PHYSICS

Paper 5054/11
Multiple Choice

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

General comments

There were candidates who were awarded almost full credit on this paper. Other candidates found the questions challenging. On this paper, **Question 11**, **Question 33** and to **Question 40** were answered correctly by almost all candidates.

Candidates should be reminded to read questions carefully before selecting their answer and ensure that they leave time at the end of the paper to check their answers.

Comments on Specific Questions

Question 3

This question was very challenging for some candidates and only the strongest candidates answered correctly. Although most candidates realised that between the two times referred to, the train is moving towards the station, a significant minority chose options that indicated that the train is moving away from the station. However, of those who had the train moving in the correct direction, the majority selected an incorrect option, **B** and indicated that the speed of the train is decreasing.

Question 8

Many candidates chose that option that corresponded to the correct mass in this question with the remaining candidates choosing the other options in more or less equal numbers. Stronger candidates deduced that the centre of mass of the beam is 10 cm from the pivot and then applied the principle of moments to obtain an equation. The moments needed to be calculated using the weights of the beam and the 200 g mass.

Question 12

This question was answered correctly by only a very small number of candidates. Many candidates simply doubled the depth *d* and incorrectly chose option **B** without considering the effect of atmospheric pressure. The total pressure at depth *d* is 2*P* and so the pressure due to the depth *d* of water is *P*. To reach a total pressure of 4*P*, the pressure due to the water has to increase to 3*P* and so the depth must triple.

Question 19

Candidates are expected to know that boiling is a change of state that occurs without a change of temperature and that temperature is related to the motion of the molecules and so to the kinetic energy. Option **D** was the most popular incorrect choice as many candidates did not consider the kinetic energy possessed by the molecules of ice as they vibrate about a fixed position. Many other candidates chose option **C**.

Question 21

Although the correct option here was the most frequently chosen, two of the other options were selected by a significant number of candidates. These reflected two common misunderstandings. Candidates who chose option **A** are likely to have used the angle shown rather than its complement as the angle of refraction. Candidates who chose option **D** have simply divided 32° by 1.4 and ignored sine functions.

Question 22

In two diagrams in these options the reflected ray is at right angles to the incident ray even though the angle of incidence is not 45° and in two diagrams the ray is shown being refracted towards the normal as the light leaves the block and returns to the air. This refraction direction is only correct for light entering a flat-sided block.

Question 24

The first two options in this question suggest that dispersion only occurs as the light leaves the prism and that the white light is refracted at the first face but then travels through the glass as a single ray of white light. This is not the correct as dispersion takes place at both the first face and the second face as shown by the second two options. Very few candidates chose options with the spectral colours in reverse order and the correct option was the most popular.

Question 26

Only stronger candidates selected the correct option. Many other candidates choose option **B**. Copper is not a magnetic material and so a copper rod with a South pole is not a possibility.

Question 27

The majority of candidates chose option **A** which has the electric field pattern (rather than the magnetic field pattern) and the correct direction. The correct pattern with the wrong direction was also a popular (but incorrect) choice.

Question 30

Most candidates selected options **C** or **D** with very few choosing other options. Both of these options included the correct significant figures but option **D** is ten times too large. Candidates need to convert the power 100 W to 0.100 kW but no other conversion is needed; the price is given in dollars as are all the answers.

Question 34

This question depended on the realisation that of the statements, neither 1 nor 2 refer to changes that affect the direction of the force whereas both 3 and 4 refer to changes that reverse the force and so if these changes are performed, the two reversals return the force to its original direction. The other options include one of the statements from each of the two categories.

Question 35

The rate of rotation of a magnet near the coil of an a.c. generator affects both the magnitude and the frequency of the induced e.m.f. The effect on the magnitude is often ignored and candidates who did not consider the effect on the magnitude of the e.m.f. often selected one of the first two incorrect options.

PHYSICS

Paper 5054/12
Multiple Choice

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

General comments

A few candidates obtained either full credit or nearly full credit. Other candidates found the questions challenging. Almost all candidates supplied to correct answer to **Question 11** and **Question 16**.

Candidates should be reminded to read questions carefully before selecting their answer and ensure that they leave time at the end of the paper to check their answers.

Comments on specific questions

Question 2

Although most candidates chose the correct option, many selected the incorrect option, **A**.

