PHYSICS

Paper 5054/11

Multiple Choice

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

General Comments

The results show that all the candidates had covered all sections of the syllabus well, but they are still less familiar with diverging lenses than converging lenses. Candidates would also benefit from further work on electrical safety.

The candidates found **Questions 20, 31** and **36** to be the most difficult.

Comments on Individual Questions

Question 20

The majority of candidates opted for B. The pressure of the gas rises because the gas **cannot** expand when it is heated. D is the correct answer because in this situation the gas is able to expand.

Question 31

Candidates are still unclear about the role of the earth wire and the fuse in electrical wiring.

Question 36

Each of the incorrect options attracted more candidates than the correct one, A. Some of this may be due to confusion between electron flow and 'conventional current'.

PHYSICS

Paper 5054/12

Multiple Choice

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

General Comments

The results showed that all sections of the syllabus had been well covered by the candidates. They are less familiar with diverging lenses than with converging lenses and their understanding of electrical safety measures could be improved.

The candidates found **Question 21** to be the easiest, while **Questions 16, 24** and **26** were the most difficult.

Comments on Individual Questions

Question 16

Half of the candidates opted for B. The pressure of the gas rises because the gas **cannot** expand when it is heated. D is the correct answer because in this situation the gas is able to expand.

Question 24

Almost the same number of candidates chose each of the options, suggesting that many were g[illegible] rather than knowing the answer.

Question 26

Many candidates are still unclear about the role of the earth wire and the fuse in electrical wiring.

PHYSICS

Paper 5054/21

Theory

General comments

The questions were accessible to all candidates and there was no section of any of the questions where a correct response was not seen. The standard of written English was high and there was no evidence of a language problem, even for the weaker candidates. The quality of expression, even among the weaker candidates was very good, even if the underlying physics was sometimes inaccurate. A small number of candidates were awarded very little credit, often as a consequence of leaving large sections of the paper blank.

The paper appeared to differentiate well between candidates of differing ability.

Where a question calls for extended prose, candidates should take time to plan their answer, and not list everything that they know about a topic. For example in **Question 10 (b)(iii)**, where candidates were asked to describe an experiment to investigate whether a sample of radioactive material emitted only beta-particles, many candidates did not approach this in a systematic way, but contented themselves with listing methods of detecting all three types of radiation.

Calculations were generally performed well and most candidates were able to quote a relevant formula, either in words or symbols and substitute correctly into it. Occasionally candidates who had performed a correct calculation lost credit by either omitting to give a unit or by giving an incorrect unit.

In ***Section B***, **Questions 8 and 10** were far more popular choices than **Question 9**, and those candidates who did choose **Question 9** tended to gain less credit for it. A minority of candidates ignored the rubric for ***Section B*** and answered all three questions. Candidates should be reminded to read the rubric carefully.

There was much evidence of candidates using more then the allotted number of dotted lines given on the paper to answer the questions, and then continuing their answers down the sides of the question paper and also on extra continuation sheets. In general, the number of dotted lines given on the question paper for a particular part of a question is an indication of the amount of space that the Examiners consider is needed to produce a full answer.

Comments on Specific Questions

Section A

Question 1

(a)

(i) Most candidates gave a correct response for the value of the time when the object was moving with a uniform speed. A single time was expected, but many candidates gave a range of times. As long as the range was correct, credit was awarded.

(ii) As in **(i)**, a single time or a correct range was accepted, although candidates found this to be more testing.

(iii) A correct value of the time at which the object was decelerating was supplied by the majority of candidates.

(b) Answers to this part were spoiled by incorrect reading of the graph scales. Most candidates realised that the area under the graph was required, but substitution of incorrect values of speed and time led many candidates to arrive at answers which were outside the accepted range.

Occasionally, candidates calculated the area under the whole graph instead of th[illegible] asked for.

Question 2

(a) The name of the force responsible for keeping Venus in its orbit was usually identified correctly as being gravitational/centripetal. A sizeable minority of candidates incorrectly identified the force as being centrifugal.

(b)

(i) The direction of the arrow was, in most cases, drawn to be tangential to the orbit instead of towards the Sun.

(ii) The calculation of the size of the force acting on the planet caused little difficulty. Some weaker candidates had trouble coping with the inevitably large powers of ten involved.

(c) This demanding final part was answered correctly by only the most able candidates. Very few candidates realised that the force acting on the planet was always at right angles to the direction of motion of the planet and so no work was done.

Question 3

(a) The *principle of conservation of energy* was almost invariably stated correctly.

(b)

(i) The most common misconception here was that the main energy change taking place in a cell was from electrical energy into heat/light. Answers that correctly started the energy change sequence with chemical energy were often spoiled by not confining themselves to the energy change in the cells. Many candidates who correctly wrote that chemical energy changes to electrical energy did not stop there, but went on to list other energy forms such as heat/light as well.

(ii) This part was well done, with most candidates giving heat and light as energy forms produced by the bulb.

(c) Completely correct answers to this part were rare. From the information provided, many candidates were able to state that the LED produced less heat than the filament lamp. It was much less common for candidates to then go on to state that since the torches were equally bright, the amount of light produced in the LED was the same as in the filament lamp. The majority of candidates incorrectly stated that, because the efficiency of the LED torch was higher, it gave out more light.

Question 4

(a)

(i) Many properties of electromagnetic waves were given in answer to this question. Unfortunately, the essential property that they can travel in a vacuum was very often missing.

(ii) The fact that television signals are transmitted via radio/microwaves was well known.

(iii) A common misconception was that radio waves transmitted by satellites travel faster than those transmitted by ground based transmitters. Only the more able candidates reasoned that there would be greater coverage, or less ground-based infrastructure needed.

