vast majority of candidates had achieved a fluency in written English which was more than sufficient for the demands of this paper. There were probably fewer opportunities than usual for writing significant amounts of continuous prose and, where the chance did arise, it was taken by the candidates who, in the main, wrote well and accurately even when the physics itself had been poorly understood. It should be borne in mind by the candidates that in an examination such as this, clarity of expression is important and answers where the meaning is clear will be capable of achieving all the marks allocated to the question. Diagrams, bullet points and drawings can all help where a verbal description might prove laboured and less transparent. This applies to all the questions in the paper even where only answer lines are supplied on the paper. Although some attempt is made to match the number of printed answer lines in ***Section A*** to the number of marks available in that section, candidates should not feel that, for a given question or question section, they are expected to fill up the lined answer sections completely.

Very occasionally, the handwriting of a candidate is so indistinct that the Examiner is unable to award the marks available despite having made a serious attempt to understand what was intended. This situation is most likely to arise where the candidate is using an unusual word or phrase which the Examiner might not expect to encounter in the answer to the particular question.

As is often the case, the numerical calculations proved a fecund source of marks for the better candidates who may, in some questions, score 2 or even 3 marks by producing a few lines of accurate calculation concluding with the correct answer and the correct SI unit. There are, of course, a few dimensionless quantities where to include a unit would be erroneous; refractive index is an example of such a quantity. Where a correct answer is not supplied by the candidate, a small number of marks is usually available for showing the appropriate working or sometimes for just quoting the appropriate formula and so the better candidates invariably show the stages by which the final answer is achieved. Other candidates might easily forfeit marks by not doing so.

In **Question 11(a)(iii)** some candidates used a calculator set in the radian mode when calculating the refractive index of glass from angles given in degrees; this gives the wrong answer. It was especially unfortunate when this was coupled with a failure to show any working and three marks were lost as a result. Candidates who give contradictory answers to the same question cannot be credited for stating the correct answer. An example arose in **Question 11(b)(iii)** where the surprisingly large number of candidates who stated that the image was both magnified and diminished scored no marks.

There is a tendency for certain questions to produce answers which are too general and do not focus sufficiently on the specific point being examined; candidates should be strongly advised to read the question carefully and to restrict answers to remarks which answer the very specific point being asked. For example: **Question 2(a)(i)** was about measuring the volume not the density; **Question 10(a)** is concerned with electrical conduction not heat conduction. The syllabus outlines the meaning of terms such as: *state, list, determine* and *show.* Reference to this list should help candidates to give a response of the sort which the examination is expecting.

Comments on specific questions

Section A

Question 1

(a) This section asked what happened at the two given times and most candidates restricted themselves to the two decelerations or to their causes. It was surprising that several candidates referred to reaching terminal velocity or to uniform or even gradual decelerations.

(b) This part of the question was generally well answered. Marks were usually lost when candidates who gave the correct answer continued and supplied further, inaccurate details. A common response had the parachutist accelerating at an increasing rate and the decrease in the acceleration was often inaccurately described as a deceleration.

(c) A disappointingly small number of candidates scored both marks. The forces were quite commonly correctly named but the fact that the resultant force on the parachutist was zero was rarely stated with sufficient clarity. Sometimes the forces were simply equal, sometimes just opposing and some candidates referred to the resultant force being cancelled out by another force.

(d) This question was very commonly correct but some candidates used a speed of 4.5 m/s or misread the graph in other ways. Likewise, marks were lost by candidates who rearranged the formula incorrectly or gave the unit of distance as m/s.

Answers: ***(d)****150 m*

Question 2

(a) **(i)** This part was very well answered since most candidates were thoroughly familiar with the displacement method for determining volume. A few candidates omitted to mention the use any liquid in the measuring cylinder. The less precise answers did not state that the level of the liquid was recorded at any stage and sometimes it was not clear which two values were being subtracted. The spelling: *substracted* was very widespread. In **(ii)**, the weaker answers did not explain why the limited volume of an ordinary laboratory measuring cylinder was relevant in this case. Some candidates stated that the mass of the rock was too great or that it would break the glass.