Question 19

Candidates are expected to know that any property that changes with temperature can be used to measure temperature and that resistance is such a property. It follows that option **C** is correct.

Question 24

To answer this item correctly, candidates must apply both the law of refraction and the law of reflection correctly. In two options the reflected ray is at right angles to the incident ray even though the angle of incidence is not 45° and in two diagrams the ray is shown being refracted towards the normal as the light leaves the block and returns to the air.

Question 26

This question assesses knowledge of the position of an object that is being viewed through a lens acting as a magnifying glass. Many candidates chose the correct option but a few chose a different answer.

Question 28

Many candidates selected the correct option for this question. Of the candidates who chose incorrect options, most chose option **C** which is twice the correct answer. The *4.0 s* given in the question is the total time for the sound to travel to the cliff and then to return as an echo.

Question 30

Only stronger candidates selected the correct option. Many other candidates choose option **B**. Copper is not a magnetic material and so a copper rod with a South pole is not a possibility.

Question 32

The correct option was the most commonly selected by candidates but many candidates chose option **D.** These candidates possibly did not notice the *k* in front of the Ω in the unit of resistance.

Question 33

The correct option was more commonly chosen than any other but there were many candidates who chose option **D**. Option **D** refers to the current in each of two resistors in series and so there is only one value of the current, the stated 0.50 A.

Question 34

The correct choice was made by many candidates and was more widely selected than any of the others. However, both options **B** and **D** were often chosen.

Question 35

Most candidates selected options **C** or **D** with very few choosing other options. Both of these options included the correct significant figures but option **D** is ten times too large. Candidates need to convert the power 100 W to 0.100 kW but no other conversion is needed; the price is given in dollars as are all the answers.

Question 37

This question showed that a graph can reveal a great deal of information if it is considered carefully. There are only two ramps and the trolley moves more quickly on the steeper ramp. Thus, the time to pass through the coil is less and the graphs show that the time for the induced e.m.f. to return to zero, is less for options **C** and **D** than for **A** and **B**. The options **C** and **D** must be for the steeper ramp. Since **C** induces a smaller maximum e.m.f. than **D**, it must be **C** than has the fewer turns on the coil.

Question 39

Most candidates selected either option **B** or the incorrect option **D. D** represents a neutral helium atom rather than an alpha-particle which is the helium nucleus shown in **B**.

PHYSICS

Paper 5054/21
Theory

Key messages

- Candidates need to plan their answers and take time to read each question thoroughly before starting their written answer. They should structure the detail they provide to match the maximum of number marks available for the question.
- Candidates should ensure that they follow the instructions given in the question and, in a calculation, determine the required quantities.
- Candidates should ensure that they give the unit to a final calculated value. They should use the units quoted in the syllabus, for example m / s^2 rather than N / kg.
- Candidates should show all relevant working in a calculation.

General comments

Equations were generally well known, but weaker candidates gave incorrect units or did not supply them at all. Some units can be worked out from the equation, whereas others, for example N and J, should be known. It is helpful if candidates write out the initial equation or principle being applied at the start of the calculation, particularly where several stages are involved in obtaining the answer.

There appeared to be no evidence that candidates were short of time in completing the paper. A slightly greater proportion of candidates chose to answer **Question 8** than the other optional questions. The performances on **Questions 8** and **9** were broadly similar. The candidates answering **Question 10** performed slightly better.

Comments on specific questions

Section A

Question 1

(a) Almost all candidates made an attempt to draw or sketch the vector diagram. It is important when drawing the resultant that the correct diagonal of the parallelogram or triangle is drawn. In this case towards the NE rather than the NW as was shown on some answers. The question asked for a scale drawing and although many candidates calculated the resultant force correctly, full credit was only obtained if the drawing provided was to scale. The question also asked for the angle between the resultant force and north. Some candidates gave the angle between the resultant force and east.

(b) (i) Most answers described uniform acceleration as a constant acceleration or a uniform increase in speed or velocity. The strongest candidates explained this in more detail, for example as “the same increase in speed in the same time interval”’. Weaker answers stated that uniform acceleration was an acceleration “at constant speed” without realising that constant speed means acceleration is zero.

(ii) The formula involving mass, force and acceleration was well known. There were some missing units in the answers provided.

Question 2

(a) Most answers were completely correct and most candidates recognised that the dull black surface produces the largest meter reading but occasionally the emitted radiation from the dull and shiny white surfaces were confused.