(b) The correct formula for distance travelled was usually selected, and the correct answer usually obtained. Some candidates were troubled by powers of ten and made arithmetical errors in the simplification of their answers. A minority of candidates doubled the distance before substituting into the formula, presumably confusing this situation with previous ones they had met where the waves were reflected back to the detector.

Question 5

(a)

(i) The formula $P = VI$ for electrical power was well known, and this straightforward calcu[...] caused little difficulty. Some candidates made harder work of the calculation by [...] calculating the resistance of the heater and then going on to use one of the alternative versions of the electrical power formula. A sizeable minority of candidates incorrectly gave the unit of power as the Joule.

(ii) Although the formula *thermal energy* = *power x time* was well known, the most common error here was to forget to convert the 2 minutes into seconds, before substituting into the formula.

(b)

(i) Candidates who used the latent heat formula were generally successful here. A surprising number of candidates attempted to include the specific heat capacity of water in the formula used, although this information was not included in the question.

(ii) Many candidates were able to give one valid reason as to why the actual quantity of ice melted in two minutes may be less than the value calculated – this was by making reference to one specified heat loss e.g. to the air/glass/surroundings. Surprisingly, only a handful of candidates earned further credit by commenting that the ice may have been at a temperature of below 0 °C before heating commenced.

Question 6

(a)

(i) This proved to be the question that candidates found most difficult in ***Section A****.* Only the very able candidates were awarded full credit. Few candidates grasped the idea that the coil is a current-carrying conductor in a magnetic field and, as a consequence, experiences a force. Since the current in the coil is alternating, so is the force on the coil, and it is this alternating force that causes the cone of the loudspeaker to vibrate. Most candidates' attempts at this question were incorrectly based on electromagnetic induction. Candidates who embarked along an explanation based on electromagnetic induction were still able to obtain partial credit for realising that the coil behaved as a magnet when the current was passed through it.

(ii) Most candidates were able to relate the sound waves to compressions/rarefactions/pressure changes/longitudinal waves, to obtain partial credit here. Far fewer candidates began their answers by stating that it was the air around the cone that was set into vibration by the vibrating cone, to obtain full credit.

(b) The fact that a stronger magnet would produce a louder note was appreciated by most candidates. A sizeable minority of candidates thought that the frequency/pitch of the sound would change.

Question 7

(a)

(i) The mechanism of charging a capacitor through a resistance was not well understood. There was much confusion between current and charge, with some candidates thinking that current was stored in the capacitor. The question asked candidates to explain what happened to the potential difference across the capacitor as time passes. Even candidates who understood the process and explained that the capacitor was storing charges on its plates made no mention of the fact that the potential difference was increasing – and fewer still that it increased at a decreasing rate/to a maximum value.

(ii) Only the most able candidates realised that it was during the time that the capacitor was charging and the potential difference across its plates was increasing that the householder would be able to leave the house without setting off the alarm.

(b) The formula relating current, charge and time was well known by the majority of candidates. Although the actual calculation caused little trouble, a substantial number of candidates incorrectly rounded off the correct answer of 2.7×10^{-9} A to 2×10^{-9} A.

Section B

Question 8

(a)

(i) The weight of the driver was usually calculated correctly.

(ii) The formula *pressure* = *force*/*area* was used correctly by the majority of candidates. There was much confusion over units and, although the cross-sectional area of each piston was given as 35 cm^2, answers were invariably quoted with the unit Pa, although no attempt had been made to convert this area to m^2. Where candidates had attempted the conversion to m^2, it was rare to see this done correctly. Only the most able candidates realised that because there were four such pistons supporting the car, the calculated pressure for one piston needed to be divided by four to obtain the average increase in the pressure of the gas in the cylinders.

(b)

(i) The question asked for a detailed description of how the <u>molecules</u> of the gas exert a pressure on the cylinder, and yet many candidates attempted an explanation without any reference to molecules. Most candidates who correctly stated that the molecules of the gas collided with the walls of the cylinder omitted to state that this caused a <u>force</u> to be exerted against the walls, and consequently could not be awarded credit. For full credit the force of the molecular collisions needed to be linked to the area of the walls against which they collided, so that the link to pressure could be made. The very best candidates wrote eloquently, and scored full credit with ease.

(ii) Most candidates merely quoted Boyle's Law in an attempt to explain why the pressure increased at constant temperature, and made no attempt to give an explanation in terms of molecules.

(c)

(i) The fact that the speed/kinetic energy of molecules increases as a result of an increase of temperature was known by the majority of candidates. There was much reference made by weaker candidates to the gas molecules expanding – such answers gain no credit.

(ii) Although most candidates realised that the height of the car body above the ground would increase, few made reference to the fact that the gas in the cylinder had expanded. Fewer still stated that the collisions would be more violent at the higher temperature.

Question 9

(a)

(i) Only the most able candidates could apply the process of refraction to the situation given in the diagram, where the angle of incidence was 90°. In cases where the correct refracted ray had been drawn, the critical angle for light in water was often wrongly marked.

(ii) Very few totally correct answers were seen. Candidates did not realise that for an angle of incidence of 90°, the angle of refraction in water cannot be less than the critical angle and so the boy is unable to see the light if his eye is any closer to the pool wall.

(iii) The calculation of the refractive index was well done by the majority of candidates who attempted this question.

(iv) Many answers appeared to be guesswork. About one quarter of candidates stated that the wavelength of blue light was greater than that of red light.

(b)

(i) Most candidates struggled to give two further properties of the image in addition to the one given. The most popular correct answer given by candidates was a 'real' image. In many cases this was followed by the contradiction that the image was also virtual.

(ii) The straight line ray from R to its image was usually drawn correctly.

(iii) Many candidates found difficulty deducing that the position of the lens was w from R crossed the principal axis. The position of the lens was often marked a any point along the axis.

(iv) Candidates who tackled this part systematically, and used the instructions given in the rub were generally successful.

