PHYSICS

GCE Ordinary Level

Paper 5054/01
Multiple Choice

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

General comments

The mean score for this paper was 26.7 out of 40 (67%). This result was similar to recent years and the statistics showed that the candidates had been well prepared for all parts of the syllabus.

Candidates found **Questions 8**, **12** and **16** to be easy and there were also high scores for **Questions 13** and **19**.

Comments on specific questions

Question 3

Just over half the candidates correctly chose **C** as their answer, but the weaker candidates seemed fairly evenly divided among the four possible values. This is often a sign of 'guessing'.

Question 5

A number of candidates chose **A** as their response, indicating that they were thinking of acceleration in terms of a change of speed only.

Question 7

Other than the correct answer (**A**) the most popular responses were **B** – completing the triangle without considering if the direction was 'reasonable', and **C** – considering the probable direction of the resultant but adding the two forces arithmetically.

Question 11

The result for this question proved somewhat surprising. The number of weaker candidates selecting **D** was slightly larger than those selecting the key **B**, they were expecting the force on the smaller piston to be larger than the applied force.

Question 15

While few candidates were of the opinion the temperature was 50°C, candidates were fairly evenly divided amongst **B**, **C** and **D**. In fact more of the lower ability range opted for either **B** or **D** than for the key **C**.

Question 18

This proved a straightforward 'recall' question for most candidates, indeed in the higher ability range 99% obtained the correct answer.

There was however a significant number who selected **D**, the crest to crest measurement.

Question 22

A significant number of the higher-scoring candidates chose option **D** (using sin 30° x 1.5).

Question 25

With only just under half the entry choosing the key **B**, **D** also proved to be very popular.

Question 31

While the better candidates found no difficulty with this question the remainder seemed evenly divided among the four possible answers.

Perhaps they could not believe that <u>all</u> could be safely connected, making the 500w heater the most powerful, and therefore the answer.

Question 37

Although almost half of the candidates chose the correct option the discrimination figures suggest that this was done with no great certainty. A large number chose option **C**.

Question 38

One surprising result was the fact that nearly 25% of the candidates selected **A** implying that they believed a positive charge is spread throughout the atom. This included a number of the more able candidates. It is possible that they did not relate the Geiger-Marsden experiment to 'normal' atoms.

Paper 5054/02

Theory

General comments

This was the first examination under a new syllabus format. The new syllabus has been written in 'learning outcomes' format and includes a number of minor changes. The new items are largely applications of physical principles that were examined in the old syllabus. Questions on new items tested in ***Section A*** were formulated in a way that candidates should have been able to answer using basic principles. Thus, in **Question 7**, candidates who knew that a concave lens causes a beam of light to diverge should have been able to realise that such a lens is needed to correct the eye defect where the rays were converging in front of the retina. In ***Section B*** the block diagram of the power station and the circuit-breaker could also have been answered from basic principles. However the listing of renewable and non-renewable sources of energy were completely new items where candidates needed to have covered a slightly new area of work.

The general calibre of the work produced in the examination seemed to have improved and it was very pleasing to find that only a very few candidates knew little of the fundamental ideas. It appeared that the examination allowed candidates to display the understanding that they had of the subject. Not only were they able to state basic equations and ideas, but the more able candidates could apply them to a more interesting range of topics provided by the new syllabus format.

Several questions asked candidates to quote the formula that they were using to solve a numerical question. This is intended to be an algebraic formula, e.g. $F=ma$, with any variable as the subject. It is helpful if candidates begin their answers with any variation of the formula which they know to be correct. If candidates fail to give the formula when asked, they are likely to lose some credit, even if their final answer is correct. Candidates should also quote their answers to the same number of significant figures as given in the question. It is not the intention to penalise the wrong use of significant figures to any great extent; only in **Question 2** was a penalty exacted. However it is very important that units are given to every numerical answer.

It has been stated in previous reports that some candidates are not using the lined pages at the end of the question paper for their answers to ***Section B***. Some Centres are still supplying each candidate with a large answer booklet before the examination starts, which, even though unused, is still attached to the question paper. Candidates should be encouraged to use the lined pages and only ask for additional sheets when the lined pages are full.