(b) The description of the formation of the convection current required the change in density of the air to be mentioned as well as a description of the full current, with statements such as “the cold air falls”. The question asked for a description of convection in the air but some answers described convection within the water or merely stated that “hot air rises”.

Question 3

(a) The formula for specific heat capacity was well known, but candidates should not write down the formula as Q = mcQ or C = mCT. A significant number of candidates showed confusion between thermal energy and specific heat capacity. Candidates who started by writing the equation as E = mcT or Q = mcT generally showed less confusion and were more successful.

(b) (i) The differences between boiling and evaporation were well known, usually either that boiling occurs at one temperature or that evaporation occurs at the surface.

(ii) Although most candidates recognised that the kinetic energy of the molecules decreases as cooling occurs. Only stronger candidates were able to explain that fewer molecules have sufficient energy or speed to escape at lower temperatures. Weaker candidates provided explanations of why evaporation causes cooling, which was not what the question asked for.

Question 4

(a) (i) The names of the two types of wave, transverse and longitudinal, were well known.

(ii) The diagram was one of the wave displacement against distance rather than against time and so a wave of higher frequency should have a longer repeat distance on the diagram. The waves drawn were often poorly sketched but it was possible to detect that the wavelength was larger in correct answers. Waves of a smaller wavelength or larger amplitude were commonly seen.

(iii) Correct answers to describe the movement included “forwards and backwards”, “to and fro” or “vibration parallel to the direction of the wave”. Although many candidates recognised that the movement was along the axis shown by the arrow, the idea of an oscillation or vibration was lacking in some answers.

(b) This question produced a variety of answers. A larger frequency was generally recognised as being associated with sound of a higher pitch and gamma radiation as having the highest frequency. The use of ultrasound in pre-natal scanning was less common, with many candidates mentioning a component of the electromagnetic spectrum.

Question 5

(a) Although most candidates correctly stated that the lens was converging or convex, a significant number of answers suggested that the lens was diverging or concave.

(b) There were a number of correct approaches to this question, describing the refraction, the change in speed or even the wavelength as the light enters and leaves the lens. Most answers mentioned refraction but for full credit, more detail of this refraction was required, for example as being “towards on entering and away from the normal on leaving the lens”. There was confusion in a number of answers where the light was described as being “refracted towards the normal” on entering the glass lens.

(c) Candidates needed to extend the rays that leave the lens backwards, to the left of the lens. This was done successfully in many cases but other answers showed the rays within the lens extended to the left of the lens. Weaker candidates attempted to draw an image on the right of the lens.

(d) Candidates who had drawn the correct position of the image in **(c)** generally suggested that the image was both upright and virtual.

Question 6

(a) Most answers suggested that the metal bar is cutting the magnetic field of the magnet and many candidates then mentioned the induction of an e.m.f.

(b) This part of the question produced a variety of answers. The reading shown on the ammeter in the first diagram was often recognised as being negative where candidates had read the question carefully and recognised that the questions stated that the original ammeter reading is in the positive direction. In many answers the movement in at least one of the last two diagrams was described as producing a large reading, whereas there should be no reading at all.

(c) The most obvious answer, that the bar should be moved faster, was described by many candidates. Candidates that suggested the bar should be thicker or have a lower resistance did not realise that the question said that the same bar should be used.

(d) Many answers to this section merely stated Lenz's law or that the current opposes the motion. Only a few answers applied Lenz's law to the situation and recognised that this current in the magnetic field of the magnets produces a force downwards when the rod is moved upwards.

Question 7

(a) Most candidates recognised that either a reduction in temperature or a decrease in light intensity increases the resistance of the appropriate component.

(b) (i) The definition of e.m.f. was well known but a few answers incorrectly suggested that the e.m.f. is the force on a charge.

(ii) Stronger candidates suggested that there has to be a voltage across the diode and some answers even gave this value as 0.6 V. Other correct suggestions were seen, such as that there is a voltage across the ammeter or even across resistance in the wires or the battery and that voltages in series components are added to find the e.m.f. of the battery.

(iii) The formula for energy was well known with only a few answers not converting the 5.0 minutes in the question into 300 s for the calculation.