(v) Marks were lost here owing to inaccurate drawing of the rays, leading to answers for the focal length which were outside the tolerance allowed. Of those candidates who obtained a correct value for the focal length from their diagram, only a small minority remembered that the given diagram was drawn to a scale where 1 cm represents 12 cm, and that their measurement needed to be scaled up.

Question 10

(a)

(i) The proton number of the atom was almost always stated correctly.

(ii) The nucleon number was usually stated correctly. Where an incorrect number was given, it was usually the number of neutrons.

(b)

(i) The nuclear equation for the radioactive decay of the phosphorus atom was deduced correctly by many candidates. The most common errors/omissions were not knowing how to represent a beta particle, giving the symbol for an alpha particle instead of a beta particle, placing the beta particle on the wrong side of the decay equation and not making sure that the sums of the superscripts and the subscripts on both sides of the equation were equal.

(ii) Most candidates knew that a beta particle is an electron, for which they were awarded credit. Further credit was only earned for some further property, such as high energy/fast moving/from the nucleus or that it could cause ionisation.

(iii) Candidates who approached this experimental description methodically, and had structured their answers, generally scored better than those who gave a list of properties of radiations, without considering what they were asked to demonstrate. The best answers used absorption methods to eliminate alpha particles and gamma rays and to prove that the sample emitted beta rays only. Few candidates mentioned the need to account for background radiation in their experimental description. Candidates were able to score many of the marking points from a well drawn diagram.

(c)

(i) The standard bookwork explanation of the term ‘half life’ was not well known. Few candidates, even the more able, were awarded full credit. Most candidates knew that it was the time for something to halve, but very few gave a measurable physical quantity. Common misconceptions were that the half life is the time for a nucleus/atom/nuclide to halve, the time for the mass of an atom/nucleus to halve, and also that it was half the life of the radioactive material. All that was required was an answer based along the lines that it is the time taken for the number of atoms/nuclei/activity/count rate to halve.

(ii) Candidates met with a reasonable amount of success in tackling this decay problem. Those candidates who calculated that the second activity was a quarter of the first, or that two half lives had elapsed, usually obtained the correct answer. A number of candidates who realised this did not make the final step in the argument, and multiplied the half life by two to obtain the required time.

PHYSICS

Paper 5054/22

Theory

General comments

The candidates taking this paper seemed to realise what was being tested in the various questions and were nearly always able to deduce the part of the syllabus from which the appropriate equations and ideas should be obtained. It was comparatively rare for candidates to leave compulsory sections of the question paper completely blank or to attempt too few answers in ***Section B***. Likewise, few candidates tried to apply a formula or concept that was not appropriate in terms of the question asked. It was encouraging to see that even the most demanding sections of the paper attracted correct and detailed answers from the most able candidates. A certain number of candidates produced the occasional answer where ambiguity or inaccuracy led to credit not being awarded. Only a handful of candidates were significantly handicapped by their poor grasp of English. There were occasional slips from candidates who were in general good.

In calculations, the sensible approach followed by many candidates is to quote the formula, rearrange it if necessary, substitute the numbers given in the question and write down the correct answer quoted to an appropriate number of significant figures with the correct unit. Those few candidates who show little or no working out or who omit units are strongly advised to adopt the more sensible procedure.

It is very strongly suggested that candidates follow the instructions and write their answers in the spaces provided. All questions now have a specific answer space and the use of additional answer sheets or booklets is unnecessary. This has ensured that handing in and sorting out candidates' responses at the Centres is simpler and less prone to error. It is also the case that candidates seem less likely to leave out sections of the paper accidentally. Where it is necessary to cross out an answer and replace it, this should be done as neatly as possible. Where there is not enough space left for the new answer, candidates are advised to indicate the location of the replacement in the original space.

In ***Section B*** a choice of questions is offered. **Question 10** was chosen slightly less often than the other two questions and it is likely that some candidates were put off by the need to draw a scale diagram. The average mark scored on each of the three optional questions suggests that candidates found them to be of roughly similar difficulty.

Comments on Specific Questions

Section A

Question 1

(a) This part was almost always answered correctly with only a very small number of candidates offering the definition of acceleration instead of that of velocity.

(b)

(i) Many candidates gave the answer 3 m/s. 47 m/s was surprisingly infrequent.

(ii) The correct definition of acceleration was commonly given and many candidates correctly used a wrong answer from **(b)(i)** and were awarded partial credit.

(iii) This part was generally well answered. Candidates who applied $F = mg$ rather than $F = ma$ were not awarded credit here.

Question 2

(a) This part was usually well answered with many candidates being able to state two ap quantities.

(b)

(i) Many candidates scored full credit but a common error was to omit the value 0.066 from the calculation.

(ii) It was very encouraging to see this testing part of the paper well answered so frequently. Some candidates used a calculation involving the ratio 0.066/0.075 but this was sometimes used upside down.

Question 3

(a)

(i) Candidates should be encouraged to include the word *perpendicular* in the definition of *moment*. In addition to the correct use of 5.0 m in the calculation, both 12 m and 13 m were commonly seen here.

(ii) This calculation proved quite difficult for many candidates. Some repeated the confusion of distances and some simply quoted 840 N.

(iii) This part also proved hard and a correct third force was only occasionally presented.

(b) Many candidates scored well here; many were able to deduce and explain the manner in which the shiny jacket and the loosely woven T-shirt were able to insulate the firefighter. Credit was not awarded to those candidates who stated that shiny surfaces are poor absorbers and poor emitters of radiation. Although this is true, it is only the poor absorption property that helps to keep the firefighter cool. Similarly, referring to the conduction property of the shiny surface could not be a correct explanation.

Question 4

(a) This calculation was extremely commonly correct. A very small number of candidates obtained the correct 19.1 Ω but then rounded it off as 20 Ω; 19 Ω is the correct answer.