(b) The density of rock A was correctly calculated very frequently indeed. Only very occasionally was the wrong formula used or an incorrect final unit given. Some candidates gave the correct answer in kg/m^3 and scored full marks.

(c) The majority of candidates were correct to state that rock C was made from a different material and correctly explained how this was deduced. The most common error, however, was to give rock D as the answer because of its much greater mass and volume.

Answer: ***(c)*** *4.59* g/cm^3

Question 3

(a) **(i)** Whilst some candidates did name the renewable energy source, a very large number did not and a variety of inspired or random guesses was very evident. Many candidates had some idea of the point which **(ii)** was testing. Many others, however, used phrases such as: *can be used again, can be recycled.* The word *renewable* was given in the question and cannot be used to explain its own meaning.

(b) These two calculations were performed correctly by many candidates but some answers were spoiled by incorrect final units. The correct and straightforward J was very common but some used the units of the quantities given in the question or made errors when trying to deduce the correct unit from the formula. Candidates who used the formula in the form: $L_v = ml_v$ were sometimes uncertain as to which quantity represents the *specific* latent heat and errors of substitution arose as a result.

Answer: ***(b)(i)***3.36×10^8 *J* ***(ii)*** 2.3×10^8 *J*

Question 4

(a) The good absorption property of black surfaces was widely given but several candidates spoiled the answer and lost a mark by also referring to their good emission property which does not constitute an accurate explanation in this case. Very few candidates made any reference to *radiation* or *IR radiation* and so the second mark was only rarely awarded.

(b) Many candidates misunderstood this question. Answers tended to explain why it was desirable for the hot water to be in the tank rather than explaining how it got there. Very few answers made any reference to the reduced density of hot water or to the setting up of a convection current; this part was poorly answered.

(c) **(i)** was generally well answered although some candidates referred to importance of electrical insulation. Many materials in **(ii)** were sensible and appropriate but some candidates suggested double-glazing the tank or manufacturing it from copper or painting it white.

Question 5

(a) Most candidates realised that the conduction of heat was due to the atomic vibrations and scored the first mark in **(i)** but some merely referred to the vibration instead of the energy being passed on. Only a correct reference to the transmission of energy scores the second mark. In **(ii)**, many candidates talked about faster vibrations or the expansion of atoms. The mark was awarded for vibrations of greater amplitude.

(b) Most candidates were able to obtain one mark here by giving one relevant change either in the arrangement or in the motion of the atoms. A significantly smaller number, however, was able to get both marks. Answers which referred only to the macroscopic properties of liquids and solids did not answer the question and did not score.

Question 6

(a) The vibration of the cone or of the air molecules near to it was mentioned by many candidates and so the first mark was awarded very commonly indeed. Very few candidates stated that the vibration of the air molecules was longitudinal and when it was scored, the second mark was usually credited to candidates who referred to the compressions and rarefactions produced in the air.

(b) Although not universally so, the highest frequency that a human with normal can hear was accurately quoted very widely. Likewise, the calculation in **part (ii)** was very commonly correct. Some candidates, however, used the answer to **part (i)** and not the frequency value given in the question to calculate the **shortest** wavelength of audible sound and not the **longest** as requested.

Answer: ***(b)(i)*** *18 000 – 20 000 Hz* ***(ii)*** *17 m*

Question 7

(a) A large number of candidates wrote down the correct answer steel in **(i)** but it is clear that many others do not realise the significance of the words *soft* and *hard* when applied to ferromagnetic materials. There was a similar confusion in **(b)(i)**. Whilst some candidates answered **(ii)** well, others did not mention the need for a current in the coil or at least for the switch to be closed.

(b) This part of the paper was very poorly answered. Most candidates drew diagrams which suggested a very limited understanding of this topic. Unfortunate features of many such diagrams included: field lines not linking up, field lines bowing outwards not inwards, field lines being concentrated on the component, field lines crossing and touching.