(iv) Most candidates suggested that there would be no reading on the ammeter, but only the strongest candidates explained why this happens, usually by describing that the diode has a high resistance or that it does not conduct when connected in reverse, as shown in the diagram.

Section B

Question 8

(a) (i) This question proved challenging for many candidates. The force *F*, the force on the horse caused by the rider, was most often shown correctly, downwards in the region of the rider. This force was often the only force that was labelled whereas other vertical forces, the weight of the horse and the force upwards from the ground were often just shown as arrows. Horizontal forces were ignored as the horse is stationary.

(ii) There were many correct expressions of Newton's third law and many candidates correctly stated that this law suggests that there is an upwards force acting on the rider.

(b) (i) Most answers showed the centre of mass in the middle of the left-hand fence, but some diagrams showed this positioned incorrectly at the base of the fence. The right-hand diagram usually showed the centre of mass lower than on the left-hand diagram, as appropriate to the extra width of the base.

(ii) Many candidates obtained some credit for recognising that a lower centre of mass makes the fence more stable but only stronger candidates were able to explain why this happens. Some candidates recognised that the extra stability is caused by the centre of mass being inside the base as the fence tilts to a greater angle or that the weight of the fence provides a moment to return the fence as it starts to topple to a greater angle.

(c) (i) The formula for kinetic energy was well known and there were few mistakes in its application. Where mistakes were made, this was sometimes by forgetting that the velocity is squared or by failing to give the correct unit.

(ii) The formula for gravitational potential energy was well known. However, calculating the height involved proved a problem, often because the centre of mass was stated as being initially 1.4 m above the ground or the candidate did not notice that the mass of the horse and rider is given as 520 kg. Many candidates obtained the rise in height of 0.58 m but did not add this value to the initial height of the centre of mass.

Question 9

(a) The symbol for a lamp was well known, whereas the symbol for the variable resistor was sometimes drawn as a fixed resistor. A significant number of candidates placed the voltmeter either in series with the lamp or across the cell rather than across the lamp.

(b) Many answers just suggested that the current reading was taken or described the problem of parallax error, whereas the question asked how the different ranges were used. The strongest answers referred to the nine points on the graph and explained which range was used for these various points. Weaker answers incorrectly suggested that it was possible to obtain different digits in the answer by moving from one range to another.

(c) Most candidates correctly referred to the actual graph shown in **Fig. 9.1** in their answer, for example by suggesting that the graph is not straight or that current is not directly proportional to voltage. A few answers merely stated Ohm's law or mentioned that the resistance is not constant but did not mention the graph.

(d) The formula for resistance was well known and applied with correct values of current being read from the graph but reading the current at 0.40 A proved difficult for some candidates.

(e) (i) Only stronger candidates answered this correctly. Others stated that resistance is proportional to voltage, sometimes quoting the formula $R = V / I$ and not recognising that current also depends on voltage. Only the strongest candidates recognised that the resistance changes because the temperature increases.

(ii) Many answers suggested that resistance increases as length increases and decreases as cross-sectional area increases but stronger candidates expressed this dependency using ideas about proportionality and inverse proportionality.

(iii) In this question candidates had to use direct proportion and also to choose the correct resistance from **(d)**. Stronger candidates chose the lower resistance value, 0.80 Ω, from **(d)** but the majority of candidates who applied proportionality chose the wrong resistance and obtained an answer of 21 cm. However, many candidates applied the correct idea to an unusual problem.

Question 10

(a) Although this question was not always popular, it provided the opportunity for candidates to show their knowledge of radioactive particles. The largest issue in answers was in stating an object that was able to stop gamma-radiation, in particular gamma-radiation was often stated as being "stopped by lead" without giving any indication of the thickness required.

(b) (i) The meaning of the term isotope was very well known with only a few answers that confused the number of protons with the number of neutrons.

(ii) The property most often chosen was the penetration of gamma-radiation.

(iii) If, as was most common, penetration was chosen as the property, more detail was required in answers than was sometimes given. However, many answers did relate the penetration to the specific example and stated that alpha-radiation could not, for example, penetrate the plastic bags. A few candidates incorrectly suggested that the weak ionisation produced by alpha-radiation meant that this radiation was not suitable to sterilise the instruments.

(iv) Most answers were sufficiently detailed and, rather than just saying "the half-life is short" suggested that the source would need to be replaced often or would soon decay to give out very few particles.