(b) The more able candidates related the increasing brightness of the lamp to its temperature and then deduced that the resistance of the filament was increasing. The majority, however, stated that the increasing brightness and the increasing current were caused by the resistance of the filament decreasing. This argument does not consider the decreasing resistance of the variable resistance.

(c) This part was often well answered; many candidates realised that limiting the current helped to protect the filament or the connecting wires from overheating.

Question 5

(a) This part produced a mixed response from the candidates. Some candidates were clearly familiar with this use of an oscilloscope and obtained the correct answer quite straightforwardly. Others need to be more familiar with the oscilloscope. There are several internet sites which can be used to help candidates if they cannot have direct access to oscilloscopes as often as one would wish. Those candidates who tried to use $v=f\lambda$ made the understandable confusion between an oscilloscope display and a wave and were unable to obtain the correct answer.

(b) This question tested a small part of the syllabus with which some candidates were unfamiliar. Some candidates scored full credit; others produced answers that scored less well. In a question such as this, candidates would be well advised to offer only three answers. Where more than three were offered, it was very common for a fourth or fifth suggestion to contradict a previous answer and cancel credit that had already been scored. An example of this was when the correct *they have equal frequencies* was followed by the statement that wave S has the higher pitch.

Question 6

A very large fraction of the candidates realised that this question was based on the magnetic prop the three materials and scored full credit. Some candidates considered the number of paper-clips li the time it took for the bars to be magnetised and were not awarded credit for this. Some answers to question suggest that there are a few candidates who are disadvantaged by a lesser fluency in English Such a candidate might have mentioned the magnetisation properties of the materials but made no reference to the paper-clips even though this was what was asked for.

Question 7

(a) Many candidates knew what was meant by *background radiation*. The most common source of error was to give answers in terms of infra-red radiation.

(b) There were many possible ways to tackle this question; however, a statement of a possible human activity with no description could not be awarded full credit.

Question 8

Although some candidates were able to give a clear and accurate explanation of star formation, many answers were poor. This is a part of the syllabus that candidates need to be more familiar with.

Section B

Question 9

(a)

(i)(ii) The inclination of the mirror at 45° to the horizontal led to some candidates being less certain of the procedure to follow. Many candidates correctly reflected one or two rays but a disappointingly small number went on to locate the image correctly or accurately. The angle of the mirror resulted in some candidates producing refraction diagrams of some sort.

(iii) Many candidates scored credit here but there were candidates who gave *virtual* as the first answer and then *real* as the second answer.

(iv) Many candidates gave the correct answer.

(b)

(i) Few candidates specifically stated the value of the constant required (the speed of light) although, for some candidates, the correct substitution into the correct formula enabled them to gain partial credit. A significant minority of candidates used the value 330 m/s which is the speed of sound and others were uncertain about the power of ten. Division by a power of ten with a negative index is an area where some candidates go wrong and 7.5 Hz was a common answer.

(ii) This was very commonly answered correctly with full credit being awarded. Errors here included giving the names of components with wavelengths greater than that of violet light.

(iii) Many candidates scored partial credit here. A correct use of one of the radiations was commonly identified and to some extent discussed but few candidates gave a sufficiently thorough discussion for full credit to be awarded. In **(iii) 2.** many candidates were able to state an appropriate health risk.

Question 10

(a)

(i) This was very commonly correct with just the occasional candidate who divided by ten or omitted the unit.

(ii) Many candidates did draw two correct arrows but it was disappointing to see candidates draw the weight arrow perpendicular to the slope.

(iii) It was good to see a few candidates scoring well here but very many more did n... r that candidates find drawing vector diagrams difficult and this was highlighted in ... the question. Some candidates who produced the correct vectors for the weight ... force exerted by the passengers drew the wrong diagonal of the parallelogram.

(iv) Some candidates knew that the resultant force on the bus was zero, but the most common answer was to quote the value obtained in **(iii)**.

(b) This was a difficult question and so it was very encouraging to see candidates scoring partial or even full credit here. Some candidates answered in terms of energy throughout rather than naming forces and some gave heat as the final form of energy in both cases.

(c)

(i)(ii) Many candidates scored full credit in this relatively straightforward question on distance/time graphs. Where errors occurred it was because the candidate was unfamiliar with what was expected. Some candidates plotted time on the *y*-axis or omitted the labels altogether.

Question 11

(a) Many candidates scored full credit here by explaining how the definition of e.m.f. was applied in this case. Some candidates simply stated the definition of e.m.f. in general terms and did not answer the specific question asked.

(b)

(i)(ii) A large number of candidates were familiar with the formulae needed here and scored full credit by writing the formulae down and substituting the correct numbers and concluding with the correct answers with the correct units.

(c)

(i) Although some candidates were able to draw a diagram of the structure of a transformer, others did not do so. The question asked for a labelled diagram and all but a very few candidates labelled their drawn diagram.

(ii) Very few candidates realised that this part of the question was seeking a numerical answer. Many simply stated that the turns ratio needed to be adjusted.

(iii) Many candidates knew the symbol for a battery or a diode but a surprisingly small number put both together in a series circuit linked to the a.c. supply.

(d) This relatively standard question on the advantages of a.c. transmission led to many good responses. Candidates who were in general familiar with the process might have been more direct in stating that a.c. is used because a transformer may only step up the voltage of a.c. There were, as always, candidates who stated that the resistance of the transmission line will be smaller when transmitting a current at high voltage. This is not the case.

PHYSICS

Paper 5054/31

Practical Test

General comments

There was better discrimination in **Section A** of the paper compared to **Section B**. In **Question 4** many candidates scored well by recording scale readings in order to determine the depression of the rule and plotted a good graph of the results.

