PHYSICS

GCE Ordinary Level

Paper 5054/01
Multiple Choice

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

General comments

The mean score for this paper was 20.1 out of 40 (50.3%) and the standard deviation was 17%. In general the responses were good throughout the paper, indicating that the candidates had been well prepared on all topics. **Question 3** was found to be very easy.

Comments on specific questions

Question 1

The best candidates chose the correct option but the largest number chose **C**, forgetting that being 11 dots apart represents 10 time intervals.

Question 7

A number of the better candidates chose **C**. Consideration of the range of possible resultant values leads to the correct option.

Question 9

Over 60% of the candidates gave the answer **B**, the work done on the box, instead of the work done against friction.

Question 14

Half of the candidates chose the units of specific heat capacity.

Question 27

This question discriminated well but many candidates chose **D**, possibly because it contained reciprocals.

Question 32

Similar numbers of candidates chose each option, suggesting an element of guesswork.

Question 35

Few of the candidates chose the correct option, the majority opting for **C**. Some of this may be due to unfamiliarity with spark counters, although they should be aware that ionisation is needed to allow sparking. There is a common misconception that all decay emissions are radioactive.

Paper 5054/02

Theory

General comments

Whilst the paper was of an appropriate standard, ***Section A*** was a little more demanding and ***Section B*** a little less demanding than normal. The overall result was that mid-range scores were more easily achieved, but, with some major challenges in the compulsory section, there was enough material to challenge the ablest candidates. The three questions in ***Section B*** were almost equally demanding and produced a similar proportion of marks for the average candidate. Although **Question 11** was more popular it did not generally produce higher marks for the average or above average candidate. The overall performance of the candidates did not appear to depend on which questions were chosen in ***Section B***.

The vast majority of candidates answered two questions in ***Section B***, with a few candidates attempting all three questions. Answering three questions is not to be recommended if each of the three questions is rushed, as the best two marks only are counted.

The paper contains a number of numerical questions where candidates are asked to state the formula that they use. A number of candidates merely quoted a numerical formula and where the numbers used were incorrect no credit could be awarded. The algebraic formula should be given as the first step in a numerical answer and after that the numbers can then be inserted. If questions are attempted in this way then the maximum credit is earned where there are any mistakes. Answers to numerical questions should, ideally, be quoted to the correct number of significant figures. An answer given to the wrong number of significant figures was only penalised in **Question 3**.

Comments on specific questions

Section A

Question 1

The vast majority of candidates knew that acceleration and velocity were vector quantities. In **(b)** answers usually correctly stated that the forces had to act in the opposite or the same direction in the two sections. Diagrams given by candidates to explain their meaning were helpful in (**i**) and **(ii)**. Statements that related the forces to one side or the other of an object, rather than mentioning directions, were often unclear. The diagram expected in **(iii)** was either a completed parallelogram or a triangle with a 60° angle between one of the forces and the resultant. It was pleasing to find many candidates realising that an equilateral triangle was the correct diagram and most gave the correct direction of the resultant.

Question 2

Very few candidates failed to give the correct answer to **(a)**, but in **(b)** many candidates gave 91.7 or 78.6°C as their answer. Although they realised the proportionality involved in the calculation, they failed to use the correct distances, 24 cm or 18 cm, measured from the lower fixed point. Very few candidates gave an acceptable answer to **(d)**. Possible physical properties include resistance, voltage, pressure and even colour. Candidates often commented on some property of mercury, such as its even expansion or high boiling point.

Answers: **(a)** 0°C; **(b)** 75°C; **(c)** 240J.

Question 3

Most candidates were awarded the first mark in **(a)**, but clearer labelling would have been helpful in some cases. In **(ii)** most answers showed enough evidence that the coils of the spring or molecules in air are closer in a compression. Only the better candidates gained full credit in **(iii)**. There was confusion between the oscillation of the particles and the movement of energy indicated by expression such as "particles travel parallel to the wave". Correct answers correctly described the features of longitudinal waves in terms of the oscillation of the particles, backwards and forwards, in the same direction as the motion of the wave or in the direction of energy transfer. There was some leniency allowed for in the measurement of the wavelength in **(b)**, but many candidates appeared to measure the distance between adjacent coils of the spring or miscounted the number of waves when measuring more than one wavelength. The formula in **(ii)** was usually quoted correctly and full credit earned for the calculation, although the correct unit for frequency was sometimes omitted. The question asks for the answer to be given to the correct number of significant figures. In this case 2 or 3 figures was usually acceptable as the value given for the wavelength was usually quoted to 2 significant figures. Only a few candidates quoted their answer to an unacceptable degree of accuracy.