The time available for the examination appeared to be adequate for most candidates. A few candidates attempted to answer three questions in ***Section B***, and, in general, their last answer appeared to be rushed and scored significantly lower marks. Some weaker candidates only attempted part answers in ***Section B***.

Comments on specific questions

Section A

Question 1

The first mark on the paper provided an easy start to the paper and the majority of candidates showed a knowledge of the formula and of the idea that forms the basis of Newton's First Law. However in **(ii)** some answers were given marginally above 600 N, which showed a misunderstanding of the requirements for steady speed. In **(b)** the majority of answers recognised the opposing effect of air or road resistance but failed to appreciate that gravity was now an opposing force. It was not intended that candidates go beyond the syllabus in any way and a mere statement that gravity was now opposing the motion or acting, in some way, backwards was enough to earn the mark. In **(c)** a good knowledge was shown of the equation $F = ma$, and those candidates who used the equation almost always gained some credit. However some candidates attempted to use a change in velocity and were unsuccessful.

Answers: **(a)(i)** 300m, **(ii)** 600N; **(c)** 0.75 m/s^2.

Question 2

The majority of candidates gave a correct definition of density or explained in words the correct formula in **(a)(i)**. Most candidates then displayed the ability to rearrange and apply the formula in **(ii)**. However many answers gave the unit as cm^3 and a considerable number gave their answer to four significant figures, even though the question only gave figures to two figure accuracy. More than three figure accuracy was penalised in this question, but nowhere else in the paper was a penalty exacted. In **(b)** the equation $Q = mc\Delta T$ was frequently known and applied, but candidates sometimes failed to see a value for the mass mentioned in **(b)** and then ignored that part of the equation. Even though the final answer was not correct, credit was given for the correct equation and for the relevant use of a temperature rise of 12°C.

Answers: **(a)(ii)** 420 or 417 m^3; **(b)** 5 820 000J.

Question 3

Candidates from many Centres were able to give convincing accounts of the passage of energy from atom to atom through a solid in **(a)**. However there were often irrelevant references to energy processes, such as convection, occurring in the water. In **(b)** the television remote control was by far the most popular answer, although communication between computer and other devices, and intruder alarms (including night-time photography) were accepted. The answers to **(c)** were usually very clear, listing differences as they might have been recorded in a text book. A confused idea produced by some candidates was that evaporation referred to the vapour that appeared once the bubbles associated with boiling reached the surface.

Question 4

The refracted ray was usually shown correctly bent towards the normal in **(a)**, but the mark for continuing wavefront 1 was often not earned, either because the wavefront given by the candidate was drawn bent towards the normal or it was not a continuation of wavefront 1. The decrease in speed and wavelength in **(b)** was generally well known. In **(c)** candidates usually correctly referred to a changed angle of refraction or an increased wavelength. It was not necessary to know that a red ray of light was refracted less at the glass interface. Any statements relating to velocity did not earn credit as they were not relevant to changes in Fig. 4.1.

Question 5

It was pleasing to find an electrical question that was generally so well answered, with many candidates earning full marks. In **(a)** the simple answer of variable resistor or rheostat was all that was required; the thermistor was a popular wrong answer. In **(b)** misjudging the horizontal scale of the graph, by considering one square to be one volt, led to an incorrect answer of 0.047A or 0.048A. The formula $V = IR$ was well known, but using 6 volts in the calculation was a common error. It was pleasing to find that most candidates in **(iii)** added together their two previous answers.

Answers: **(b)(i)** 0.050A, **(ii)** 0.012(5) A, **(iii)** 0.062(5) A.

Question 6

The formulae for moment and work were well known and applied. However units were often omitted or incorrectly given, e.g. N/m was incorrectly given as the unit for moment. Most candidates appreciated the function of the counterweight in providing an opposing moment and in **(ii)** allowing the load to alter in value or in position along the arm. However, the diagram in Fig. 6.1 led some candidates to imagine that the whole crane arm lifts upwards from the horizontal to lift the load. Candidates were not penalised for this.

Answers: **(a)** 240 000Nm; **(c)** 180 000J.