Comments on Specific Questions

Section A

Question 1

(a) The majority of candidates were awarded full credit for the measurement of temperature. The two main sources of error were:

- the omission of units or the wrong units for temperature, typically ° rather than °C,
- a temperature rise that was too small. It was expected that the temperature would rise by at least 5 °C but a small number of candidates obtained rises as low as 3 °C.

(b) A large number of candidates did not know that the heat gained by the water was measured in joules. The units of specific heat capacity were often quoted instead of joules. Credit was given for correct numerical calculations and units or lack of units was ignored. A number of candidates made errors in calculations because:

- average values were determined for the specific heat capacities,
- the specific heat capacity of the *metal* was used when considering the heat gained by the *water*,
- the specific heat capacity of *water* was used when considering the heat lost by the *metal*.

The temperature of the Bunsen flame should have been found by adding the final temperature of the water to the fall in temperature of the metal. Very few candidates used this procedure; most were awarded credit for **(i)** and **(ii)** only.

(c) Most candidates appreciated that heat was lost but it was not always clear that the heat was lost when the mass was transferred from the Bunsen flame to the water. A number of candidates talked about heat being lost from the mass when it was being heated, others talked about heat being lost from the metal to the water but neither of these points gained credit.

Question 2

Some candidates drew a normal from the point M and placed an object pin O, 10.0 cm from M, but did not know how to use the sighting pins to find the position of the image. Some other candidates correctly drew the normal and O and used sighting pins to locate the image, but did not use the best experimental techniques. All candidates would benefit from more practise in experimental techniques.

The more able candidates drew the normal and O and used sighting pins to locate the image but also used the following techniques:

(a) Placed the sighting pins along a particular ray a long way apart e.g. at least 5.0 cm apart.

(b) Used rays on opposite sides of the normal and quoted the length of the line from I to [obscured] the nearest mm. Such candidates were likely to achieve full credit.

Question 3

(a) The switch, the capacitor and the voltmeter were in parallel with each other. The resistor and the power supply were then in series with this arrangement. Unfortunately a number of candidates drew the switch in series with the resistor and the power supply and this was not correct.

(b) The time taken to charge the capacitor to 2.0 V should have been in the region of 50 s. If the voltmeter used did not have a high resistance, then this time would have been longer. In the mark scheme, a time of up to 99 s was allowed. A number of candidates were misreading the stopwatch. An answer such as 1.10 s or even 1.10 minutes was more likely to be 70 s, i.e. 1 minute and 10 seconds. Since an average value for the time was required, it was expected that candidates would repeat their measurements but only the more able candidates did this.

(c) When the time for the capacitor to charge to 1.0 V was determined, the majority of candidates obtained the correct answer. Again, repeated measurements were expected.

(d) The ratio calculation was solely based on the candidates' measurements; no particular range of values was required. Many candidates were not awarded credit and there were 2 reasons for this:

- the ratio was given with units of seconds but it should have no units,
- the ratio was quoted to too many significant figures.

Section B

Question 4

(a) The set square should have been placed between the floor and the vertical metre rule in order to check that the rule was vertical. It was not always clear that one edge of the set square was in contact with the floor.

(b)(c) Many candidates gave correct answers to **(b)** and **(c)**. Most candidates showed the scale readings that enabled them to determine the two *y* values, measured those scale readings to the nearest mm and correctly recorded the mass values.

(d) Examiners expected stiff wooden metre rules to be used and so expected a maximum deflection somewhere in the region of 10 cm with the results producing a linear graph. In some cases Centres seemed to have used very flexible rules, possibly plastic, which gave deflections up to 50 cm and usually produced a graph that was a smooth curve. The mark scheme allowed for both types of graph to be produced and a large number of candidates obtained full credit for this section.

(e) Graph work was generally good. The most common error was in drawing the straight line or smooth curve. Lines should be thin and, if the graph is a straight line, candidates should use a 30 cm ruler rather than a 15 cm ruler to draw the line. This ensures that there are no kinks in the line where two short lines have been joined.

(f) Able candidates were awarded full credit for the gradient. Weaker candidates made the following mistakes:

- used 2 points on a curved graph to find the gradient - if the line is a curve, then a tangent should be drawn to the curve and the gradient of the tangent should be found,
- used a small triangle to find the gradient - the base of the triangle used to find the gradient should occupy at least half of the page in the appropriate direction,
- calculated a value to either 1 or more than 3 significant figures.

PHYSICS

Paper 5054/32
Practical Test

General comments

There was better discrimination in **Section A** of the paper compared to **Section B**. In **Question 4** many candidates scored well by recording scale readings in order to determine the depression of the rule and plotted a good graph of the results.

Comments on Specific Questions

Section A

Question 1

(a) The majority of candidates were awarded full credit for the measurement of temperature. The two main sources of error were:

- the omission of units or the wrong units for temperature, typically ° rather than °C,
- a temperature rise that was too small. It was expected that the temperature would rise by at least 5 °C but a small number of candidates obtained rises as low as 3 °C.

(b) A large number of candidates did not know that the heat gained by the water was measured in joules. The units of specific heat capacity were often quoted instead of joules. Credit was given for correct numerical calculations and units or lack of units was ignored. A number of candidates made errors in calculations because:

- average values were determined for the specific heat capacities,
- the specific heat capacity of the *metal* was used when considering the heat gained by the *water*,
- the specific heat capacity of *water* was used when considering the heat lost by the *metal*.

The temperature of the Bunsen flame should have been found by adding the final temperature of the water to the fall in temperature of the metal. Very few candidates used this procedure; most were awarded credit for **(i)** and **(ii)** only.

(c) Most candidates appreciated that heat was lost but it was not always clear that the heat was lost when the mass was transferred from the Bunsen flame to the water. A number of candidates talked about heat being lost from the mass when it was being heated, others talked about heat being lost from the metal to the water but neither of these points gained credit.