Answers: **(b)(i)** 2.6-3.0 cm, **(ii)** 25-29 Hz.

Question 4

The measurement of the focal length should have been from the centre of the lens to the place where the rays would converge having passed through the lens. The range of acceptable answers was chosen in **(a)** to exclude candidates who measured from the centre of the lens to the bottom of the plastic disc. A large number of candidates had difficulty in applying the scale conversion and either failed to divide the actual measurement by ten or actually multiplied it by ten. A penalty for misusing the scale factor was only applied in **(c)(ii)** and so misuse of the scale factor only earned a penalty of one mark in the whole question. In **(b)** recognising that the light was refracted or bent as it entered the plastic was sufficient for the first mark but other effects on light, such as the reduction in speed or wavelength, were only given by the better candidates who gave detailed answers. It was considered that merely stating that light moves into a denser medium was not describing what happens to the light itself. Correctly refracted rays were almost always drawn in **(c)**, but the second mark was often not awarded because the correct scale factor was not used. Most candidates realised that the distance between lens and disc must increase in **(d)**, but lowering the disc was an unacceptable answer.

Answers: **(a)** 2.6-2.9; **(c)(ii)** 0.5-1.2 mm.

Question 5

In **(a)** the numerical answer was given in the question and, as a consequence, full marks were not awarded without a correct statement of the formula relating power, current and voltage. A surprising number of candidates failed to give 1.25 mm as the smallest diameter of wire that can be safely used. In **(b)(ii)** few candidates gave a complete explanation involving an increased resistance of the wire, the wire overheating and possibly melting or causing a fire. In **(c)** many candidates did not answer the question and explained how a fuse blows, rather than explaining what fault within the flexible cable causes the fuse to blow. Better candidates correctly identified that the live wire must touch the neutral or earth, possibly because the wire's insulation has been damaged.

Answer: **(b)(i)** 1.25 mm.

Question 6

A high proportion of candidates scored full marks in **(a)**, although spurious lines that do not go from the positive in the cloud to the negative earth were surprisingly common. Candidates in **(b)** usually realised that either the negative charge in drop 1 flows to drop 2 or stated that the charges in drops 1 and 2 that are in contact neutralise each other. Some candidates stated that the drops were neutral without explaining the neutralisation process that occurs. The better candidates correctly stated that drop 1was positive and drop 2 negative in **(ii)**. It was pleasing to find so many candidates producing correct definitions in **(c)**. Even those who did not know the definition tried to answer in energy terms, as requested in the question, and many were successful with non-standard but correct definitions.

Question 7

This was a straightforward question on electromagnetic induction. In **(a)(i)** most candidates made sensible references to magnetic flux or field lines but often it was not clear that these field lines had to cut through the coil, in some form, for the current to be produced. Although the answers to **(b)(i)** and **(ii)** are easy, many candidates reversed the answers and stated that nothing happens when the magnet is removed. It was required in **(b)(ii)** that a current or needle deflection in the reverse direction should be given as the answer and good candidates also stated that the deflection would only be brief. In **(ii)** a little more explanation would often have made it clear that the candidate intended to say that the meter reading or current remained at zero.

Question 8

Many candidates scored only a few marks in this question. In **(a)** there was often only a statement that radioactivity involves the emission of alpha, beta or gamma particles, but to earn full marks more information was required, e.g. that the nucleus is unstable and decays at random or spontaneously to emit particles. In **(b)** the majority of candidates correctly explained that gamma particles are able to penetrate through hospital equipment, but, as a second property, they often stated that gamma particles have the least ionisation. The other property expected was that the gamma particles are able to kill bacteria and viruses. Answers to **(c)** showed a clear understanding that radiation is dangerous to the human body, by for example causing cancer. However it was disappointing that almost all candidates failed to explain why radioactive sources should be held away from the body. Candidates appeared to think that, having explained that radioactivity is dangerous, they had fully answered the question. Few candidates clearly explained that the particles spread out and so miss the body if it is at a distance, or that the air may absorb some of the radiation, particularly if it is alpha or beta radiation. There was often confusion between the radioactive sources and the radiation that they emit with candidates sometimes incorrectly stating that sources pass through the body.

