PHYSICS

Paper 5054/01
Multiple Choice

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

General comments

The mean score was 21.5 out of 40 (54%) with a standard deviation of 19%.

All areas of the syllabus were shown to have been covered well. Candidates found questions 1 and 37 easy, but 16 and 21 caused some problems.

Comments on Individual Questions

Question 9

Half of the candidates just multiplied the two given values, choosing **A**. However, it was mainly the lower-scoring candidates who did so.

Question 16

The greatest number, including many of the better candidates, chose **B**. The question did remind them that the change of state occurs at constant temperature.

Question 21

Similar numbers chose each of the options, suggesting there may have been some guessing.

Question 36

Several of the better candidates opted for **D**, with electrons flowing in only the ‘negative’ half of the circuit.

PHYSICS

Paper 5054/02

Structured and Free Response

General comments

The Examiners gained the impression that the standard achieved by the candidates was very similar to that reached in recent years; few candidates were awarded extremely high marks and even fewer obtained low marks. An encouragingly high number of candidates achieved very convincing scores whilst those candidates who obtained the lowest scores, very commonly did so as a consequence of leaving a substantial fraction of the questions unanswered. Inevitably, most candidates were awarded a mark somewhere between these two extremes which reflected their individual understanding of the subject as tested by this paper.

There was no evidence that a significant number of candidates had excessive difficulty in understanding the language of the questions or in writing English which was at least comprehensible to the Examiners and which in many cases was both clear and accurate. The experimental description in **Question 9(a)** gave the candidates a certain, limited opportunity for writing continuous prose and many responded well to the challenge. In answering this question, others were able to compensate for a lesser fluency by drawing labelled diagrams or by answering in bullet points. A competent physicist, when making a point, should not be reluctant to include diagrams in written answers and in an examination paper such as this one, this technique is likely to make ideas and concepts which can be difficult to express in words alone, clearer. There was no evidence that the candidates had to hurry through the paper in order to finish within the time allowed.

The best candidates usually scored very well indeed on the calculations but when answering such questions, all candidates would be very strongly advised to show both the formula used and the numbers substituted into it. Candidates who do not do this might well lose marks as a result. In **Question 10(b)(ii)** there were, of course, candidates who having correctly written the formula $V = IR$, produced a rearranged version such as $I = R/V$. Such an error will always result in the loss of marks. Although in **Question 6(b)** the answer *efficiency = 0.60*, does not need a unit, numerical answers almost always require the correct unit if a loss of marks is to be avoided. It is unfortunate when good candidates forfeit marks through the omission of units. Encouragingly, most candidates are quite meticulous about this.

Most candidates are aware of the different styles of response expected when a question uses a command word such as *describe, explain* and *state* and produce an appropriate answer. **Question 5(c)** specifically asks for a diagram and the overwhelming majority of candidates supplied one in their answer. A candidate will not, however, be rewarded for reproducing information already supplied or for an answer which is inconsistent with the question. An example of the former occurred when candidates explained that the ends of the rods in **Question 3(a)** were coated with wax and placed near to a Bunsen flame. Likewise candidates who did not use an experimental method to determine the centre of mass – as requested in **Question 9(a) –** cannot expect to score many of the available marks.

Comments on specific questions

Section A

Question 1

(a) Many candidates – including those whose final scores were rather poor –obtained full marks in this section. The most common errors resulted from misinterpreting or confusing the horizontal and vertical scales.

(b) Some candidates did not fully understand what is meant by *acceleration* and as a result scored few marks in this part. Since this numerical answer was calculated from readings taken from the graph, an answer given to an excessive number of significant figures was penalised. This was the only question where such a penalty was applied. A significant minority of candidates gave the answer as the fraction *2⅔*; this was not credited. Here the unit of acceleration was asked for separately and some otherwise quite competent candidates were unable to supply it. Very common errors included *m/s*, m/s^{-1} and m/s^{-2}. There were also, of course, many completely correct answers given.