Question 7

Most candidates, with a basic knowledge of a converging lens correctly drew rays focussing on or near the back of the eye. The diagram in Fig. 7.1 was not intended to be to scale and it was intended that the image on the retina should be smaller than the object. However in the final diagram the image distance was slightly larger than the object distance. It was felt that candidates could answer **(ii)** by stating that the image was smaller or larger if they interpreted the diagram in different ways and so both answers were accepted. It was, however, essential for full marks that the image was real and upside down. Many candidates ticked only one box despite the question suggesting that “boxes” should be ticked. In **(b)**, a concave or diverging

lens was accepted. It was not necessary to state that the lens was a concave meniscus or convexo-concave lens. Those candidates who correctly drew a diverging lens on their diagram in **(b)(ii)** had not always correctly named it beforehand. Many candidates failed to realise that the lens is placed in front of the eye and thus did not earn many marks in this last section. Common diagram errors showed rays that did not deviate after passing through a lens, lenses introduced in the body of the eye, and rays not finally meeting on the retina.

Question 8

As expected, most candidates knew the repulsive and attractive forces between like and unlike charges in **(a)**. However in **(b)** although most candidates appreciated that the positive paint droplets would be attracted to the negative plate, they failed to realise that the initial spreading out of the droplets was due to the repulsion of like charges as the droplets emerge from the nozzle. As always candidates can produce alternative answers, and in this case some answers sensibly suggested that as the paint emerges from a higher pressure into the lower pressure of the atmosphere the volume would expand.

Section B

Question 9

The majority of candidates knew the correct order for the block diagram of a power station in **(a)**. Where candidates clearly explained where each of the energy changes that they were describing actually occurred, they tended to earn much credit. A long list of energy changes merely separated by arrows is not always easy to interpret and candidates who did not describe the changes that occurred often lost credit. Many good answers were given that mentioned the change from chemical to thermal energy or even to kinetic or potential energy of the steam produced in the boiler. The turbine was often described as having mechanical energy rather than kinetic energy and this was accepted. Weaker candidates did not describe energy changes at all but merely stated that kinetic energy was in the turbine. The answers to **(b)(i)** often incorrectly stated that non-renewable sources of energy were not recyclable or could not be used again. A significant minority of candidates correctly explained that such sources will run out or cannot be replaced. Other non-renewable sources of energy included oil (or petrol), gas, and nuclear sources of energy. Renewable sources of energy that were accepted included solar, tidal, wind, geothermal, hydroelectric, waves and various forms of biomass (including trees and wood). The formulae for the calculations in **(c)** were well known. However, where candidates started by merely writing down numbers, they often used 900kW as the denominator in the expression for efficiency and did not realise that 1200kW is the energy input. The commonest error in **(ii)** was a failure to convert kW to W, followed by taking one hour as 60 rather than 3600 seconds.

Answers: **(c)(i)** 0.25 or 25%, **(ii)** 1.08×10^9 J.

Question 10

Part **(a)** produced many correct answers. It was important to focus in **(i)** on the fuse limiting or stopping the current in the circuit and to explain that the fuse melts, rather than merely breaks. The calculation in **(ii)** was well attempted although too many candidates either failed to give the final fuse rating (a whole number slightly larger than their calculated value) or omitted a unit. The answers to **(b)** were often very encouraging with many candidates realising the true purpose of the circuit breaker and explaining its action in terms of the simple effect of the magnetic effect of a current. As the iron lever is attracted to the core it was intended that the spring should pull the spring metal away from the contacts and keep it away until the reset button is pressed. Some candidates thought the action was more like an electric bell where the spring metal goes backwards and forwards or a relay where the current closes the contacts, but the most common error was the statement that the system resets itself when the current stops flowing. Even in these cases candidates were earning reasonable marks for an interpretation of the magnetic effects of the current.

Answers: **(a)(i)** 8.7A.