Section B

Question 9

The kinetic theory explanations in **(a)** were well answered, except in **(ii)**. Even good candidates tended to state that to evaporate high kinetic energy is required but then stated that potential energy decreases as kinetic energy increases. The question refers to the change in energy of a molecule as it evaporates, not as it is heated before it evaporates. It was pleasing to find most candidates knowing the formula for pressure and able to correctly attempt a moment calculation. Almost all calculations used the correct distances in the moment calculations and correctly converted from N to kg. Even with several concepts being handled in one sequence of calculations most candidates were able to follow the logic successfully within the question.

Answers: **(b)(i)** 60 N, **(ii)** 2 kg.

Question 10

The mode of operation of the relay was well known and scored highly, although it was not always made clear that the initial magnetisation of the core was caused by current flowing in the coil. Some candidates incorrectly stated that the current flows in the soft-iron core. In the reed relay, answers did not always make clear that the two pieces of soft-iron are attracted. There were few candidates who scored two marks in **(a)(iii)**, although reference to the closeness of the contacts in the reed relay was the most usual correct answer. Other possibilities, such as the reed relay contains less massive or smaller parts or that the spring takes time to be extended, were rarely given. In **(b)**, where candidates understood the thermistor they scored well in the calculation although a source of confusion was not recognising that the p.d. across the thermistor is 10V in **(ii)**. Reference to an increasing current through the relay coil was needed for full credit in **(i)**, rather than merely a statement that the current starts to flow.

Answers: **(b)(ii) 1** 20Ω **2** 10V **3** 100Ω.

Question 11

This proved to be the most popular question in ***Section B***, perhaps because 12 of the 15 marks were available for calculation. In **(a)** the commonest error was to misread the question and calculate the distance using a time of 24s. In **(b)** the majority of candidates knew and could apply the formula for kinetic energy but it remains a common fault to find that candidates fail to square the value for the velocity when calculating kinetic energy. There was a large amount of misunderstanding shown in the answers to **(ii) 1**. The most common correct answer was a statement that the engine provides a force to cancel or to do work against the force of air resistance or friction. In **2** the question asks what happens to the energy provided by the engine and not within it. Although heat was often identified as the final outcome of the energy provided by the engine, insufficient explanation was provided. In particular it was not clear where the energy was provided by the engine and it was sometimes wrongly stated that heat developed within the engine was the cause of the car travelling at constant speed. Long lists of energy forms were not helpful and candidates would have been better merely stating that heat is produced in the surrounding air or at the tyres in contact with the road. In **(c)** the calculation was again well done but rarely was the concept of a friction force moved through greater distances per second seen in **(iii)**. Instead increased driving force, increased friction or braking force were commonly seen as an explanation of the greater power developed in the brakes at higher speeds.

Answers: **(a)(i)** 300m, **(ii)** 360 000J, **(iii)** 18 000 W; **(b)(i)** 90 000J; **(c)(i)** 3.7(5)m/s^2, **(ii)** 3000N.

Paper 5054/03

Practical Test

General comments

The Examiners felt that the standard of the examination this year was similar to the previous year. It was expected that **Question 1** would be more difficult because it was open ended, however the candidates performed reasonably well on this question. The range of marks may well be smaller than in November 2000 as the Examiners did not seem to see any very good or very poor scripts. The paper differentiated well between candidates with exceptional candidates scoring a total mark in the high 20s, good candidates scoring marks in the low 20s and weaker candidates scoring marks of less than 20.

Comments on specific questions

Question 1

The best candidates scored full marks on this question. These candidates either shaped the plasticene so that it fitted into the measuring cylinder or split it into smaller pieces that fitted into the cylinder. Also, they ensured that the plasticene was fully immersed. They obtained a volume in excess of 20cm^3 that gave a good value for the density of plasticene. Weaker candidates used only a small volume of plasticene, in some cases this was as low as 2 or 3cm^3. In some cases this gave a reasonable density value but Examiners felt that it was not appropriate to give the value mark, as the volume of plasticene used was so small. Some candidates used the beaker to obtain an approximate value for the volume of the plasticene. In a typical method the beaker was filled to 100cm^3, the plasticene was then added to the beaker, and water was poured out of the beaker into the measuring cylinder until the level of liquid in the beaker was back to 100cm^3. This method gave a reasonable value for the density, but was not thought to be the best method and therefore the method mark was not awarded. The majority of candidates quoted the correct unit for the density but an inappropriate number of significant figures was used in some cases.