Answers: **(a)(i)** 12 m/s **(ii)** 16 s **(iii)** 192 m **(b)** 2.7/2.67 m/s^2

Question 2

(a) A common answer here was 0 even though the correct answer of 10 or 9.81 m/s^2 was also very frequently given. Very unusually, the Examiners ignored an incorrect or omitted unit in this part since the unit of acceleration had been specifically examined in the previous question.

(b) Although a pleasing number of candidates scored two marks, there were surprisingly few completely correct answers. There were four possible mark scoring statements. In each part, candidates could compare the sizes of the two forces and comment on the size of the resultant force. Even the highest scoring candidates tended to give only one of these answers in each part.

(c) This proved to be the hardest part of the question and only occasionally was it well answered. It highlighted the worryingly common misapprehension that there is no gravitational field in a vacuum. A large number of candidates was tempted to supply more than the two possible differences asked for. When an extra difference was wrong or contradicted a correct answer already given, marks were lost which might have otherwise been scored.

Answer: **(a)** 10 m/s^2

Question 3

(a) The overwhelming majority of candidates realised what was demanded, answered the question accurately and scored both marks. A small minority, however, although aware that the best conductor could be determined by observing the order in which the wax on the rods melts, did not state that the wax on the best conductor was the first to melt.

(b) Many candidates stated that the white teapot cooled more quickly because its surface absorbed heat from the water more slowly than did the surface of the black teapot. Both the answer and its explanation are wrong and no marks were scored. Candidates who correctly stated that the black teapot cooled the more quickly scored one mark. This, of course, is because of the excellent emission properties of the black surface and not because a black surface is a good absorber of radiation. Those who suggested absorption as the explanation – either on its own or in addition to the correct explanation – did not score the second mark. The third mark was scored by stating that it is infra-red rays or radiation – not just heat – that is emitted; this mark was awarded relatively infrequently.

Question 4

(a) The overwhelming majority of candidates drew both the normal and the reflected ray accurately and so scored well in this section. Those who did not use a ruler and a sharpened pencil or who did not make any measurements were the most likely to draw the lines too far from acceptable positions. In **(ii)** there were many accurate answers although some candidates gave 50˚ as the value for either or both of the angles requested.

(b) Responses of a widely varying quality were given here but those which merely stated or assumed the location of the image, did not answer the question. Possible methods included both experimental techniques and geometrical constructions and a wide range of acceptable answers was offered. It is slightly disconcerting to see ray diagrams in which light emerges from a human eye but incorrect or missing arrows were not, on this occasion, penalised and the use of dotted lines behind the mirror was not insisted on. Some candidates spoiled otherwise respectable answers by confusing the terms *image* and *object* or by using them carelessly or interchangeably.

Answer: **(a)(ii)** 40˚ 40˚

Question 5

(a) This part was generally well answered but some candidates were insufficiently precise and drew arrows whose direction was either unclear or outside the acceptable limits.

(b) A few candidates misinterpreted the question and failed to draw all four letters requested. Most candidates, however, did follow the instructions and of these a very significant majority did so correctly.

(c) Almost all candidates revealed a partial understanding of how to demagnetise the nails but many gave incomplete answers and only scored the first of the two marks. Omissions included: not using an a.c. in the solenoid, not removing the nails from the solenoid at all, not heating the nails to red heat and not hammering or dropping the nails repeatedly. It was noticeable that a very large fraction of the candidates who referred to an a.c. source in the explanation, drew the symbol for a d.c. source in the diagram. It was particularly encouraging to see how few candidates confused magnetism and electrostatics in their answers to this question.

Question 6

(a) The question asked for two energy changes and those candidates who merely offered two forms of energy did not answer the question. The energy changes given did include most of the acceptable answers but a significant number of candidates offered rather surprising and unlikely suggestions. This almost certainly indicates that this is a section of the course which many candidates find challenging. There was also a tendency by some to give excessively lengthy chains of energy changes which almost invariably included ones which do not occur in this case. The Examiners did not, in this example, consider the term *mechanical energy* to be sufficiently precise.

(b) The calculation was often performed correctly which ensured that both marks were scored. Weaker candidates, however, made a variety of errors. These included: inverting the definition of efficiency, substituting 3200 J instead of 2000 J and expressing the answer as 0.60%.