Question 11

The answers to **(a)(i)-(iii)** were largely known and well produced by candidates. In **(iii)** the best marks were earned by candidates who described a neutron hitting the nucleus, splitting it into several fragments and also producing more neutrons and some energy. Credit was lost by those candidates who merely described the whole atom as splitting and who thus did not describe nuclear fission. Only the better candidates produced the correct answer to **(iv)**. Credit would have been given if any correct use of half-life had been made or if 6 half lives had been stated, but too often the only answer was, incorrectly, 64 times the half-life of Uranium-235. The relevance of answers to **(b)** showed a general improvement. In the past the answers to similar questions have often only produced vague references to the properties of particular radiations. The accepted answer was Technetium-99, although possible reasons for choosing other isotopes were also given credit if they were chosen instead. Such reasons need to be tied to the actual situation and usually described the gamma radiation as being able to pass through the ground, and the shorter half-life as being most reasonable as, for safety reasons, it is desirable that the radioactivity present in the ground should decay quickly.

Answers: **(a)(iv)** 4.3×10^9 years.

Paper 5054/03

Practical Test

General comments

The standard of candidates and the range of marks were similar to the standard of previous years. There has been a significant improvement in practical work from candidates in some areas. The much-improved practical skills of these candidates were unfortunately spoiled by careless mistakes when recording observations. Common mistakes included omitting units from measurements and the final answer in calculations, and not using sufficient precision when recording observations, e.g. recording the height of an object as 2 cm rather than 2.0 cm. With some additional care in these aspects, candidates should be able to make a more significant improvement next time.

Comments on specific questions

Section A

Question 1

(a) This section of the question involved setting up the apparatus and no marks were awarded here.

(b) In this section candidates were awarded a mark for recording at least one length to the nearest mm with unit and recording the force to 0.1 N with unit. A small number of candidates gave all their measurements to the nearest cm and quoted the force to the nearest Newton. A very small number of very weak candidates obtained a force value of less than 4.0 N, which was impossible, if the experiment had been set up correctly.

(c)(i) In order to check that AB was horizontal it was expected that candidates would measure the height of the string above the bench at positions A and B. The majority of candidates did this, although their answers were not always completely clear. In particular, candidates often referred to measuring the heights of A and B without referring to the fact that they were measuring them from the bench.

(ii) The metre rule used to measure the heights h_1 and h_2 accurately should have been vertical. Examiners were therefore looking for a method that ensured that the rule was vertical. This could have included the use of a set-square against the horizontal bench or checking that the rule was parallel to the edge of a window frame, etc. Only the best candidates were able to describe such a method.

(d) Most candidates calculated sin θ correctly but a number then failed to convert this to a value for θ. A number who correctly calculated θ then omitted the unit.

(e) Examiners marked the scale diagrams generously. The vertical side of the triangle should have had a length of 4.0 cm corresponding to the 4.0 N weight. The hypotenuse of the triangle should have had a length corresponding to the reading on the newton meter and the angle at the base of the hypotenuse should have had a value corresponding to the angle determined in part (**d)**. This often lead to a triangle that was not right angled, or did not close, because of friction in the system. A number of candidates adjusted their diagram so that it was right angled and Examiners allowed this. Some candidates drew a horizontal line to represent T and drew the correct angle along that line to meet the top of the line representing 4.0 N force, which often meant that they had a slightly incorrect hypotenuse. Others drew the horizontal line to represent T and then drew a hypotenuse of the correct length to meet this line, which often meant that they had a slightly incorrect angle. Both these alternatives were allowed.

Question 2

(a) The mass of the beaker was generally correct but at least 50% of candidates had the incorrect value for the mass of water. The beaker containing water was weighed but the mass of the empty beaker was not subtracted from the result of the weighting. Examiners expected a value for the mass of water of about 50 g but a large number of candidates were obtaining values close to 100 g. A significant number of candidates omitted units from their mass measurements.

(b)(c) The majority of candidates obtained sensible values for the temperatures, only the best candidates attempted to interpolate between the divisions on the thermometer in order to quote a temperature to better than 1°C.

(d)(e) Calculations of Q and power were often incorrect because Examiners insisted on a sensible value for the mass and temperature rise. Even those candidates who used correct values for these often omitted units for either Q or power. To avoid an over reliance on calculations, it should be noted that there was only one mark for the calculations of both Q and power with appropriate units.