Question 2

The values of u and h_O should have been 100mm and 10mm respectively. Examiners expected these values to be quoted to the nearest mm. The majority of candidates scored the mark but a number quoted distances to the nearest cm. If candidates had set up the apparatus correctly, then the value obtained for h_I should have been 15mm, provided the focal length of the lens was 150mm. Good candidates obtained a value very close to this and went on to obtain a good value for the focal length of the lens. These candidates normally scored full marks for the question. If candidates obtained a value for h_I which was very different to 15mm, then Examiners felt that the experiment had not been carried out correctly and no further credit was given. The main error in the calculation was the use of inappropriate units. In particular, the quantity *m* was sometimes given units of mm or cm, and units were sometimes omitted from the value of *f.*

Question 3

In order to determine the extension of the spring, candidates should have noted the position of the end of the spring when it was unloaded, and then noted the position again when a load was placed on the end of the spring. The subtraction of these two scale readings would have given the extension of the spring. In some cases, candidates did not show the scale readings and were not awarded the first mark. Also, when extension values were quoted to the nearest cm, the mark was not awarded. In some cases, candidates obtained an extension value which was twice the expected value. This extension value was clearly incorrect because it gave a value for *g* that was twice the expected value. It is possible that candidates were confusing the extension and the total length of the spring. The majority of candidates obtained a correct value for the period of oscillation by timing at least 10 oscillations and repeating this measurement. Occasionally the value of 10T was substituted into the formula for *g* rather than the value of T. By ignoring unit considerations, candidates could often obtain the 'correct' value for *g*, i.e. an extension value in cm divided by a 10T value in seconds gave a *g* value of 9.8ms^{-2}. This was not awarded the mark for correct calculation. Some candidates obtained values for the frequency rather than the period of oscillation. In some cases, units were either omitted from the value of *g* or inappropriate units such as ms^{-1} were used. Candidates were allowed to work in cm provided the unit of *g* was consistent with the working.

Question 4

Circuit diagrams were reasonably well drawn but Examiners noted the following common mistakes.

- The symbol for a thermistor was given, rather than that of a variable resistor.
- Weaker candidates often showed the voltmeter connected in series with the lamp.
- Where a length of resistance wire was used as a variable resistor, there was no indication of how the length of the wire could be varied. i.e. There was no evidence of a lead with a crocodile clip on the end which could be connected to various points on the wire.
- The symbol for the lamp was not often clear. Examiners allowed the symbol for both a filament and an indicator lamp, but a number of candidates used inappropriate symbols. These included drawings of the lamp and the use of a coil inside a circle. These were not accepted as the correct symbol for the lamp.

If the specified lamp was used, Examiners expected the potential difference across the lamp to be in the region of 2V when the current was 30mA. Supervisors clearly used a number of lamps that had a different specification, and Examiners were grateful for the data that was then supplied by the Supervisor.

Readings

In this section, marks were awarded for technique. Examiners expected candidates to do the following;

- use the full range of available currents,
- take a large number of readings in order to fully define the curve produced,
- tabulate their readings giving appropriate units.

The best candidates were those whose results produced a smooth S shaped curve. A number of candidates had clearly altered voltage and current values in order to produce results which lay on a straight line.

Graph

The graph work was generally quite good. In most cases, the axes of the graph were correctly labelled and units were included on the axes. Some candidates included the origin on their graph, and this was acceptable as a resistance value was to be read off at small currents. The data was usually plotted correctly. The plotted points should have produced a smooth S shaped curve. At least half of the candidates drew a straight line through these points. This was allowed, provided the points were balanced either side of the line. The following points were penalised when the curve was drawn.

- Connecting the points by a series of straight lines.
- Drawing the curve or straight line such that the majority of points lay on one side of it.
- Drawing a 'wavy' curve rather than a smooth curve.

Examiners also did not award the curve mark to those candidates who did the following.

- Drew a thick pencil line.
- Drew a line with a pen.
- Used a large 'blob' to represent their data points, rather than a fine-circled dot or a cross.