(c) (i) Stronger candidates suggested that the alpha-particles are repelled by the nucleus and also explained why this happens, because both the nucleus and the alpha-particle have a positive charge.

(ii) Only a few candidates successfully explained that most of the atom is empty space and this means that an alpha-particle rarely comes close to a nucleus to be deflected as it travels through an atom.

PHYSICS

Paper 5054/22
Theory

Key messages

- Candidates need to plan their answers and take time to read the question thoroughly before starting to answer. They should try to explain logically and chose the length of their answer by looking at the marks available for this question, for example answering with more than one idea if two marks are available.
- Candidates should show all relevant working in a calculation and the unit of the final calculated value.
- Candidates should give their calculated answers to two or more significant figures and check that any rounding is correct.

General comments

Overall, the level of understanding and the quality of answers was mixed, with many candidates displaying gaps in their knowledge. However, there were also some strong performances.

Candidates who started a calculation with a formula answered well because they showed at least partial understanding and also because they usually substituted the correct numbers into the formula, taking into account any conversion between units required. There were few unit errors and very few candidates who systematically omitted units in more than one question.

There was no evidence that candidates were short of time in completing the paper.

Many candidates attempted all three questions from ***Section B***, either in part or completely.

Candidates may draw or use diagrams as part of their answer, for example in:
Question 2(c), where different sections of areas under graph were sketched
Question 4(a), where the equal angle values can be marked on the diagram
Question 7(a), where a labelled arrow was useful to show the current direction.

It is also advisable to use a ruler and pencil where precision is obviously required, for example in:
Question 1(b), to draw a labelled vector diagram to scale
Question 5(a), to draw electric field lines perpendicular to plates
Question 10(a)(iv) and **(b)(ii)**, to draw wavefronts with constant wavelength and a ray diagram.

Comments on specific questions

Section A

Question 1

(a) (i) There were many fully correct answers to this question. The most common answer was that vectors have magnitude and direction whereas scalars only have magnitude. Weaker candidates sometimes gave other details such as “both quantities have units” or confused direction with displacement. There were some very general answers such as “a scalar quantity is more accurate” or “scalars measure short distances and vectors long distances”.

(ii) This question also produced good results with the majority of candidates giving correct answers. Typical examples mentioned were that distance, speed, time or temperature are scalar quantities and that displacement, velocity, force and acceleration are vectors quantities. The most common incorrect answers suggested that speed was slated to be a vector quantity. Very weak answers referred to measuring instruments or general topics such as sound and light.

(b) Stronger candidates showed clearly constructed parallelograms or triangles and some candidates used compass marks to construct the triangle or parallelogram accurately. Stronger candidates also marked arrows, labels and the angle of the resultant on their diagrams. The most common error was to construct a parallelogram and to show the wrong diagonal on the parallelogram, one with a smaller angle to the horizontal than vector P. In a number of diagrams the resultant was correctly shown but the arrow on the resultant was in the wrong direction. Weaker candidates did not follow the instructions which were that the diagram should be to the same scale as in **Fig.1.1**. Such answers often had longer lines for P or Q or the angle between P and Q was incorrect.

Question 2

(a) This question, involving the interpretation of a speed-time graph, was answered correctly by most candidates, reading from the graph the time when speed changes from 20 m/s as 1.4 s. However, a significant number of candidates gave the answer as 1.2 s by misreading the scale on the graph as being one small square representing 0.1 s rather than representing 0.2 s.

(b) (i) Stronger candidates stated “the same change in speed in unit time” or “the same change in speed in the same time interval” as their answer. However, there were many incorrect answers and some candidates merely defined acceleration or stated that “acceleration is constant”, “speed changes constantly”, or just stated that the gradient of the graph is constant. A small number of weaker answers used speed to mean rate or gave an answer such as “the velocity is increasing at a constant speed”.

(ii) There were many good answers to this question in terms of the line on the graph not being straight or the gradient not having a constant value. A few answers merely stated the meaning of deceleration without looking at **Fig 2.1**.

(c) The concept of finding the distance by using the equation average speed × time or from the area under a graph was well understood. Many candidates showed the different areas that they found in their calculation, which allowed maximum credit to be given for those answers. The question asked for the distance covered after the car starts to slow down but many candidates calculated the distance covered from $t = 0$. A significant number of candidates used incorrect equations to calculate the area of a triangle or trapezium.