(f) Surprisingly, only the better candidates scored the final mark in this question, generally for writing the standard phrase “heat lost to the surroundings”.

Question 3

(b) Most candidates recorded the correct voltages. Some had clearly made a serious error because they recorded either 0 Volts or 5 Volts for all values. A small number of candidates omitted units from their measurements and others had answers that were incorrect by a factor of 10, e.g. 0.15 V rather than 1.5 V.

(c) The majority of candidates could state that the sum of the potential differences across the two resistors was equal to the potential difference supplied.

(d) There were two problems when the current was recorded, answers which were incorrect by a factor of 10, e.g. 3.0 A rather than 0.30 A and answers which did not include the unit of current.

(e) In order to give credit to the candidates who had made correct measurements throughout this question, Examiners insisted that resistance values were correct. Thus no error carried from incorrect currents and voltages was allowed. A number of candidates calculated the total resistance rather than the values of the individual resistors.

Section B

Question 4

(a) The most common faults when the height of the object was determined were either quoting the height as 2 cm rather than 2.0 cm or omitting the unit. Candidates must appreciate that they should always measure to the precision of the instrument that they are using and that an answer without a unit is not correct.

(b) To check that the image was inverted Examiners expected the candidates to use the apparatus in front of them. The best answers suggested covering the top of the object with a finger which would appear at the bottom of the image. Other candidates suggested making a different arrangement such as a triangular shaped object, but this was not given credit.

(c) With the apparatus set up as shown in the question paper the image distance was expected to be about 80 cm and the image height about 8 cm. Good candidates obtained these values. Other candidates had clearly altered the arrangement so that the image distance was smaller and obtained consistent results. In other cases it appeared that candidates had taken the distance between the object and the screen as the image distance when the question clearly states that it is the distance between the lens and the screen.

(d) The only error in this part was the inclusion of units in the value for the linear magnification. This value does not have units as it is simply one distance divided by another.

(e) Candidates were instructed to use a range of distances between the object and the screen of between 65 cm and 100 cm, a number of candidates used a considerably narrower range than this. Systematic errors were also a significant feature of this section. A number of candidates thought that u + v was actually v and were given a systematic error penalty. Others confused u and v and obtained values for v in the range 16 cm to 25 cm with corresponding image heights that decreased in size as the distance increased. Another systematic error involved v values which were approximately the correct size but which produced image heights that decreased as the image distance increased. This suggests that candidates were taking measurements from a scale rather than finding actual image distances. The final systematic error involved the use of the radius of the image rather than the diameter.

(f) Graph plotting was generally quite good. There has been a significant improvement in this area. A number of candidates plotted the graph the "wrong way round" with v/cm on the y-axis.

(g)(h) Good candidates used a large triangle when determining the gradient of their graph. As a reward for the candidates who had taken correct measurements throughout this experiment, Examiners expected the gradient to be within a reasonably wide range of the correct answer. Those who had taken accurate measurements obtained a value for the focal length that was within a tighter range.

Paper 5054/04

Alternative to Practical Test

General comments

The standard of the candidates' answers was most encouraging. The scripts were well presented and written in very good English. Many answers used diagrams, these were neatly drawn and illustrated the relevant points with clarity. The full range of marks, viz 0 – 30, was awarded.

The best preparation for the paper is a well designed practical course involving hands-on experience using apparatus.

Comments on specific questions

Question 1

This question tested how well the candidates' could follow instructions and apply the results of the example to a practical situation. The cylindrical glass shade was not a familiar application.

(a)(i)(ii)(iii) These parts were generally well answered. The lines drawn were neat and thin. Most of the candidates used either $i = r$ or OC = CI in order to locate the position for the image I. Some used the angle $90 - i$, this was accepted here, but not in **(a)(ii)**. [i was accepted in the range 30 to 34 degrees.]

(b)(i) The Examiners were pleased to note that most of the candidates gave the correct position for G, the image of F. (G is on the line AB such that FC = CG.) A minority of the candidates located G such that FB = BG on the continuation of line AB. This assumed that the bold line through B was a plane mirror. There were other quite inexplicable positions for G.

(ii) The image of the flame was often drawn very well. It is a mirror image and lies to the left of the axis through C.