Question 8 EITHER

The question was well understood by many who attempted it and 4/4 was quite a common mark. Marks were forfeited for answers where the amplitude or the periodic time were out by a factor of 2 or where the diagram was so poorly drawn that it was not clear which length should be taken to represent the amplitude or the periodic time.

Question 8 OR

(a) This part of the question was almost universally very poorly answered and it is clear that almost none of the candidates has any idea of the manner in which a transistor functions in a circuit such as this.

(b) Very few candidates suggested a suitable use for the moisture detector; several candidates stated that it could be used to switch on a pump or it could measure moisture levels. The device referred to in the question could do neither of these.

Section B

Question 9

(a) The calculations enabled many of the better candidates to score well here. Familiar errors in the unit of acceleration and the inaccurate rounding to an appropriate number of significant figures were responsible in some cases for candidates' not scoring full marks on **(i)** and **(ii)**. When applying $F = ma$ some candidates used a = 10 m/s^2 rather than the calculated value from **(i)**. **Part (iii)** was much more poorly answered. Most candidates relied on vague and unconvincing answers involving the application of opposing forces by the airbag or to air escaping from the bag and hence absorbing the force in some uncertain manner. Few of those who stated that the deceleration was reduced realised that this was because of the increase in the duration of the deceleration.

(b) Many candidates were able to define pressure but some who might have scored the mark gave sloppy and imprecise definitions such as: *the force acting on a certain area.* Many candidates simply stated the defining equation and scored the mark. In **(ii)** it was surprisingly rare for a candidate to score both marks. Again several candidates reverted to answers which repeated those already given for **(a)(iii)**.

(c) Again many of the higher scoring candidates were able to obtain the 3 marks in **(i)** for just a few lines of accurate calculation and the correct answer with the correct unit. Given the very specific wording of the question, an unfortunately large number of candidates used the volume 29 400 cm^3 in the calculation. Most candidates realised that pressure was caused by molecular collisions with the container walls but many of the candidates who did not score full marks here, wrote about the airbag alone and did not make a specific statement concerning the reduction in the number of air molecules in the cylinder.

Answer: ***(a)(i)*** *4.7 m/s*^{2} ***(ii)*** *23 N* ***(c)(i)*** *280 000 Pa*

Question 10

(a) Most candidates realised what was required here and were able to score quite well on this section. Answers which included a circuit diagram tended to score well and helped candidates to make clear their intentions. There was a significant number of answers involving heat conduction and some tested for good thermal conductors before stating that good thermal conductors are good electrical conductors. Such answers were not credited; nor were experiments which involved the administering of electric shocks to human beings. Almost all candidates were able to name a good and a poor electrical conductor.

(b) This part of the question was, in general, quite poorly answered. Although most candidates were able to define resistance, many restricted their answers to general statements about resistance being a measure of the opposition to current flow or the force which opposes current flow and did not give its exact numerical definition. It was noticeable that in **part (ii)**, many answers stated how the current varied with potential difference or referred to the resistance being directly proportional to the potential difference. The first does not answer the question and the second is neither true nor readily deduced from the sketch graph in the question. Many candidates used expressions such as: *P gets smaller as the potential difference rises*. It is not clear what P means here as in the question it is stated that P is a component not a measurement or quantity. Whilst many candidates did state that component P is a tungsten filament lamp or made one or two other equally probable suggestions, a rather larger number produced answers such as: *resistor, thermistor,* and *diode.* In **(iv)** only a very small number of candidates realised that the effect was caused by the rising temperature of component P and of these few scored more than 1/2.

(c) Many of the better candidates were again able to score well on the calculations. Common errors included the use of inaccurate rearrangements of the Ohm law: $V = I/R$. Some candidates halved the potential difference calculated in **(ii)** for the answer in **(iii)** whereas the values are the same. The value of R in **part (iv)** was often given as a fraction; this was not accepted.