Question 3

(a) Many correct explanations for finding the mass were seen, usually using the equation $W = mg$ in symbol form or in word form, with the correct quantities given. Other correct answers stated that the mass is found by dividing the weight or the reading on the spring balance by some factor relating to g. However, there was confusion about the terminology for g. It was often referred to as just gravity or gravitational force rather than gravitational field strength or acceleration of free-fall. A number of candidates described how to take the reading itself and did not mention the conversion of a reading of a force to a value of the mass. Weaker candidates referred to force and extension to determine the mass.

(b) (i) The majority of answers were correct statements of the principle of moments. Stronger candidates also mentioned that the moments were measured about the same point or pivot. Weaker candidates only gave the formula for calculating a moment or did not use the term “moment” at all, sometimes giving a general description of the object being balanced, often in terms of balanced forces or masses.

(ii) Those candidates who gave clear steps in their working generally answered well as they included the formula and the correct substitution for the values. The most common mistake was to use both of the distances from the newton meter rather than from the pivot. A number of candidates only worked out one moment, usually showing $3 \times 30 = 90$ N. The correct unit was usually given for the answer. However, sometimes this unit was omitted or was incorrect.

(c) Some candidates found this question challenging and showed a variety of misconceptions relating to mass and gravitational field strength. Those obtaining some credit usually mentioned that a force acts upwards on the brick from the water. However, a large number of candidates who gave completely incorrect responses suggested that there is now no gravitational force acting or that the weight or mass of the brick decreases. Weaker candidates gave very general answers such as "the water affects the reading", "the brick's density is less than water" or "the brick is floating". Stronger answers described how the pressure of the water causes a force upwards on the brick, or explained that the decreased force acting upwards causes a reduced anticlockwise moment which then requires a smaller force from the newton meter to achieve balance.

Question 4

(a) (i) The syllabus mentions simple experiments to show the reflection of sound waves and the majority of answers showed the tube in the correct position to receive reflection of sound. A few answers showed the tube touching the smooth surface or placed against the barrier and would not have been suitable to hear the sound.

(ii) Although many candidates mentioned that reflection occurs, relatively few candidates were able to explain that the reflection occurs so that the angle of incidence equals the angle of reflection. A significant number of candidates mentioned refraction instead of reflection.

(b) The value for the speed of sound in a solid was usually given as higher than 330 m/s but often not sufficiently high enough. A wide range of values were seen, including the speed of light. A few candidates omitted the unit for their answer.

Question 5

(a) The shape and direction of the electric field between the plates was usually correct. Common errors were to show the magnetic field of a current carrying coil or even the magnetic field of a bar magnet rather than an electric field. A number of candidates did not draw arrows on their field lines to show the direction of the field or drew the arrows in the wrong direction. Candidates should be advised to draw field lines carefully, preferably with a ruler if they are straight lines. These lines should touch the metal plates. The edge effects were not required.

(b) (i) The question asked for a description of the movement of charge and not for the forces that act on the charge. "Repulsion" or "attraction" were taken as forces rather than movements and it was rare to find an answer in which electrons were clearly stated as moving downwards from the top layer to the bottom layer of sand grains. A significant number of candidates incorrectly referred to the movement of positive charge or mentioned positive electrons.

(ii) Most candidates understood that unlike charges attract in answers. Some candidates did not mention that the sand is positive and just said "sand is attracted to the negative plate" and so the idea of charge causing the attraction was absent from their answer.

(c) The majority of candidates answered this question well with only a few not using the equation that relates energy, charge and potential difference correctly. Those candidates who wrote the formula at the start of their calculation were most often successful.

Question 6

(a) There were many correct definitions for power referring to the rate of doing work or change of energy per second or per unit time. There were also many answers that merely stated that power is the product of voltage and current. Although this is true, it is not a statement of what is meant by power. Weaker candidates gave very general answers such as "the amount of current of energy to light the lamp" or "the amount of energy something produces".

(b) (i) Most candidates showed understanding of how to calculate current, given values for power and voltage. The candidates who showed clear steps in their working showed the formula and their working with units. The most common misunderstanding was to attempt to calculate current from power using only the formula $V = IR$. A number of candidates calculated the current as 1.6 recurring but wrote down the answer as 1.6 A which is incorrect rounding.