Question 2

Some candidates drew a normal from the point M and placed an object pin O, 10.0 cm from M, but did not know how to use the sighting pins to find the position of the image. Some other candidates correctly drew the normal and O and used sighting pins to locate the image, but did not use the best experimental techniques. All candidates would benefit from more practise in experimental techniques.

The more able candidates drew the normal and O and used sighting pins to locate the image but also used the following techniques:

(a) Placed the sighting pins along a particular ray a long way apart e.g. at least 5.0 cm apart.

(b) Used rays on opposite sides of the normal and quoted the length of the line from I to the nearest mm. Such candidates were likely to achieve full credit.

Question 3

(a) The switch, the capacitor and the voltmeter were in parallel with each other. The resistor and the power supply were then in series with this arrangement. Unfortunately a number of candidates drew the switch in series with the resistor and the power supply and this was not correct.

(b) The time taken to charge the capacitor to 2.0 V should have been in the region of 50 s. If the voltmeter used did not have a high resistance, then this time would have been longer. In the mark scheme, a time of up to 99 s was allowed. A number of candidates were misreading the stopwatch. An answer such as 1.10 s or even 1.10 minutes was more likely to be 70 s, i.e. 1 minute and 10 seconds. Since an average value for the time was required, it was expected that candidates would repeat their measurements but only the more able candidates did this.

(c) When the time for the capacitor to charge to 1.0 V was determined, the majority of candidates obtained the correct answer. Again, repeated measurements were expected.

(d) The ratio calculation was solely based on the candidates' measurements; no particular range of values was required. Many candidates were not awarded credit and there were 2 reasons for this:

- the ratio was given with units of seconds but it should have no units,
- the ratio was quoted to too many significant figures.

Section B

Question 4

(a) The set square should have been placed between the floor and the vertical metre rule in order to check that the rule was vertical. It was not always clear that one edge of the set square was in contact with the floor.

(b)(c) Many candidates gave correct answers to **(b)** and **(c)**. Most candidates showed the scale readings that enabled them to determine the two *y* values, measured those scale readings to the nearest mm and correctly recorded the mass values.

(d) Examiners expected stiff wooden metre rules to be used and so expected a maximum deflection somewhere in the region of 10 cm with the results producing a linear graph. In some cases Centres seemed to have used very flexible rules, possibly plastic, which gave deflections up to 50 cm and usually produced a graph that was a smooth curve. The mark scheme allowed for both types of graph to be produced and a large number of candidates obtained full credit for this section.

(e) Graph work was generally good. The most common error was in drawing the straight line or smooth curve. Lines should be thin and, if the graph is a straight line, candidates should use a 30 cm ruler rather than a 15 cm ruler to draw the line. This ensures that there are no kinks in the line where two short lines have been joined.

(f) Able candidates were awarded full credit for the gradient. Weaker candidates made the following mistakes:

- used 2 points on a curved graph to find the gradient - if the line is a curve, then a tangent should be drawn to the curve and the gradient of the tangent should be found,
- used a small triangle to find the gradient - the base of the triangle used to find the gradient should occupy at least half of the page in the appropriate direction,
- calculated a value to either 1 or more than 3 significant figures.

PHYSICS

Paper 5054/41

Alternative to Practical

General comments

The aim of the examination is to enable candidates to display their knowledge and understanding of practical physics techniques. These include:

- graph plotting,
- tabulation of readings,
- manipulation of data to obtain results,
- drawing conclusions,
- dealing with possible sources of error,
- control of variables.

The general level of competence shown by the candidates was sound. Candidates are to be reminded that this paper should be approached from a practical perspective; it is not a theory paper. Most candidates attempted all sections of each of the questions and there was no evidence of candidates suffering from lack of time. Many candidates dealt well with the range of practical skills being tested. The more able candidates followed instructions, recorded observations clearly and performed calculations accurately and correctly. Units were well known and usually included where needed, writing was legible and ideas were expressed logically.

Comments on Specific Questions

Question 1

(a)

(i) In the majority of instances, the ruler used to measure h_0 was drawn correctly, close to the end of the clamped ruler and perpendicular to the floor. Some candidates positioned their ruler too far from the end of the clamped rule for accurate measurement of h_0 to take place.

(ii) Most candidates drew the eye in a correct position, looking towards the rule. Occasionally, candidates had the eye in the correct position, but looking away from the rule.

(b)

(i) The table was filled in correctly by the majority of candidates. Some candidates did not heed the information given at the head of the table, namely that $d = h_0 - h$ and incorrectly subtracted each value of h from the one immediately above it.

(ii) The standard of graph plotting continues to improve and most graphs produced by candidates were neat and made maximum use of the grid supplied on the question paper. Sensible scales were usually chosen, points plotted accurately and neat best fit lines drawn. The best fit line for this particular graph did not pass through the origin, though some candidates contrived to make their lines pass through the origin. Candidates should be encouraged to check that the lines that they draw are the best fit for the data they have plotted.

(iii) The candidates who had drawn appropriate lines of best fit were able to comment correctly that d and m were not directly proportional because their line did not pass through the origin. A sizeable minority of candidates gave explanations which did not correspond to the graph that they had drawn.

(c)

(i) Most candidates were able to obtain a value for the gradient of the graph which the levels of tolerance allowed. Where candidates were not awarded full credit t ignored the instruction to show their working clearly or had not used at least half the g the calculation.

(ii) Candidates were required to extract information from the given diagram and subtract two distances. Many candidates appeared to be confused by the manner in which the information was presented, and subtracted the wrong values.

(iii) This substitution of values of quantities already determined in earlier parts of the question into a given equation was done correctly by the majority of candidates. Those who had earlier calculated these quantities incorrectly were not penalised further because Examiners applied the 'error carried forward' procedure.

Question 2

(a)

(i) The calculation of the average time for the wave to travel 5.0 m was performed correctly by the vast majority of candidates.

