PHYSICS

Paper 5054/12
Multiple Choice

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

General comments

There were several questions which were answered well by a large number of candidate. These included **Questions 3**, **8, 16**, **24**, **29** and **40.** Candidates found **Questions 2**, **4**, **17**, **22**, **23**, **25**, **33**, **36**, **37**, **38** and **39** more challenging.

Comments on Specific Questions

Question 2

The question asked for an average velocity and not for an average speed. Velocity is a vector quantity that is equal to the rate of change of displacement with time. More candidates gave an answer that was calculated using the distance travelled rather than the option that used the total displacement of the athlete.

Question 4

Some candidates gave the correct answer, but many candidates chose an incorrect option. Candidates needed to interpret a distance-time graph which is not dissimilar in shape to a speed-time graph for an object falling through the air and reaching terminal velocity and many failed to do this.

Question 17

Some candidates gave the correct answer here as they used the vertical height moved by the car in the calculation. However, many candidates used the distance along the slope. The other incorrect options were chosen by a small number of candidates.

Question 22

The correct definition of latent heat was widely known but a few candidates chose the other options.

Question 23

Only the strongest candidates answered this question correctly. The question concerned the motion of a hydrogen molecule in the time after one collision and before the next. During this time there are no collisions and the molecule moves in a straight line at constant speed. The majority of candidates chose an option where there was a continuous change of direction of motion.

Question 25

This question was challenging for many candidates. The most commonly selected option was the correct one **A** but a number of candidates chose the incorrect option **C**.

Question 33

Although many candidates answered this question correctly, there were some who believed that the motor would speed up or that the brightness of the lamps would not be changed.

Question 36

A number of candidates selected the incorrect option **A** suggesting that a current of the same magnitude as before would now be shared by the two heaters. The current supplied doubles when the switch is closed and it is this current that is then shared equally. The larger current is the source of the problem and it explains why option **C** is correct.

Question 37

There were many correct answers here. A significant minority gave answer **A** which suggests that they had not considered that increasing the rate of rotation of the coil, increases the rate at which magnetic flux is being cut and hence the magnitude of the electromotive force induced.

Question 38

The most popular choice here was option **D**, rather the correct option **C**. The other two incorrect options were chosen by very few candidates.

Question 39

The correct answer **A** was chosen by more candidates than any other but all the options were selected by a few candidates. This question was challenging for many candidates.

PHYSICS

Paper 5054/22
Theory

Key messages

- Candidates should show all relevant working in a calculation so that credit can be given for all parts of the question that are answered correctly.
- Numerical data is given in the paper to two significant figures. Candidates should give their answers to at least two significant figures and check that any rounding is correct.
- Candidates should ensure that they give the unit to any final calculated value.
- Candidates need to plan their answers and take time to read the question thoroughly before starting their answer.

General comments

In general the majority of responses were both legible and understandable. However, a few candidates appeared to write their answer in pencil and then overwrite the pencil answers, often in ink. This practice should not be encouraged as the script is difficult to read when scanned electronically.

In several questions candidates are asked to give a specified number of responses, e.g. in **Question 9(b)** where they are asked for **two** factors that increase braking distance. A number of candidates gave more than the specified number of factors. This is not advisable as only the first specified number of factors are marked and correct factors appearing later in the list are ignored. Candidates should be advised, when asked for a specified number of responses, to give the specified number that they think are the best answers.

A number of candidates seemed unaware of the meaning of the command words used in the examination, for example 'state' does not mean 'explain'. In **Question 9(b)** a number of candidates not only stated a factor that increases braking distance but gave explanations of why this increases the braking distance. Although such arguments are not penalised it does reduce the time available to answer the rest of the paper.

There appeared to be no evidence that candidates were short of time in completing the paper.

Comments on specific questions

Section A

Question 1

Most candidates in this question showed a good understanding of measurement using a measuring cylinder and of the formula for density.

(a) The majority of candidates were able to score full marks in this section. Good answers showed a methodical approach in determining the volume, giving a correct order for conducting the experiment. A number of candidates referred to the diagram, quoting the initial volume of water in the measuring cylinder as 40 cm^3. Others continued this approach to speculate on the new volume when the irregular object was added and included this in their final calculation or referred to the initial volume as V1 and the final volume as V2. Good candidates made it very clear what measurements were being taken, for example measuring the volume of water with the measuring cylinder. Many good responses also included extra features to improve the accuracy, such as fully immersing the object or ensuring that there are no splashes. Some candidates lost marks by not specifying that the initial volume is actually measured or recorded, or, alternatively, they did not include the subtraction of the final and initial volumes in their answer. Some weaker candidates referred to water being lost, measurement of the mass of the cylinder or melting the iron and pouring this into the measuring cylinder.