Answer: ***(c)(i)*** *1.0 A, 1.0 A* ***(ii)*** *8.0 V* ***(iii)*** *8.0 V* ***(iv)*** *13 Ω*

Question 11

(a) **Part (i)** of the question was often well answered and even candidates in the middle of the mark range often scored 2/2. In **(ii)**, some knew the three correct answers whilst others were obliged to guess and sometimes gave answers which were inconsistent with each other: the velocity is reduced whilst the wavelength and frequency increase. **Part (iii)** was frequently well answered and there was little indication to suggest that candidates, who know that the value is 1.5, simply wrote it down without calculation.

(b) In **(i)** there was a fair amount of uncertainty amongst the candidates as to what was being asked for. Many gave an answer which suggested that they were trying to define the focal point and those candidates who referred to it by name used terms such as: *the focal, the focus, the principal length.* In diagrams, the diameter of the lens was frequently labelled: *the principal axis.* The diagrams were usually fairly untidy and arrows drawn to indicate the focal length would often begin and end short of the correct positions. In such cases, the second mark was forfeited. It was interesting that some weaker candidates were able to produce large, carefully drawn and accurate diagrams in **part (ii)** and hence score some useful marks. The answers given here were variable in quality but most candidates who attempted this part of the question had some idea of what was required. A common error was to position the object at some random location rather than where the scale located it and thus to obtain an image whose magnification lay outside the allowable limits. Some candidates marked the point where the two refracted rays crossed as the image and did not link this point to the principal axis to produce an extended image; they scored only 2/3. Many of the candidates were able to obtain at least one and frequently both of the marks available in **part (iii)**. This was sometimes as the result of an error in the diagram being carried forward.

Answer: ***(a)(iii)*** *1.52*

PHYSICS

Paper 5054/03
Practical Test

General comments

Generally speaking the paper was of a similar standard to that set in November 2006. Making measurements on the block of wood in **Question 1** was possibly easier than making measurements on the lens in 2006. However, ray-tracing through a glass block was more difficult than ray tracing in a plane mirror that was set in 2006. The potential divider circuit used in the second question was also more accessible than the accelerating sphere problem set in November 2006. In November 2006, the discussion of the motion of the sphere was difficult for candidates because of the confusion between velocity and acceleration. There was no such confusion in November 2007 although the final three marks on the mark scheme were rarely scored. Many candidates did not realise that R could be read directly off the graph; quite a few candidates attempted to measure a gradient at this point. Other candidates, who realised that R could be read off the graph, read the value at 0.5 V rather than $0.5V_0$ volts. Very few candidates realised that if the potential differences across the two resistors were equal then the values of the resistors were equal.

Comments on specific questions

Section A

Question 1

(a) Weaker candidates often only measured to cm precision. Examiners expect all measurements made with a half-metre rule to be measured to at least mm precision.

(b) Most candidates obtained a mark for the diagram. Examiners were prepared to allow any diagram that showed a significant feature. In particular marks were scored for: a scale on the end face of the block; a cross-section that showed the top face either level or at an angle; a clear 3-dimensional diagram of the block.

(c) This was the most disappointing part of the first question. Examiners expected that the block would not float horizontally in the water, in fact most of the diagrams drawn in part **(b)** showed this. However, most candidates in this section only took a single reading of the depth to which the block sank in the water and it is difficult to see how this would be possible. Good candidates took readings at each of the 4 corners and obtained a good average value. In other cases, candidates took 2 values, presumably in the middle of the two end faces.

(d) Most candidates obtained a value for the ratio which was within the very wide range that was allowed. However, quite a large number of candidates incorrectly gave a unit of either cm or mm to this ratio.

Question 2

(a) to **(d)** The two main reasons for the loss of marks when producing the incident ray were:

- An angle of incidence of 30° being used rather than an angle of incidence of 60°.
- The two pins on the incident ray being too close together. Examiners expected these pins to be at least 4 cm apart; in some cases candidates placed pins within 1 cm of each other.