(ii) The formula for average speed was well known, and the arithmetic was nearly always carried out correctly. Large numbers of candidates, who had carried out the calculation correctly, did not give their answer to a suitable number of significant figures, as requested. It was common to see the answer given incorrectly to four significant figures, when the data was presented to 2/3 significant figures.

(b)

(i) This proved to be the one of the most demanding parts of any question on the paper. Only a small minority of candidates realised that the students needed to be in line with the end of the rule to stop the parallax error occurring. Merely stating that the students were not looking perpendicular to the rule was insufficient. Credit was awarded to candidates who realised that an error would also be caused by the large distance between the rule/spring and the students.

(ii) This part also proved difficult for candidates, but answers were better than to the previous part. Many candidates did not realise that because of the positions in which the students were standing they would start the stopwatches after the wave had passed the start, and stop them before the wave had got to the other end – both of which would contribute to making the measured value of t too small.

(iii) Most candidates appreciated that the variation in the times recorded was due to the fact that the students had different reaction times, even if this was expressed somewhat unclearly.

(iv) Only a small minority of candidates were able to suggest how the time could be measured more accurately. Credit was awarded to answers that suggested how the stopwatches could be started more accurately, e.g. a student should stand at the start of the spring/rule. Credit was also awarded to answers that suggested how the stopwatches could be stopped more accurately, e.g. the student at the far end shouts 'stop' when the wave reaches him/her. Many candidates thought, incorrectly, that the students could measure more accurate times by standing closer to the rule.

(c) Again, few candidates were able to make a sensible suggestion as to how the wave pulse could be made to travel more slowly along the spring. The most common incorrect answer was to increase the tension in the spring, whereas in fact the opposite is true. More able candidates correctly suggested that the spring could be immersed in water or oil, or that the teacher should be closer to the candidate.

Question 3

(a) It was apparent that the standard method of measuring the resistance of the thermistor (ammeter and a voltmeter) was poorly known and understood. The more able candidates awarded full credit for connecting the ammeter in series with the thermistor and a power supply a connecting a voltmeter in parallel with the thermistor. It was common to see voltmeters connected in series in the circuit, and occasionally ammeters were seen in parallel with the thermistor. Alternative circuits containing ohmmeters were also given full credit as long as there was no power supply connected in addition to the ohmmeter.

(b) The Examiners expected that the thermistor would be immersed in a water bath, with some means of heating the water bath. A thermometer also immersed in the bath would then be used to record the temperature of the water/thermistor. Only the most able candidates scored full credit here. Many candidates showed the thermistor being heated in air with no means of measuring its temperature. Some candidates suggested heating the thermocouple in an oven and using a thermocouple to record the temperature, for which they received credit.

(c) Again, only the most able candidates could explain why the resistance of the thermistor needed to be measured at more than two different temperatures to be able to plot a graph of resistance against temperature. Very few candidates appreciated that more than two values are needed so that the shape/curve of the graph can be determined and a decision made as to whether or not the graph is linear. Most candidates made vague references to accuracy of the readings, for which they received no credit.

Question 4

(a) Candidates used diagrams to very good effect in this question to suggest methods, often ingenious, of pushing the pencils into the modelling clay with the same force. Most correct answers produced the force by balancing some weight/mass on the top of the pencils, and ensured that the force was the same in each case, by using the same weight/mass. Other correct methods involved dropping the pencils from a constant height onto the modelling clay.

(b) A large minority of candidates did not appreciate that the greater pressure at the pointed end would push that end further into the modelling clay. Many candidates incorrectly thought that, because the force was the same in both cases, the pointed end and the flat end would sink equally deeply into the modelling clay.

PHYSICS

Paper 5054/42

Alternative to Practical

General comments

All marks on this paper were gained by some candidates, although no candidate was awarded full credit. The majority of candidates were well prepared for the paper and able to answer questions on the practical aspects of a range of experimental situations.

The numerical work involved taking readings from a newton-meter and measuring an object. Most candidates were able to answer these questions easily, but some gave answers that bore no resemblance to the question, e.g. for measuring the diameter of the coin (d = 2.6 cm), answers of 9.42 cm and 8.17 cm were seen.

When answering numerical questions, candidates should be advised not to change answers by overwriting as this can often lead to confusion. If they change their mind, they should cross out their original answer and re-write the answer clearly.

Drawing graphs is a very important part of practical work and on this paper there were fewer instances of candidates unable to attempt the graph. The points on a graph can be plotted to 3 significant figures, and some candidates did not do this, e.g. plotting 2.0 instead of 2.07 and so were not awarded credit. Other candidates had difficulty plotting the graph as they only wrote two values on the axes. The more values they write on the axes, the easier it is to plot the points and the less chance there is of making a mistake.

The choice of equipment to use in a specified situation is a skill which most candidates use automatically without realising it. Others do not think about it as they use the apparatus provided. This skill was tested here in **Question 2(a)** and caused some difficulty even for the more able candidates.

The ability to express practical points clearly is an important feature of practical work and many candidates still find it difficult to explain an experimental method or how they would take readings in a logical way.

There was no evidence of candidates having insufficient time for the paper. There were many instances of candidates checking through and correcting errors.

Overall the standard of candidate responses is pleasing and candidates are showing more ability to answer the questions in the context of the practical situation given, rather than relying on stock answers which are not relevant to that situation.

Comments on Specific Questions

Question 1

(a) There were a wide range of acceptable answers here. Many candidates gained credit by clearly drawing additional apparatus on Fig. 1.1. Written responses were often unclear or insufficient, e.g. ‘measure the distance from the bench’ or ‘use a ruler’, so candidates should be encouraged to use diagrams in this type of question.

A common response which was not credited was a vague use of set squares e.g. a single set square sitting on rule A.