(b) Many candidates started with the equation, substituted the correct values and then showed their final answer with the correct units. This is a successful approach and is to be encouraged. A number of answers gave the wrong final unit, sometimes because there had been a wrong change of unit from g to kg or cm^3 to m^3. Correct changes of unit are acceptable but are often not needed and can lead to error. The conversion of g to kg was usually correct but when converting from cm^3 to m^3, candidates tended to divide by 100 rather than 10^6.

(c) Very clear working out was shown by many of the candidates who scored full marks, usually with the density of copper calculated first and then the rearrangement of the density formula shown correctly. Many candidates, however, used the density of iron rather than copper in their calculations.

(d) This question provided a variety of answers. Correct answers tended to be concise stating that density decreases as volume increases. Others gave much more detail, often with a molecular interpretation of expansion in terms of motion and increased separation of particles. Weaker answers suggested that mass decreases on heating, or failed to explain why density decreases sometimes giving incorrect or insufficient reasons, such as the particles are lighter or vibrate more. It is considered that the particles themselves do not become less dense when a substance is heated. The substance itself may become less dense but that is because the distance between the particles increases and not that the density of an individual particle decreases.

Answers: **(b)** 7.8 g/cm^3 **(c)** 460 g

Question 2

This was a question on the manometer.

(a) Many correct definitions were produced for pressure, either in terms of the force per unit area or the force on an area of 1 m^2. Some definitions referred to a ‘certain’ or a ‘specific’ area which was not accepted.

(b) This proved a challenging question and full marks were only achieved by a few. Most candidates remembered the formula for pressure in terms of density and depth and this resulted in some credit. The more able converted the distance of 16 cm into 0.16 m before calculating the pressure difference. Only the most able candidates subtracted the value obtained for the pressure difference from atmospheric pressure. Others ignored atmospheric pressure completely or added the pressure difference to atmospheric pressure rather than subtracting it from atmospheric pressure.

(c) (i) Most candidates were able to give a reasonable value for the level of mercury, realising that as the level rises on one side it falls an equal distance on the other. A number of candidates gave 0 or 16 cm as their answer.

(ii) It was encouraging to find many candidates able to describe authoritatively the increase in kinetic energy and more frequent collisions of the molecules with the walls or with the mercury. The question asks for an explanation in terms of molecules but some candidates failed to mention molecules at all or seemed unsure of whether they were describing the gas or the molecules in the gas, drifting from one explanation to the other.

Answers: **(b)** 7.8×10^4 Pa **(c)(i)** 8.0 cm

Question 3

This was a question on refractive index, total internal reflection and critical angle.

(a) Most candidates knew that the middle ray was associated with the critical angle. Just over half of the candidates were able to accurately label the critical angle correctly.

(b) Many answers correctly suggested that the angle of incidence is larger than the critical angle. A significant number of answers did not clearly identify the angle of incidence in their answer, suggesting, for example, that 'the incident ray is greater than the critical angle'.

(c) (i) The majority of candidates correctly recalled the equation for refractive index but often produced an answer less than 1, not realising that the refractive index of a substance is obtained by taking the angle in air or a vacuum divided by the angle in the substance. A few candidates used angles from the surface to the ray rather than from the ray to the normal. A common mistake was to give a unit for refractive index as °, whereas it has no unit.

(ii) Where candidates obtained an answer less than 1 for the refractive index *n,* they often found difficulty in using the equation n = 1/sin c to find the critical angle c, although others were able to calculate the angle correctly even when $n < 1$. When quoting the final angle, a common error was to omit the unit for the angle.

Answers: **(c)(i)** 1.3(2) **(ii)** 49°

Question 4

This was a question on the electromagnetic spectrum from a star.

(a) Most candidates gave a response within sensible and allowed limits for the wavelength of the peak of the curve. The unit was often omitted but in this case the lack of a unit was not penalised.