(ii) The formula relating resistance, current and voltage was very well known. There was correct use of units in most answers.

(c) Fully correct answers were usually set out logically making use of relationships to justify the answers. Many candidates were able to recognise that the resistance of the wire increases if it is thinner and of the same length but were unable to explain how this affects the power output or they stated that as resistance is higher, power must then be higher. This was sometimes accompanied by the formula $P = I^2R$, with candidates not realising that current is also affected by the increased resistance.

Question 7

(a) There was some confusion here between the d.c. motor and the a.c. generator. This was shown when some answers referred to electromagnetic induction or to the right-hand rule or when the word induction was used even when not talking about electromagnetic induction. e.g. "the battery induces a current in the coil". Most candidates mentioned either the use of the left-hand rule or gave the correct direction of the current, e.g. "current is from A to B" or "current is from positive to negative" but did not apply the left-hand rule in detail to show the forces on opposite sides of the coil. However, few candidates gave sufficient detail for full credit.

(b) (i) Although most answers showed an understanding that adding the soft-iron cylinder causes a stronger magnetic field or that the soft-iron magnetises easily, many answers did not then explain how this increases the turning effect. Stronger answers described the increased forces on the sides of the coil if the magnetic field is increased.

(ii) This question was answered well by most candidates with "larger current" and "more turns on the coil" being the most common answers.

Question 8

(a) Very clear working out was seen in some answers, where the combined resistance for each calculation, the current and the voltage were clearly calculated. Alternatively, the potential divider formula was clearly shown with correct substitutions being made. Incorrect answers to the second calculation often used the same current initially calculated for the two 8.0 ohm resistors. Another common mistake was to see the equation $V = IR$ applied with the 6.0 V taken across one resistor, even though it is applied across both series resistors. Although the working did not need to be shown, space was left for the working and some candidates with the wrong final answer were able to score partial credit for showing, for example, the potential divider formula.

Either

(b) (i) Only stronger candidates were able to show the correct symbol for the light dependent resistor. The most common incorrect answer seen was that of a variable resistor or a thermistor. Sometimes the variable resistor arrow was included within the symbol for the LDR.

(ii) In this question many candidates incorrectly stated that resistance increases when the LDR moves from darkness to light. Even those answers where the resistance of the LDR was stated as decreasing did not always recognise that the output voltage is across the fixed resistor and that this voltage will increase.

(iii) Most candidates were able to state that a thermistor is used. A variety of incorrect answers were seen including a variable resistor, switch, thermostat, capacitor, filament bulb, diode and LED.

Or

(b) Few candidates answered this question. Those that did, often gave the correct symbol for the NOR gate, but this was sometimes shown with only one input. Very few candidates were able to give any meaningful description of what is meant by a bistable circuit, often writing "it has two inputs and one output" rather than that it has two stable states and can be made to switch from one to the other by an applied signal.

Section B

Question 9

(a) This question was well answered in all four parts. However, there were a few misconceptions. Although the form of energy stored in the battery is chemical potential energy, a number of candidates suggested that it was stored as electrical energy. Similarly the useful forms of energy output from the mobile phone are light and sound but a number of answers included heat as a useful form of energy output.

(b) Most candidates produced the correct answer, with clear working showing the conversions from mA to amperes and minutes to seconds. A number of incorrect answers did not convert from mA to A or from minutes to seconds. Some candidates wrote down the formula $Q = It$ correctly but replaced 1.3 for Q in the formula and effectively used I / t to calculate the charge. The unit was well known.

(c) (i) The majority of candidates were able to determine the correct value for the thermal energy, particularly where clear working with the correct formula were shown. It is not helpful to write the formula as $C = mcT$ as this seems to lead to confusion between specific heat capacity and thermal energy. The most common mistake in those who gave the formula correctly was not converting the mass to kilograms. Some candidates did not understand or read the question carefully and used 5200 J for the heat energy supplied and calculated a temperature rise, or having correctly worked out 456.5 J, subtracted this from, or added this to, the useful energy output of 5200 J.

(ii) Only stronger candidates were able to state the full meaning of efficiency. Candidates should make clear that the ratio they describe is the useful energy output divided by the energy input. A number of answers had this ratio inverted or did not make clear that it is the useful energy output that is used in the numerator. Weaker candidates often gave a general statement such as “the amount of energy stored” or “how a good the battery is in using energy”’.