(c) This part was rather poorly answered, principally because many attempts were too imprecise. The bare answers *heat, friction* and *sound* did not score the marks. The better candidates stated where the heat was produced or where the friction was acting or supplied other possible mechanisms of energy loss.

Answer: **(b)** 0.60/60%

Question 7

(a) The correct answer *electromagnetic induction* or something extremely close to it was given by an encouragingly high number of candidates. Incorrect answers included *electric induction, magnetic induction* and *induction* but the surprisingly wide range of other answers offered suggested that some candidates found themselves very uncertain as to what was being asked for here.

(b) This was correctly answered very commonly and only a small minority of candidates failed to score the mark. Many of these candidates, however, gave confusingly expressed or ambiguous answers rather than ones which were clearly wrong.

(c) Surprisingly, this part of the question was very commonly answered in a reverse manner by candidates who stated that a moving wire which cuts the magnetic field lines causes the needle of the meter to deflect. Not all of these candidates continued by stating or even implying what happens when the wire is held stationary and did not, therefore, answer the question which had been set. Some candidates stated very clearly that a wire lying stationary in a magnetic field is cutting the field lines. This misinterpretation of the meaning of *cutting* was however, pleasingly rare.

Question 8

(a) This part was often correctly answered; a few candidates used $V = IR$ and set $I = 0$. In this particularly convincing way it was shown that $V = 0$. The answer 16 V was the most common wrong answer given.

(b) Many candidates were able to work through these calculations very straightforwardly and scored all five marks. This included many candidates who had given a wrong answer in **(a)**. The importance of elementary mathematical procedures for this subject was illustrated by those candidates who were unable to rearrange the formula $V = IR$ successfully. Most of these candidates lost marks in both **(ii)** and **(iii)**.

Answers: **(a)** 0 **(b)(i)** 8 Ω **(ii)** 2.0 A **(iii)** 12 V

Section B

Question 9

(a) The question asked for an experimental determination of the centre of mass and candidates who used only a geometrical method scored very few if any of the marks available. This experiment was well described by a substantial fraction of the candidates who attempted the question. Few candidates, however, made any reference to setting the lamina oscillating or to waiting for it to stop once this was done. Many candidates were able to score marks from clear, well-drawn diagrams and this helped some of those whose writing style was less fluent and less clear. It is unfortunate when a candidate has learnt by heart the description of a standard experiment such as this and then – without noticing – omits a crucial section when writing it out in the examination. There is a range of acceptable methods available but the least accurate ones would rarely have been awarded full marks.

(b) The majority of candidates attempting this question did not define the term *the moment of a force.* Much more commonly the meaning of the quantity was described or explained by stating what it does. Such an explanation is not, of course, a definition and it does not answer the question. It is quite worrying that such a high proportion of the entry did not understand what was intended here. In **(ii)** very few candidates measured the correct perpendicular distance with sufficient accuracy and although the calculation was usually performed correctly, many candidates did not include the appropriate unit. Wrong units included *N/cm* and *Ncm* (where the distance had been measured in metres).

(c) This part of the question was rather poorly answered. In part **(i)** and **(ii)** few candidates made any reference to either the weight of the block or the moment it produced. Very commonly, answers were imprecise and lacking in detail. A statement such as: *In Fig. 9.2 there is more weight on the right hand side* was typical of many less than satisfactory answers.

Answer: **(b) (ii)** 3.0 cm 0.30 Ncm

Question 10

(a) This part of the question was often well answered and many candidates scored full marks. Some candidates, however merely matched the colour of the insulation of the wire with the name of the corresponding pin. Such a candidate might well have realised that more was required here both from the wording of the question and from noting the allocation of four marks to this part.

(b) A not unusual confusion between the normal operation of the neutral wire and the earth wire was illustrated by those candidates who stated that the neutral wire was not needed in the plastic lamp as it does not carry any current. In **(ii)** most candidates stated that plastic is an electrical insulator but some wrote that an earth wire is not needed for a device which has a power of only 100 W. In **(iii)** few candidates produced the simple meaning of the term *100 W* but many were able to calculate the current drawn and hence to obtain an appropriate value for the size of the fuse required. Candidates who were unable to manipulate $P = VI$ accurately were penalised. It was, however, extremely satisfying to see the large number of candidates who were able to obtain the correct answer in part **(v)** and to score all three marks allocated.