(b) This section produced the weakest response with ultraviolet being a popular but incorrect answer. The answer to **(a)** is larger than the largest wavelength in the electromagnetic spectrum and it may have been the powers of ten in the answers that led candidates to incorrectly think that 10^{-6} is smaller than 10^{-7}.

(c) Most candidates were able to recall the correct formula relating speed, frequency and wavelength and were able to rearrange it correctly. The division by wavelength, a number with a negative power led to errors with answers such as 250 Hz being common. Many candidates did not give a unit for the answer to this calculation.

Answers: **(a)** 1.2×10^{-6} m **(c)(i)** 2.5×10^{14} Hz

Question 5

This was a question on charging by induction.

(a) The majority of candidates clearly understood the physics of this question; that like charges repel, unlike charges attract and that charges can flow to and from the earth. However, many answers did not specifically mention the repulsion of the electrons on the metal sphere and a minority incorrectly suggested that positive charge moves towards the dome. A few candidates suggested that charge physically moves between the dome and the metal sphere.

(b) Candidates appeared to find this question difficult, although a significant number gave the correct order D C B E. Candidates who gave sentence D as the start and sentence E at the end of the process gained some credit.

Question 6

Most candidates showed a good knowledge of series and parallel circuits and of the formula for resistance in terms of voltage and current.

(a) This section was very well answered with the majority achieving success, although the rearrangement of the formula to find current caused problems for some candidates.

(b) It was encouraging that a large number of candidates successfully negotiated the subtraction of currents to obtain the correct answer. A number of candidates obtained the total resistance of the circuit, 9.2 Ω, rather than the resistance of lamp Q.

(c) (i) Candidates clearly knew their circuit symbols and this produced the highest-scoring section on the paper. However there was still room for improvement in that more care could have been taken over the drawing of the circuit in many cases, with fewer accidental gaps.

(ii) Over half of the candidates gave a sensible explanation to this part of the question about why the current is reduced when resistors are connected in a series circuit. Candidates who did not realise that the total resistance would be greater found this more challenging to answer. A commonly seen answer, which does not explain why the current is less, was the statement ‘current splits in a series circuit’.

Answers: **(a)** 0.4(0) A **(b)** 24 Ω

Question 7

This was a question on the motor effect requiring interpretation of a diagram with a current carrying conductor in a magnetic field.

(a) Many candidates gave the wrong direction for the current, indicating the direction of the movement of the electrons rather than the direction of the electric current in the wire. The convention for direction of current is to show the direction in which positively charged particles would move.

(b) Correct answers usually suggested that the current in the copper wire either produces its own magnetic field which interacts with the magnetic field of the magnet or that a magnetic field and current produce a force according to the left-hand rule. Many responses were too vague and a common error was to suggest that electromagnetic induction is involved.

(c) The question asks for the names of two different devices using the effect described in **(b)**. The motor or a device using a motor was the most common correct answer and loudspeakers or moving-coil meters were also sometimes correctly suggested. Many devices were not accepted, such as generators, transformers, relays and solenoids. Some suggestions were also vague, such as a ‘television’, which may contain a loudspeaker but also involves the use of other devices for its main purpose.

Question 8

This was a question on thermionic emission and electric fields.

(a) Many candidates correctly stated that the anode attracted electrons and many also correctly referred to thermionic emission or heating of the filament as the source of the electrons. However some candidates did not restrict themselves to answering the question but went on to refer to X- and Y-plates, fluorescence of the screen, etc.

(b) The structure of the cathode ray oscilloscope is not in the syllabus and does not need to be taught. It was unfortunate that many candidates merely discussed the purpose of the X- and Y-plates rather than the electric field set up between two oppositely charged plates. Those who did understand the concept of the question scored full marks easily for stating that one plate should be charged or connected to +ve and the other –ve, relating this to the electric field between the plates and the direction of movement of the electrons. This was sometimes better explained with a sketch diagram showing field direction and the direction of deflection of the electron in the field. Many weaker candidates seemed to think that this question was about electron flow in a magnetic field or suggested connecting both plates to positive.

Question 9

This was a question involving the motion of a car and included displacement as a vector, stopping distances, kinetic energy and acceleration.