Very weak candidates obviously had difficulty seeing the pins through the block and showed sighting pins to the side of the block. Those who could obviously see the pins on the incident ray and correctly located the sighting pins often lost the mark because the sighting pins were too close together. As in previous years, Examiners used the holes in the paper as a guide to where the pins had been placed. Only a very small minority of candidates marked the positions of the pins. The labelling of the pins would leave less doubt in the Examiners' minds as to where the pins had been placed.

(e) to **(f)** Good candidates obtained a value of *r* in the correct range and went on to obtain a good value for the refractive index of glass. In some cases, candidates were not as accurate with their measurements and obtained answers outside the ranges. In such cases the candidates were likely to obtain 1 out of the 3 marks for this section. A number of candidates measured the angle of emergence rather than the angle of refraction. Most candidates understood how to calculate *n* even if the angles on the diagram were incorrect. A small number of candidates gave *n* a unit of degrees.

Question 3

(a) to **(c)** Most candidates obtained the 3 marks for locating the position of the centre of mass. Common errors in this section included:

- The use of only two holes rather than 3.
- Lines which did not start at one of the holes. Presumably candidates located the position of the centre of mass by geometry and then drew lines intersecting to show the centre of mass but these lines started from random points rather than the centre of a hole.
- Lines which were drawn free-hand and were therefore not accurate.
- Lines that did not extend to the edge of the card.
- Lines that did not intersect at a point, presumably because the card was not freely pivoted on the nail or because the marks on the card had not been placed with sufficient accuracy.

(d) Often the value of BX was too small because candidates had measured from the hole rather than the corner at B. In some cases the points C or A were at the right-angle of the triangle rather than the point B. However, Examiners used different ranges for the distance BX in these cases.

(e) When asked to describe a different experiment to confirm that X was the centre of mass, a number of candidates described the same experiment and were not awarded the mark. Most candidates described a method whereby X was balanced on an object. Those candidates who used a blunt object such as the finger were not awarded the mark, but those who described balancing on a pointed object gained the mark.

Section B

Question 4

(a) In the majority of cases a correct circuit diagram was drawn. Common faults with the diagram included:

- The lack of a gap between points A and B.
- The use of a variable resistor rather than a fixed resistor.
- The use of components other than a resistor, e.g. a thermistor.

(b) to **(c)** Most candidates scored full marks here, particularly since missing units were not penalised at this stage.

(d) Weak candidates typically used the three single resistors and gained 2 out of the 4 marks. Some candidates omitted units from the table but this was very rare. Others confused Ω and kΩ, but again this was rare. Good candidates used all series combinations of resistors and gained full marks.

(e) Graph plotting was generally good. Candidates clearly labelled the axes and chose a suitable scale. The three main sources of error tended to be:

- Candidates who forced a straight line through what was clearly a curve. These candidates lost the line mark.

- Candidates who used a scale that was too small. This was particularly the case on the horizontal resistance axis. In some cases candidates used a resistance scale that meant the data occupied just under 8 cm. This scale could have been doubled since there were 16 cm on the grid in the horizontal direction.
- There were some plotting errors, particularly with regard to the points corresponding to 0.47, 1.47, 2.67 and 3.67 kΩ. In several cases, the point was plotted the wrong side of the vertical grid line. Also, a number of candidates rounded these values to 0.5, 1.5, etc. for plotting purposes and again lost the plotting mark because the points were not plotted with sufficient accuracy.

(f) Some candidates attempted to measure the gradient of the graph in this section and this was not required. Good candidates realised that the value of R had to be read off the graph. A common mistake was to read off the resistance at a potential difference of 0.5 volts rather than 0.5 V_0 volts. Only the best candidates realised that when the voltage across X was 0.5 V_0 volts, then the voltage across the series resistance was also 0.5 V_0 volts, which meant that X and the series resistance had the same value.

PHYSICS

Paper 5054/04
Alternative to Practical

General comments

The full range of marks was achieved by candidates (from the maximum for the paper (30) to zero).

There were fewer candidates scoring very few marks this session and it was pleasing to see candidates able to answer all the questions and give good detail of practical procedures in their answers.