Answer: **(b)(iv)** 0.5/1.0/2.0/3.0 A **(v)** 180 000 J

Question 11

(a) Most candidates who attempted this question scored well in this part of it. The correct time of travel was very commonly obtained, although some candidates did erroneously divide the speed by the distance. This illustrates a problem both of understanding and of algebraic manipulation. Encouragingly, many candidates were able to state two correct similarities and a difference between infra-red and microwave radiation. The Examiners did not, however, consider the fact that neither is visible to the human eye to be a sufficiently significant similarity.

(b) In neither **(i)** nor **(ii)**, did many candidates realise the role played by gravity. Only very rarely indeed was gravitational attraction referred to as the cause of the coming together of the dust and gas. Most of the candidates who answered this question stated that it was an electrostatic attraction between charged particles which was in fact responsible. Likewise, few candidates realised that clouds of gas and dust possessed potential energy of any sort before the collapse. Many types of energy were suggested somewhere – including both nuclear and chemical energy. A good number of candidates, however, realised that one relevant energy change was that from kinetic energy to thermal energy. On the other hand, a very large number of candidates suggested that a very high temperature was required to supply the energy to split up hydrogen nuclei and very few proffered the correct answer; only a minority related the rise in temperature to the increased velocity or the increased kinetic energy of the particles. The structure of the hydrogen-3 nucleus was known by most candidates but some candidates also included electrons in the nucleus and so failed to score full marks for this part of the question. In the penultimate part of **(b)** many candidates indicated that they were well aware that the product of nuclear fusion is helium although many other elements ranging from hydrogen to uranium were proposed by some. Most candidates were able to suggest a genuine effect of nuclear fusion in a star and thus to obtain the last mark.

Answer: **(a) (i)** 0.002 s

PHYSICS

Paper 5054/03

Practical Test

General comments

Generally speaking the candidates found the paper slightly harder than the paper that was set in November 2005. In particular the mark scheme for **Question 3** and the second half of **Question 4** were quite demanding. In **Question 3**, candidates were expected to use good experimental techniques to locate the images of pins in a plane mirror. These techniques were not used, for example candidates placed both the object and sighting pins close together rather than far apart. Few candidates mentioned that refraction would take place at the air-glass boundary in a plane mirror. At the end of **Question 4**, candidates had to describe the acceleration of the sphere. There was often confusion between velocity and acceleration e.g. a typical answer might state that the graph was a straight line showing increasing acceleration rather than constant acceleration, where the gradient of the graph decreased, candidates referred to deceleration rather than decreasing acceleration, etc. Examiners were very generous with the calculation of the average rate of change of velocity but there were still considerable errors. The word average obviously confused some candidates and they worked out the average velocity rather than the average rate of change of velocity. Any sensible change in speed divided by time was allowed but few candidates obtained a reasonable answer. Often units of speed rather than units of acceleration were used which meant that the final mark automatically fell.

Comments on specific questions

Section A

Question 1

(a) The diameter of the lens was frequently measured correctly but not all candidates scored the mark. The two most frequent mistakes were quoting the diameter to the nearest cm, e.g. 5 cm, or omitting units from the final answer.

(b) A good diagram could have scored the precaution mark. Examiners expected to see:

- The eye vertically above the edge of the lens where the reading was being taken on the scale – not vertically above the centre of the lens.
- Readings being taken across two perpendicular diameters.
- The use of set squares like the jaws of vernier callipers. Many candidates drew a correct diagram in part **(d)** but not here.

Examiners also allowed repeat readings taken in part **(a)** to score a mark here so many candidates obtained the part **(b)** mark for that reason.

(c) Generally candidates obtained a correct value for *T,* quoted the answer to the nearest mm or better and gave an appropriate unit. Examiners allowed a wide range so it was unusual for a candidate to lose a mark in this section.