(a) (i) Few candidates really understood how to measure displacement from the diagram. This could be done by drawing or by calculation involving, for example, Pythagoras' theorem. Most candidates were able to score some credit for using the scale of the diagram and to give an approximate direction such as North East but the bearing of a displacement or the use of points of the compass eluded many candidates, even though this is the most direct method to suggest a direction.

(ii) Good answers succinctly stated that distance is a scalar and displacement a vector. Although many candidates gave a correct answer, some responses were too vague and referred to the shortest and longest distances between two points and did not refer to the direction being involved in displacement and not in distance.

(iii) It was encouraging that many candidates were able to make the link that the car is changing direction and good answers included both a change of direction and a change in velocity or a reference to centripetal force or acceleration. Many candidates suggested that the car is accelerating due to a change in direction or 'turning' but failed to link this to a change in velocity. A common misconception was that the car accelerates because it is going downhill, even though the question says that the car has constant speed. Weaker answers confused resultant and gravitational forces, suggesting that going uphill needing acceleration in order to remain at constant speed.

(b) (i) This section was well answered by the majority of candidates; however a significant proportion stated that thinking distance was a 'time' rather than a 'distance'.

(ii) There were many good suggestions for factors that increase braking distance, usually factors that reduce friction either at the surface of the road or at the tyres, or increase the mass or speed of the car. Some candidates gave answers that were too vague e.g. just stating 'speed of car' rather than 'higher speed'. Weaker answers suggested factors that affect thinking distance rather than braking distance.

(c) (i) Almost all candidates gave the correct equation for kinetic energy but a small number of candidates failed to square the velocity when substituting numbers into the equation. Calculations involving powers of ten, in this case positive powers, were usually correct.

(ii) Although knowledge of the formula $F = ma$ was well known, this section produced the lowest average mark of the calculations in this question. This was often because the unit for acceleration was omitted or wrong, or that the mass was changed from kg into grams when used in the equation.

(iii) Most correct answers made a reference to friction, although some candidates merely referred to 'rubbing' or 'heat produced' and others referred to friction in the wrong place, e.g. between the driver's foot and the pedal.

Answers: **(a)(i)** 52 km 073°, N(73°)E **(c)(i)** 540 000 J **(ii)** 1.5 m/s^2

Question 10

This was a question about a soldering iron and a thermocouple used to measure its temperature.

(a) The answers to this question produced relatively few fully correct answers. The melting point of the metal used in the tip, 1000 °C, was correct more often than the melting point of solder, 200 °C. The metal used in the tip must still be a solid at 380 °C and so should melt above that temperature and the solder must be liquid at 380 °C and solid at room temperature, 20 °C. Choosing the melting point for solder as 380 °C is not appropriate as the solder would still be a solid at this temperature and not melt when placed on the soldering iron.

(b) (i) It was encouraging that most candidates used the correct formula and the temperature rise in the calculation. A few candidates confused thermal energy and specific heat capacity and the formula $E = mcT$ is recommended, using E for the energy.

(ii) The majority of candidates were successful in this section.

(c) (i) The best answers mentioned electron diffusion from the hot end to the cold end and suggested that electrons hit other particles to pass on their energy as they move throughout the metal. A number of answers failed to mention electrons at all or were answers where conduction was the passage of thermal energy from one vibrating particle to another, the process involved in non-metallic conduction.

(ii) Almost all candidates obtained some credit for realising that hot air rises. It was unclear in a number of answers that air, rather than particles of the metal tip were rising. The explanation was often attempted in terms of a change in density and the simple explanation that hot air expands and becomes less dense was the most succinct answer. Molecular explanations for the change in density were often not helpful and did not make clear that the air as a whole, when heated, was less dense.

(d) (i) The circuits drawn usually involved a hot junction and a meter. A cold junction was also often shown but was not required as the junction with the meter can act as the cold junction. The feature most often omitted was that there should be two different metals at the hot junction and it was encouraging to see specific metals named in good answers.

(ii) The most common reason why a thermocouple is suitable was most often quoted as being because 'it can measure high temperatures' or 'has a large range'. Other possibilities, such as its speed of response, its small size or the fact that it gives an electrical output were less often seen. The sensitivity, cost or ruggedness of a thermocouple were not accepted.

Answers **(b)(i)** 790 J 073°, N(73°)E **(ii)** 270 J

Question 11

This was a question about nuclear fusion, fission and the Geiger Marsden experiment.