Candidates are now scoring well on calculations and using data given in questions to analyse relationships. However there were a few problems with decimal places and significant figures. The correct number of decimal places to be quoted in an answer proved to be difficult for some candidates and there were more instances of rounding errors in calculations in this paper. In measuring lengths using a ruler (with a smallest division of 0.1 cm), some candidates gave answers to the nearest cm, and others gave answers to the nearest 0.01 cm. It is an important practical skill to be aware of the smallest scale division when using any measuring instrument and to be able to quote values accordingly.

In drawing circuit diagrams (**Question 2**), ray drawing (**Question 3**) and graph plotting (**Question 4**), the pencil used by candidates should be soft (i.e. HB or B) but they should be used to produce a line that is clearly visible. There were a noticeable number of scripts where the pencil marks were very faint and it was difficult to tell whether an attempt had been made to erase workings. Fewer candidates are drawing lines that are too heavy and thick.

Comments on specific questions

Question 1

This question carried 13 marks.

The question was about practical techniques used in timing a falling sphere in a dense medium. The candidates were asked to explain practical procedure, comment on relationships from given sets of data and appreciate the variables that need to be kept constant in an investigation.

The question was well attempted and candidates continued to the end, answering all parts even if they were unsure of the answers to some sections.

(a) A large proportion of the candidates were able to appreciate that the sphere had not reached terminal velocity at the top. Although the question stem clearly stated that the sphere was held below the surface of the oil before being released, some candidates said the sphere would slow down upon entering the oil. A few candidates did not read the stem carefully enough and thought the tweezers were released and allowed to fall through the oil.

(b) The use of the rubber bands in knowing when to start or stop timing was well explained by the majority of candidates. The explanation that it made the measurement of x more accurate was allowed. A few candidates had some difficulty understanding that the bands were around the outside of the jar, not inside, and explained that the sphere bounced off the band or caused it to vibrate.

(c) The two marks here were scored by most candidates. Many good candidates calculated the two velocities and added a column on the table, then referred to the values in their answer. Some credit was given to candidates who calculated the two values and then said that the metal sphere had not reached terminal velocity as the values were different. The difference was very small and some candidates commented well that it was within the limits of possible errors in timing.

(d) (i) The symbols used to represent the eye on the diagram were improved this time. Very few drew the eye looking away from the jar. The majority of candidates scored this mark, but some drew the eye level with the surface of the oil or with the lower band.

(ii) The positioning of the ruler used to measure the distance x caused problems for some candidates who did not relate the diagram to the actual experiment. Most correctly drew the ruler touching or close to the jar to measure the distance between the rubber bands. A few incorrectly drew the ruler touching the two-headed arrow labelled x. The ruler was accepted if it was drawn between the two-headed arrow and the jar, or on top of the jar.

(e) (i) Many candidates found the manipulation of the values in the table straightforward and scored all three marks here. Some were unable to calculate the velocity, and instead multiplied or divided the diameter and the time, rather than using the 40.0 cm distance given. Few candidates gave too many or a variable number of decimal places in their answers, thereby losing one mark. Some did not round the values to 1 d.p. correctly and so lost one mark.

(ii) The candidates were asked to use the data in the table, so if they did not quote values in their answers they could not score both marks. There was some confusion with the meaning of *directly proportional* with some candidates stating that the product of v and d was not constant, rather than referring to the ratio. A number of students attempted to show non-linearity when the question clearly stated 'not directly proportional'.

(iii) Most candidates scored one out of the two marks available. Few identified the correct three (diameter of sphere, metal used for sphere, type of oil) only. There were no responses that were consistently chosen wrongly by candidates. Some candidates ticked more than three boxes.

Question 2

This question carried 5 marks.

The candidates were required to show knowledge of a simple circuit and to be able to draw circuit symbols. The question required the candidates to be aware of the practical details of producing magnetic field lines due to a current carrying conductor using iron filings.