(d) Good candidates correctly drew a diagram of the set squares being used like the jaws of vernier callipers. Some lost marks because the set squares were not in contact with one of the edges of the rule. Examiners allowed a diagram where the set squares were in contact with the centre of the rule, believing this to be a three D picture of the rule.

(e) Because of the large variation in the shape of the lenses, examiners allowed a large range of values for the values of *f*. Good candidates obtained a value in the allowed range but often lost the mark because the answer was not given with an appropriate unit. In some cases, it was almost as though candidates had deliberately decided that the answer should not have a unit rather than the careless omission of a unit.

Question 2.

(a) The first mark was often lost for the reasons described below.

- Units of current were quoted as A rather than mA, e.g. 5.0 A.
- Current values were incorrect by a factor of 10, e.g. 0.05 A or 0.5 A rather than 0.0050 A.
- Current or voltage measurements were not made to sufficient precision, e.g. 3 V or 5 mA rather than 3.0 V and 5.0 mA.

(b) The most common error here was either not converting mA to A when calculating resistance, or incorrectly converting mA to A, e.g. 5 mA = 0.5 A, etc. A number of weaker candidates did not know that $R = V/I$ and used $R = I/V$ or $R = I V$.

(c) & (d) Despite the loss of marks in **(a)**, on an error carried forward basis, marks were often gained in both **(c)** and **(d)**.

(e) To gain the mark in this section, candidates had to relate the change is resistance to the change in light intensity, simply re-stating the results did not get the mark e.g. when the LDR was covered the current decreased and the voltage increased did not get the mark.

Question 3.

Virtually all candidates gained the mark for the position of the normal and the angle of incidence. Although a small number of candidates set up the angle between the incident ray and the plane of the mirror. Hardly any candidates gained the practical skills marks which were related to using a large separation for the pins so that the rays could be drawn more accurately and the images could be sighted more accurately. Most candidates obtained a correct value for the angle of reflection, but only the better candidates could describe the refraction at the air-glass boundary.

Section B.

Question 4

(a) Most candidates obtained an acceptable value for *t*. There were three popular mistakes;

- Some candidates quoted times to the nearest second.
- Some candidates omitted units from the measured time.
- Some candidates obtained a time value outside the acceptable range even though Supervisors had been instructed to arrange the apparatus so that the sphere took approximately 2 seconds to descend the 80 cm along the ramp.

(b) Virtually every candidate scored the mark for the calculation of the speeds.

(c) & (d) The table of results gave good discrimination between candidates, with the most able candidates scoring all 5 marks and weaker candidates scoring 0. The best candidates used a wide range of values of *x* so that they obtained a wide range of *t* values. Candidates were instructed to use *x* values above 40 cm, so examiners expected a range of, say, 45 cm to 100 cm to be used. A number of candidates started at 45 cm but did not go beyond 80 cm. In some cases the 80 cm result was not tabulated or plotted resulting in a narrow range of, say 45 cm to 70 cm being used. Where candidates only had a small range of values, often only small increments of distance were used and this resulted in the values of *t* not showing a trend to increase as the values of *x* increased. Equally *v* should have increased as *x* increases and this may not have been shown if small increments of distance were used. Where the above ranges and trends were not used or found, then marks were lost. The general rule is that candidates should use as wide a range as possible when taking their measurements so that a greater difference between results is found.

(e) Graph plotting was not as good as in previous years. The recorded times were mainly between 1.0 s and 2.5 s and the calculated speeds were typically between 50 cm/s and 90 cm/s. This usually meant that the graph did not have to start at the origin. Quite a number of candidates therefore lost the scale mark. Candidates should realise that the plotted data should occupy more than half the page in both directions, graphs where the plotted data occupies a very small area of the page will lose the scale mark. Candidates should also appreciate that there are random errors involved in their measurements and so best fit curves should be drawn through the data and such curves do not have to pass through every point.

(f) Candidates confused the concepts of velocity and acceleration. A velocity-time graph that was a straight line was said to show increasing acceleration rather than constant acceleration. Where the graph was an S shape, candidates often talked about increasing acceleration but then failed to mention the section where the acceleration was decreasing. If the gradient of the graph reduced with time, this was often referred to as a deceleration rather than a decreasing acceleration, etc.