(a) (i) This section, surprisingly, produced the poorest response in the question. The question asks for the cause of an initial collapse in a cloud of gas in space. Rarely was the simple answer of gravitational attraction mentioned and often the answer started off by describing the high temperature.

(ii) Although many candidates recognised that high temperature was necessary for nuclear fusion to occur, other conditions such as high pressure or high density were less commonly given. Some candidates mentioned specific temperatures which were sometimes the surface temperature of the Sun, 4000 °C, rather than a core temperature.

(b) (i) The majority of candidates correctly gave protons and neutrons as the particles found in the nucleus of uranium and gave the correct numbers of each. Some answers gave fission decay products such as krypton and barium or alpha and beta particles, rather than the particles actually found inside the nucleus itself

(ii) It was common knowledge that isotopes contain the same number of protons. Weaker answers mentioned just 'protons' without mentioning the 'number of protons'. A few answers also added the same number of electrons, which was not penalised.

(iii) The description of nuclear fission required a neutron hitting or being absorbed by the uranium nucleus, splitting into two particles and the emission of more neutrons. A significant proportion of candidates failed to mention the role of the neutron at all or gave details about a nuclear power station, such as the moderator or control rods, which were not required.

(iv) The general difference between fission and fusion in terms of fission involving splitting and fusion the joining together of nuclei was used most commonly as the answer to this section. Even though the language used was sometimes vague, the general understanding of the difference was well known. Other differences such as the fact that the waste products in fusion are likely to be less radioactive for long were sometimes seen.

(v) The equation, when attempted, was almost always completely correct.

(c) (i) Over half of the answers correctly located P, the place where most flashes occur, in the middle of the screen on the right.

(ii) All that was required was a description that fewer flashes are seen moving away from P. Only a few candidates suggested that the flashes were less frequent and many answers, on the right lines, suggested that the flashes were dimmer, weaker or that there were no flashes at all.

(iii) Where candidates appeared to have met the experiment before there were some very sensible and well-written answers suggesting that the centre of the atom (the nucleus) is small, contains most of the mass and that the charge is concentrated there. Candidates who may not have met the experiment before often answered in terms of the absorption properties of the alpha particle.

Answer: **(b)(i)** proton number 92; neutron number 143

PHYSICS

Paper 5054/42
Alternative to Practical

Key messages

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

- Handling practical apparatus and making accurate measurements.
- Tabulating of readings.
- Graph plotting and interpretation.
- Manipulating data to obtain results.
- Drawing conclusions.
- Understanding the concept of results being equal to within the limits of experimental accuracy.
- Dealing with possible sources of inaccuracy.
- Control of variables.
- Choosing the most effective way to use the equipment provided.

General comments

The level of competence shown by the candidates was sound, although, as in previous years, some candidates continue to approach this paper, as they would a theory paper, and not from a practical perspective. Candidates need to think about what they would do in a practical situation rather than try to answer the question from the point of view of a theory paper.

The better candidates were able to follow instructions, record observations clearly and perform calculations accurately and correctly, although a few were unable to give an answer to the correct number of significant figures. Units were generally well known and usually included where needed. The standard of graph plotting continues to improve.

Comments on specific questions

Question 1

(a) Most candidates drew the correct symbol for a voltmeter and placed it in parallel with the heater. Very few candidates drew the voltmeter connected in series in the circuit. Candidates should be reminded that correct symbols for electrical components are required. A voltmeter symbol with a line drawn through it was not accepted for credit.

(b) (i) The scale of thermometer was read correctly by the majority of candidates. Commonly seen incorrect answers were 41.0 °C and 48.5 °C.

(ii) 1 The best answers stated that when the heating coil was completely immersed, all the thermal energy produced by it would be transferred to the water and that none would be lost to the surroundings. A commonly seen incorrect answer given by candidates was ‘so that all the water could be heated’.

2 Most candidates realised that the water was stirred before taking each temperature reading to ensure that all the water was at the same temperature.

(c) (i) The graph question was done well, with many candidates scoring 3 or 4 marks. The axes were usually labelled, and sensible scales were chosen. Some candidates ignored the instruction to start the temperature axis at 20 °C and as a consequence, lost credit.

There were far fewer 'awkward' scales (multiples of 7, etc) seen this year. Such scales provide problems with plotting and are not easily read.

Most candidates plotted the points accurately and made good attempts at drawing a curve of best-fit, as requested.