(a) Many candidates gave only half the answer here, scoring one of the two marks. They either drew an ammeter (to measure the current) or a variable resistor (to vary the current). Those who drew an ammeter gave the correct symbol but many could not draw the correct symbol for a variable resistor. A common error was to draw a resistor symbol with a line through it rather than an arrow. The power supply needed was often omitted or poorly drawn. A D.C. supply was required. A few candidates drew the field lines round the wire instead of completing the circuit.

(b) (i) A large proportion of the candidates were aware that a large current is needed to produce a large enough field to produce a pattern with the iron filings. Some answers here were too vague – for example referring to 'more fields' or making the iron filings 'more magnetic'.

(ii) Many candidates were able to gain this mark. A common incorrect response was to say that it was to remove dust from the card.

(iii) The most common correct response seen was an explanation that the field could be seen more accurately with smaller iron filings. The response that the small iron filings could be magnetised more easily or more quickly was not accepted.

Question 3

This question carried 6 marks.

The question required candidates to have an understanding of ray tracing and to be able to follow instructions. Taking measurements from a diagram required an appreciation of the accuracy of the measuring instrument used. A simple substitution into an equation tested mathematical computation skills. It was obvious that many candidates had performed experiments with refraction through a parallel sided block. Rays and lines drawn were generally of good quality with only a few being too thick, too faint or not drawn with a ruler.

(a)(i) Most candidates scored this mark, but this simple instruction caused difficulty for some candidates who drew the refracted ray rather than a single straight line.

(ii) This ray was well drawn and most candidates scored this mark. A small number of candidates only drew the ray between pins P_3 and P_4 or made the ray change direction at P_3 rather than at the surface of the block.

(iii) Only a few candidates scored this mark. Many did not mark the distance d at all, or drew a horizontal line rather than a line perpendicular to the rays.

(iv) **0.9 cm**
The mark was awarded here for a value between 0.7 and 1.2 cm. Some candidates lost the mark by quoting 1 cm. The length should be measured to the nearest mm. It is possible to measure d to the nearest mm, so candidates should be encouraged to show the precision of their measuring instrument in their answers. However, answers given to 0.1 mm were not accepted.

(b) **5(.0) cm**
It was surprising that some candidates could not measure the thickness of the block labelled t on the diagram and left the answer space blank. Recording this as 5 cm (rather than 5.0cm) was not penalised here.

(c) **1.56**
The mark was awarded here for correct use of the candidate's values in **(a)(iv)** and **(b)**. However, negative answers were not allowed. A mistake seen quite often was to give a unit (such as cm, ° or even °C) when no unit is required.

Question 4

This question carried 6 marks.

The question required candidates to be able to understand the description of a practical situation that was probably new to them, to plot a graph from given data, and to comment on how accurate readings could be taken.

(a) The question required the candidates to answer giving practical detail. They needed to have read the stem of the question carefully in order to appreciate the experiment described. Many excellent answers were given in terms of the need to stretch the elastic band in order to provide a force to move the block. A common incorrect response was simply to state that D and d are directly proportional.

(b) The graph was generally well constructed, with candidates scoring well. Many candidates did not read the question carefully and did not start their axes from the origin. There are still some candidates who lost marks by not labelling the axes with both quantity and unit. In general the axes were drawn the correct way round. Plotting of the points was also good. It was surprising that the point at d = 9.0 cm was the one most commonly misplotted. The use of dots rather than crosses to mark the points lost some candidates a mark as occasionally the dots were too large, but more often too small and faint to be seen. Candidates need to remember to re-plot the points if they inadvertently rub them out when rubbing out the line in order to have a second attempt at drawing a smooth curve. The graph line was only slightly curved which caused some difficulty in producing a good line. In general, many more candidates attempted a smooth curve and only a few drew a straight line.

(c) Any sensible practical detail gained a mark here. There were many good answers referring to avoiding parallax error when reading the ruler. Common misunderstandings were to use a stopwatch or to measure to the resting position of the block. Neither of these were acceptable responses. The correct answer seen most often was to take repeat readings and find an average value for D. In general, candidates did not differentiate between repeating the reading (to check a single result) and repeating the experiment. This was not penalised here, but it is hoped that candidates will become more aware of the difference in future.