An error carried forward mark was awarded for a correctly drawn shape of the image, assuming that the glass, represented by the bold line through B, was a flat reflecting surface.

Question 2

This question tested various aspects of designing an experiment. It appeared to be the hardest question for the candidates. Some common sense points were missed throughout the question.

(a) Most of the candidates drew a table with labels *V* and *h*. Very few gave units for both *V* and *h*. The Examiners noted that many gave the unit mm for *h*. This was a very good choice; for small values of $h < 300$ mm, it would ensure working to three-significant figures.

(b) There were several techniques available. Some of the candidates chose to measure the dead-space with another rule. However most of these failed to realise that the dead-space distance had to be added to the reading on the rule. Raising the bottle above the bench or aligning the zero line with the edge of the bench, were two popular methods.

(c) Many candidates proposed using string or just trying to look perpendicular to the level water when below the point X. A ridged fiducial aid (e.g. a set-square) was required to obtain an accurate reading.

(d) The expected graph consisted of (1) a short straight line through the origin connected by a short smooth line to (2) a longer straight line having a smaller gradient than the line (1). The shape of the short smooth curve was not part of the test. Very few candidates scored both marks. Many candidates drew one "long" straight line through the origin.

Question 3

This question on thermometers was answered with confidence, the candidates scored well. There were however some unexpected points, mainly in the answers to **(a)(ii)** and **(a)(iii)**

(a)(i) Most candidates referred to Celsius/Centigrade/ (1/100)(location of the upper fixed point – that of lower fixed point). Some candidates wrote, "it is the SI unit of temperature" this was not considered sufficient to answer the question.

(ii) Most dots and the label **E** were approximately in the correct position, on a line perpendicular to the thermometer.

Some dots were placed on the thermometer. These were not given any credit.

(iii) Although very few candidates drew lines in the wrong direction many lines were drawn free hand.

A few candidates drew lines parallel to the thermometer. The Examiners question whether these candidates had had the opportunity to use a thermometer.

(iv) Most candidates ticked the third box, the correct answer.

(b)(i)(ii) Both parts were well answered by most of the candidates. In answering **(b)(ii)** many wrote about avoiding parallax errors, a correct answer. The Examiners were pleased to note that there appeared to be some understanding of how this avoided a parallax error.

Question 4

This question tested aspects of good experimental procedure and whether candidates could predict values from the pattern of a set of experimental observations.

(a) The majority of the candidates did not place the eye so as to be opposite the position of the lower rule when it was moving fastest.

Some of the wrong positions were surprising e.g., looking vertically upwards under the centre of the fixed rule.

(b) Most candidates knew that repeating observations leads to consistent readings and many wrote about the process of averaging values to reduce errors.

(c) Nearly all of the candidates were able to state that N increased as x increased. A large number could see that $N = kx$. They either said so here in part **(c)** or clearly used this principle in calculating the value for N in part **(d)**.

(d) Well answered by the majority of the candidates. [N was accepted in the range 17.5 to 18]

Question 5

This question tested the candidates ability to:

- plot a graph of readings obtained in an experiment
- make deductions
- interpret the results of the experiment.

(a) Most candidates were competent in all aspects of graph plotting. However, there were candidates who chose awkward scales and so made plotting errors. Some used non-linear scales to produce a fictitious straight line.

Plotting was very accurate although a large number had difficulty in plotting the point (1.09, 0.4). They did not understand the scale in the region 1.00 to 1.90.

The graph line was curved but many drew a straight line. Generally the line-work was neat and thin.

(b)(i) The deductions of x and I were very accurate. There were some candidates who entered them into the wrong box in the table. The multiplication was usually good, except where calculators did not appear to be used.

(ii) A large number of the candidates do not understand what is meant by inversely proportional. The graph line was curved, I decreasing as x increased. If the relationship were inversely proportional then the product $Ix = k$, a constant. A correct set of values in the table in **(b)(i)** shows this is not the case.

Many candidates wanted to use $I = -kx$ when writing about inversely proportional. This was usually stated that the change in I was proportional to minus the change in x. This is not inversely proportional.