Candidates should be reminded that they need to plot to the nearest half square. Plotting all the points on grid intersections can sometimes mean an error in the plot.

(ii) Candidates were asked to use their graphs to determine the temperature rise of the water in the first 200 s of heating. Almost half of the candidates determined the temperature of the water after 200 s correctly, but did not subtract the initial temperature of the water from this value.

(d) (i) Most candidates substituted correct values into the given equation to calculate the thermal energy supplied by the heater in the first 200s.

(ii) The determination of the specific heat capacity of the water was done well, with candidates making correct substitutions of their values into the given equation and rearranging the equation correctly. Occasionally the mass of the water was converted into kilograms before substitution, and the answer was out by a factor of 1000. Answers were usually quoted to a sensible number of significant figures, but there were many examples of incorrect rounding of the final answers. Candidates should be reminded to round their final calculation values correctly and not simply truncate the value obtained on their calculator.

(e) (i) Most candidates were able to examine the apparatus set-up in Fig. 1.1 and make a sensible suggestion as to why their calculated value of the specific heat capacity *c* was inaccurate.

(ii) Sensible improvements to the apparatus set-up to produce a more accurate value of *c* were made by most candidates. Most answers followed on from candidates' suggestions in **(e)(i)**.

(f) Very few candidates realised that the temperature of the water stopped rising when it reached 82 °C because the hot water was losing thermal energy at the same rate that the heater was supplying it. Most answers stated that the water had begun to boil at 82 °C, and as a consequence of this, the temperature remained constant.

Question 2

(a) The angle of incidence of the ray of light at point X was measured correctly by most candidates. A commonly seen incorrect answer was 60° instead of 30°

(b) (i) Most candidates used a ruler and protractor and drew neat diagrams. The refracted ray was usually drawn correctly; some answers showed it on the wrong side of the normal inside the prism.

(ii) The normal at the point of emergence of the ray from the prism was usually drawn correctly. The most frequent error was to draw the normal at the point of emergence as a vertical line, instead of at right angles to the prism surface.

(c) Only a minority of candidates were able to explain completely how the path of the emergent ray could be marked on the paper. Most candidates described a method of using pins or marking the emergent ray with crosses. Very few went on to complete the description by stating that a ruler and pencil should be used to join the pinholes or the crosses with a straight line back to the prism surface.

Question 3

(a) (i) Most candidates realised that the bottom of the ball needed to be level with the point of release, 55 cm.

(ii) The position of the eye, correctly placed to view the height of the ball was well understood. The majority of candidates drew an eye looking towards the ball and perpendicular to the ruler.

(b) (i) Despite the instruction in the stem of the question to use all of the results, the majority of candidates only used three results and discounted the first value of 55 cm. The averages were usually calculated correctly, but many candidates did not record the final answer to 2 significant figures.

(ii) Only a small minority of candidates gave a correct response to this question. Most candidates did not appreciate why it would be inappropriate to give the bounce heights to the nearest millimetre. Most candidates made reference to the fact that the ball would be moving too fast, when in fact, it is at rest when it reaches the highest part of the bounce. All that was required was a realisation that the bounce height would be very difficult to judge because the ball is only momentarily at rest and its direction changes quickly, so there would not be enough time to read the scale to that precision.

(c) Candidates met with much more success here, and most realised that for a drop height of 10 cm, there would not be enough time to read the scale or that it would be difficult to lower the head in time to take the reading.

Question 4

(a) (i) Most candidates realised that if the box contained a broken wire, then the lamp would not light. Very few candidates added to this statement to say that this would be true whichever way around the terminals P and Q were connected to the crocodile clips. This omission was not penalised in this part of the question.

(ii) Very few candidates produced a satisfactory answer to this straightforward part.

Most candidates realised that if the box contained a connecting lead, then the bulb would light when terminals P and Q were connected to the crocodile clips. Only a small minority of candidates stated that it would also light when the connections to P and Q are reversed. This extra reasoning is important because it is the only way to distinguish between the connecting lead and the diode.

(iii) This part was again poorly answered with most candidates describing the action of a diode, rather than what they would do to determine if the component in the box was a diode.

(b) Candidates met with much more success here, with most realising that if the circuit was connected to the box containing the resistor, the lamp would light less brightly, or the ammeter reading would be less.