(b) This part question was poorly answered. Candidates found it difficult to describe in words how they would ‘check that the two strings are equal distances from the centre of metre rule B’. Some confused metre rule A and B. The responses allowed them either to use an additional rule or tape measure to measure them, or to use the markings on the rule to calculate the distances.

A common mistake was to measure the lengths of the strings.

(c)

(i) The candidates were asked to draw on Fig. 1.2 here. However, many drew on Fig. 1.1 which was immediately above the question, so on this occasion this was accepted. Candidates should be reminded to follow the instructions carefully in future papers. The commonest incorrect response here was to draw the eye at the centre of the rules.

Many candidates drew an 'optics eye' which is acceptable as long as it is looking towards the rule. A dot labelled eye is the simplest response.

(ii) Few candidates gained full credit here, although most gained partial credit. The marks available should inform candidates that a detailed answer with three clear points is required.

T is the time for one oscillation, so just timing *N* oscillations is insufficient; it must be divided by *N* to give a value for *T*. Again, just repeating a reading is insufficient; the average must also be taken. Credit was awarded for a good practical point, such as use of a fiducial marker. A common answer that did not gain credit was simply 'use a stopwatch'. A surprising error is that some candidates calculated N/t_N instead of t_N/N.

(d)

(i) The graph work was generally good with many candidates gaining full credit.

The most common error was not starting the graph at the correct values as given in the stem of the question. Again, reading the question carefully and following instructions is important.

The quality of the curve drawn by candidates was generally good. Those who filled the graph grid had a more difficult task in producing a larger curve so this was taken into account.

Many candidates mis-plotted one or more points and these should always be carefully checked. There are still some candidates who, when faced with one point which is far away from the best fit line through the other points, detour the line to the incorrect point rather than check the plotting.

(ii) In this part question the candidates were asked to 'use data from the table'. This required the values to be quoted in the answer. Good candidates clearly showed that $T \times d$ was the same for two sets of values.

Many candidates incorrectly think that all inverse graphs are inversely proportional. They just stated that as *d* increases *T* decreases, which is insufficient for full credit.

(iii) This part question required candidates to think about extending the experiment and the consequences of using a smaller distance. This question was below the graph on the question paper, so it is surprising that many candidates thought that the time would become smaller rather than larger. Some candidates gained credit for comments that the rule would be difficult to oscillate with the strings close together.

Question 2

(a) This part question was poorly answered, with the majority of candidates believing incorrectly that the stopwatch was the better instrument to use as it would be more accurate or read to 0.01 s. This is true but not relevant to the experiment.

Responses concerning reaction time or implying that the stopwatch was started and stopped after each minute were not credited.

Several able candidates gave clear answers stating that the time measured was large (or readings every minute) so the wall clock was the better choice.

Answers referring to the stopwatch had to be justified by it being held close to the apparatus.

(b)

Many candidates gained full credit here. It is better for candidates to write the name of t in the table heading rather than just the symbol, especially in this situation where both given the symbol *t* or *T*. The use of the same symbol for both quantities was not credited.

The units required were minutes (min) and °C. It is not good practical procedure to convert the time to seconds when measuring the temperature for 30 minutes. Fewer candidates wrote the unit for temperature incorrectly than in previous papers.

(c)

(i) Few candidates could take the information in the stem of the question and produce a realistic graph to gain full credit.

Credit for the general shape of the graph was gained by about half the candidates. The graph will be a smooth curve becoming horizontal. Many candidates drew two straight lines.

Further credit was for starting the graph at a temperature above zero. Many candidates started the graph at the origin. Some candidates appear to have very high room temperatures, but this was not penalised.

Credit was also available for adding values of temperature and time where the graph becomes horizontal. This was the most commonly awarded marking point of the three.

(ii) Few candidates appreciated that the energy gained from the heater was equal to the energy lost to the room. Candidates were given credit for realising that the heater was not powerful enough to raise the temperature any higher.

Common incorrect answers were that the water had reached its boiling point or that the water was not pure.

Question 3

(a) Most candidates were able to read the scale of the newton-meter accurately as 1.5 N. A large range of answers were seen, from 0.5 N to 200 N. The most common incorrect answer was 2.5 from reading the scale in the wrong direction.

(b) Again, most candidates were able to measure the diameter accurately although some answers bore no resemblance to the coin.

(c) Although more able candidates gained full credit here, many gained only partial credit by giving insufficient detail. They tended to either describe the measuring instrument in great detail or describe how to obtain the average thickness by measuring more than one coin.

(d) The majority of candidates were able to calculate the density correctly from their values in **(a)** and **(b)**. The most common error was to fail to square the diameter.

(e) The majority of candidates were able to both state and explain their answer. This depended on their answer to **(d)**. Some weaker candidates did not seem to understand the concept of density and there were comments about dividing by 20 as there were 20 coins.

Question 4

(a) This part question was generally well answered with about half the candidates gaining full credit.

The candidates were required to draw a diagram showing how the apparatus was used, to describe the practical procedure and then how the result was obtained.

For credit to be awarded, the procedure described by the candidate must work. Some candidates therefore gained no credit for describing how to plot the magnetic field using a plotting compass. Credit could only be awarded only if they clearly placed the second magnet in the same place.

Many candidates incorrectly thought that time was important here and if they left a magnet near some paper clips then the longer they left it the more paper clips it would attract.

Some candidates gave no explanation of how they would perform the experiment. Som of how the experiment was a 'fair test' gained credit, e.g. 'the magnets were placed th distance from the paper clips'. A few candidates did not clearly state how the results showed was the stronger magnet, by just plotting a graph or stating 'the experiment will show which is stronger'.

(b) Many clearly understood the principle that only the two magnets can repel and the iron bar will always attract. There were many excellent answers, and good explanations. Some candidates thought the iron was non-magnetic. The most common error was to use additional equipment such as paper clips or another magnet.