Calculations

The majority of candidates correctly read the resistance values from the graph. The final mark in this question was only awarded to the best candidates. Weaker candidates thought that the change in resistance was due to the change in the variable resistance. i.e. As the variable resistance was reduced, the resistance of the filament was increased. This was, of course, incorrect. Better candidates realised that there had been a change in the physical conditions, and hence Ohms Law was not obeyed. However, only the best candidates realised that the temperature of the filament had increased, and that this had lead to the increase in resistance.

Paper 5054/04
Alternative to Practical

General comments

The overall standard of answers was most encouraging. **Questions 1** and **5** were, in some aspects, unusual questions. Both of these were attempted with confidence. The standard of the candidates' written English was generally very good. The candidates wrote clear, easy to understand answers. In **Question 2** there were some helpful diagrams to explain the point that was being made in the answer.

There was no evidence of lack of calculators in Centres.

The candidates understood the rubric of the questions.

The best preparation for the paper is a well designed practical course, that gives the candidates experience of the major techniques used in experimental physics.

Comments on specific questions

Question 1

(a) Most of the candidates' calculations were accurate and given to three significant figures. {0.51 and 47.1}

(b) The candidates' values for R were usually in the range accepted by the Examiners, viz 92.2 – 92.3. An error carried forward from part **(a)** was allowed. R is a ratio, but there was no unit penalty for the very small number of candidates who gave the unit g.

(c)(ii) Many candidates found it difficult to generalise, for example, stating 'the presence of dissolved substances decreases the value of the ratio *R*'. Some candidates thought that the polyacrylamide dissolved in the water.

(iii) That the manufacturer used 'very pure water' was well deduced by most candidates. However, a small number thought that there had been some cheating!

Question 2

(a)(i) Most of the candidates said, or drew a diagram that implied, that the rule should be placed close to the apparatus. The question referred to a metre rule. Many candidates said that they would use a 300mm rule. The Examiners hope that all candidates have performed an experiment similar to the one outlined in the question, in which a metre rule would be used rather than the short 300mm rule.

(ii) To avoid a parallax error when taking a reading on the rule, the line of sight must be perpendicular to the *reading*. In the context of parallax error, candidates should avoid using the term vertical instead of perpendicular. The line of sight is not parallel to the reading. The head is not just placed above the *rule*. The head is not just placed in front of the rule.

(iii) The Examiners were very surprised that there was misunderstanding about the size of the smallest division on a metre rule. 0.01m, 0.01cm, 0.1mm and even 0 were among the wrong answers given.

(iv) Most of the candidates named a set square as the additional apparatus. It was difficult to describe how to use the set square. Appropriate diagrams were accepted.

(b) A diagram was a useful way of answering this question. About half of the candidates knew that the 'centres of the lamp, the object and the lens should be on the principal axis of the lens'. The rest had difficulty in conveying the correct answer. The correct alignment of these items is an important practical procedure to obtain a real image.

Question 3

(a) Although many of the candidates completed the table correctly, there were some unexpected interpolations. Many of these were very inaccurate or totally wrong. A frequent careless error was to interpolate a reading of 0.6m for the length for the frequency of 400Hz. Interpolations should read accurately.

(b) This part was well answered.

(c) Only a small minority did not give the correct answer 'frequency x length = a constant'.

Question 4

Although many candidates scored full marks, others gave some irrelevant items, for example, ice. Any relevant item was accepted, for example, thermometer, clock, stirrer etc. Items such as pencil were not accepted.

There were some extremely well written answers in the 'Use' boxes.

Question 5

(a) The scales for the graph axes were well chosen and easy to use. Scales must be linear. The point plotting was generally very accurate, the point [4, 1.03] was the most common mis-plot. Candidates seemed reluctant to draw a 'best fit' *straight* line, having graph points either side of the line. There were far too many lines drawn from point to point. A neat thin line is required for the graph line.

(b)(i) The candidates' comments were too simplistic, for example, 'the current increases as the number of lamps increases'. For this question, the candidates could have described the obvious proportional relationship shown by the graph line or the table of readings.

(ii) There were some clear determinations of the required resistance based on the fact that the p.d. in the LDR circuit, is constant. Using table values, we have the following.

V = 0.54 x 3000 and
V = 1.60 x R
giving R = 1013 Ω

Correct table values or the candidates' interpolated graph values were accepted for the calculation. Clearly explained answers based on $I \propto N$ and therefore $V/R \propto N$ were also accepted.