(g) Since examiners had asked for the average rate of change of velocity, we did not expect candidates to draw a tangent to the curve etc. Any sensible $(v - u)/t$ was allowed. Candidates could use any two points taken from the table, any triangle on the curve even if it had a curved hypotenuse, the gradient of a tangent to the curve, the gradient of the best straight line drawn through all the points, etc. Despite this very few candidates gained any marks in this section. Possible errors included working out the average velocity rather than the average rate of change of velocity, using the velocity unit for the rate of change of velocity, etc.

PHYSICS

Paper 5054/04
Alternative to Practical

General comments

Candidates achieved the full range of marks, from 30 to zero.

The majority of candidates entered for the paper showed that they had performed or seen many experiments in the laboratory during their course in Physics and they were able to draw on this when answering questions concerning the use of apparatus and practical procedures. The one exception to this was the question on the Cathode Ray Oscilloscope which proved to be challenging to the candidates.

Graphical work was generally well executed and candidates followed instructions well.

Numerical calculations caused some problems, particularly with finding a cube root and in quoting an appropriate number of significant figures.

It was pleasing to see more candidates writing within the spaces given for their responses in the questions and being more selective with their answers.

Comments on specific questions

Question 1

This question carried 6 marks and involved numerical calculations, namely taking an average and finding a cube root.

Many candidates scored full marks for this question.

Candidates lost marks by not reading the question carefully enough thereby not appreciating the practical details of the situation.

(a) (i) **27.8 cm^3**

Candidates were required to ring or indicate in some way the reading that was significantly different from the others in the list.

The majority of candidates gained this mark.

A very few did not indicate any reading or indicated two, thereby losing the mark.

(ii) The response 'due to parallax error in taking the reading' was suggested by many candidates and gained the mark.

Many candidates lost the mark by indicating in some way that the reading being taken was the length of the side of the prism. The units given are clearly cm^3 and the stem of the question states 'a displacement method is used'. Candidates need to be encouraged to read the stem of the question very carefully to avoid this type of mistake.

(iii) **24.6(5)**

The two marks here were for obtaining the correct answer, which could be rounded to 24.6 or 24.7.

Many candidates who did not obtain this answer gained a compensation mark for showing clear working of an average. Candidates should always be encouraged to show their working in questions of this type

Errors seen here included
- finding the average of all five volumes
- forgetting to divide by the number of volumes
- arithmetic errors
- rounding errors

(b) **3.84 cm**

Some candidates were unable to attempt this part of the question.

They were required to use their value for *V* found in **(a)(iii)** and substitute it into the equation.

Credit was given for rearranging the equation correctly even if the answer was not evaluated.

The final answer required a unit and a suitable number of significant figures. Since both the constant in the equation and the original values for V were given to 3 significant figures, three were required in the final answer.

Question 2

This question carried 12 marks.

The candidates were required to demonstrate an understanding of a timing experiment; to give practical detail of how such an experiment is carried out, plot a graph, take a reading from the graph and then describe the relationship shown by the graph.

(a) The responses to part **(a)** needed to be marked on the diagram. No credit was given for comments in the body of the question**.**

(i) A large number of candidates were unable to mark the height *h* accurately on the diagram. *h* was clearly defined in the stem of the question as 'the height of the centre of the wooden rod above the bench'. Almost every possible length of string or wooden rod was indicated by the candidates. Candidates need to be encouraged to read the stem of the question very carefully when answering this type of question. The commonest incorrect answer was the total length of the string.

(ii) This part question was testing that candidates knew that when timing a pendulum the eye must be positioned perpendicular to the plane of the swinging pendulum. It was easiest to do this on the right hand diagram and the eye could be positioned anywhere between the rod and the pendulum bob. Many candidates tried to draw a three dimensional representation on the left hand diagram which was inevitably ambiguous.

There was considerable variation in the symbol used to represent the eye. A dot labelled 'eye' was perfectly acceptable, as was the symbol showing a cross section through an eye used in ray diagrams. If this was used, however, it had to be looking towards the pendulum, not away from it.

(b) (i) Candidates were often ingenious in their descriptions of how to make sure the rod was horizontal. The most commonly seen correct answer was to measure the height of both ends of the rod above the bench. Credit was given to a range of suggestions.

(ii) Many candidates were able to explain that this would give more accurate values for *h* or *t*.

A common misunderstanding was that if the rod was not horizontal it must be vertical and then the string would not hit the rod. This was not credited.

(c) There was only one mark for this part question, so the required response was to time a number of swings (more than 10). Many candidates gave excellent answers here explaining how to obtain the value of t and then repeating it to find an average. Credit was not given for answers which implied that one swing was timed several times

(d) Candidates are now generally well prepared for graph plotting questions. Many excellent graphs were seen. Few candidates were unable to label the axes clearly with both quantity and unit, but the second mark for the scales was often lost by making the scale too small so the plotted points occupied a small region of the graph. Candidates should be encouraged to make their plotted points cover more than half of the graph paper.

The candidates were asked to draw a best fit curve and a surprising number drew a straight line. Candidates should be encouraged to practice drawing a smooth best fit curve as many still joined the points which did not score the fourth point.

(e) Describing a relationship between quantities from a graph causes difficulties for some candidates. In this question there were two marks available. The majority of candidates gained one mark for explaining that increasing h increased t. Additional information such as 'they are not directly proportional' was required for the second mark. Some excellent answers such as 'as h increases, t increases at a decreasing rate ' were given by able candidates.

(f) **16.5 cm**

The majority of candidates were able to read a value correctly from the graph, although the unit was required which lost the mark for some candidates. The most common error here was to misread the scale, giving answers such as 10.6 cm.

Question 3

This question carried 12 marks.

This was the most challenging question on the paper. Candidates were given a view of the screen and scales of a cathode ray oscilloscope and required to use the scales given to obtain information about the waveform shown.

(a) (i) **8 V**

Many candidates were able to find the peak voltage from the height of the trace (1.6 div) and the Y-input scale (5 volts/div). Credit was given here to candidates who measured the height of the trace in cm and used a scale of 5 volts/cm.

(ii) **6.7 ms**

Able candidates were able to find the time for one cycle by spotting that there are exactly 3 cycles on the screen i.e. in 10 divisions. Using the timebase scale of 2 ms/div gives 3 cycles in 20 ms. The use of one cycle only by some candidates gave an answer close enough to score the mark.

Some candidates were confused by the unit ms, thinking it was short for minutes.

(b) **150 Hz**

Credit was given here for the correct calculation of *f* using the answer found in **(a)(ii).** Unfortunately many candidates then lost the mark for an incorrect unit or powers of ten.

(c) (i) There were often good explanations seen here where candidates compared the new frequency of 15 Hz to the value they had obtained in **(b)**. Correct explanations were also given in terms of the difference in their period or the number of waves visible on the screen.

(ii) **10 (ms/div)**

Many candidates gave responses here that were not scale settings given on Fig. 3.1.

Question 4

This question carried 6 marks.

Many candidates scored full marks on this question.

(a) **15, 2.0 30, 3.1 60, 5.8 70, 6.4**

The majority of candidates were able to draw a table with correct headings and take readings of the plotted points from the graph.

Errors seen here includes:
- no units in the headings
- giving additional points from the graph e.g. (0, 0.8)
- misreading the scale, especially the 3.1 Ω reading.
- giving headings only (no values from the graph)

Some candidates gave additional columns for current and voltage readings. These were ignored.

(b) A range of answers were acceptable here.

Examples of good responses given by candidates were:
- take more than four readings
- repeat or check readings
- increase length by equal amounts each time e.g. 10 cm, 20 cm, 30 cm etc.
- use longer lengths

Many candidates gave answers which related to improving the accuracy of readings taken rather than obtaining a 'better set of readings'. These were not credited.

Candidates should be encouraged to give one suggestion in each of the sections given for the answer.

(c) Although there is still some confusion amongst some candidates over the meaning of 'directly proportional', many gave excellent responses. Most simply correctly stated that the graph line does not go through the origin, while others calculated the ratio of R/I for each value in the table and showed they were not the same.