(iii) It was very common to see candidates just using their answer from **(i)** and dividing this by 5200 J, even though the question clearly stated that the useful energy output is 5200 J. This meant that fully correct answers were only given by stronger candidates. Those answers that gained full credit gave their working out in a logical and methodical order which enabled them to realise that if the thermal energy lost is 460 J and the useful energy output is 5200 J then the total energy input is 5460 J.

(iv) Most candidates were able to gain at least partial credit by mentioning that energy was lost, usually in the form of heat from the battery or the mobile phone. This loss is in addition to the thermal energy, measured from the temperature rise within the battery. Candidates who scored full credit usually then mentioned that the temperature change should be larger than 5°C or that the energy loss value used in the calculation, 460 J, is too small. Weaker answers merely stated that the student had only estimated the values used or gave general answers such as “the mobile heats up”, “the heat of the battery increases” or “the phone is not always on so battery wastage is reduce”’.

Question 10

(a) (i) Although this is a simple determination of the wavelength from the diagram, many candidates interpreted **Fig.10.1** as showing five, rather than four, complete wavelengths in 12 cm and so obtained an answer of 2.4 cm rather than 3.0 cm. There were also candidates who believed this to be a calculation and tried to use $v = f\lambda$ in some way. They were sometimes successful if the speed was calculated correctly from the distance and time but recognising that a wavefront travels 12 cm in a time of $5.0 \times 4 / 10$ s often proved too difficult.

(ii) The majority of candidates recognised that frequency = 1 / time period. However, few were completely successful in determining the frequency, as the value used for the time period was that for 10 complete up and down movements and not the time for one period. The unit of frequency was well known.

(iii) The formula $v = f\lambda$ was well known and most candidates were successful in this question, but a significant number of candidates gave the unit of their answer as m/s where the wavelength they used was in cm.

(iv) This question proved challenging for many candidates who recognised that the frequency remains the same but then linked the box labelled as “speed” with the only other unlinked box, rather than recognising that the speed also increases if wavelength increases.

(v) Although few candidates gained full credit on this question, there was some general understanding shown by the wavefronts produced. Most candidates drew wavefronts that met the wavefronts in the shallow water. Some candidates drew parallel wavefronts at equal distances apart but very few candidates drew wavefronts refracted in the correct direction, with an increased wavelength. Many wavefronts were drawn at right angles to the boundary and along the normal. The weakest answers missed out every other wavefront or just drew vertical lines.

(b) (i) The majority of candidate gave four colours in the visible spectrum but a few candidates gave infrared and ultraviolet as part of the visible spectrum. Full credit was not awarded often as the colours were often given in the reverse or a wrong order.

(ii) Many candidates did not recognise how to split white light into different colours, most often using a prism. Those who used a prism also did not always show how a narrow beam is produced, usually with a slit. The most common correct answers seen were the drawing of a prism and then dispersion of a ray of light, usually when leaving the prism. Correct refraction at both the first and second faces of the prism was rarely seen but those candidates who used a prism generally showed some understanding of dispersion and refraction.

Question 11

(a) The electron was well known as the particle with the same mass and charge as a beta-particle.

(b) Many candidates either suggested that the metal case was able to stop or absorb the beta-particles or that it provided protection or safety for the person carrying out the experiment. However, not all candidates mentioned both of these points in their answer. There was some confusion when candidates suggested that the metal casing stops the radioactive source, rather than the beta-particles, from escaping.

(c) This question was intended to examine the understanding of the approximate distance travelled by a beta-particle and what happens to a beta-particle in air. Most candidates gained at least partial credit for these questions and recognised the penetrating power of beta particles. Many candidates realised that there is a slight decrease in the reading in **(i)** but did not go on to explain that this was due to the particles spreading out or that some of the particles are stopped or absorbed by air. In **(ii)** there is a large reduction in the reading but it was rare to see a reference of the range of beta-particles in air or a clear description of why the readings are reduced. On the rare occasions that ionisation was mentioned a common and significant error was made when the beta-particles themselves were stated to become ionised whereas it is the air atoms that are ionised as the beta-particles pass through the air.

(d) Many candidates were successful in this question, with only a few candidates giving the proton number of yttrium as 37 rather than 39.

(e) (i) The difference in the processes of fusion and fission was generally well understood and usually presented clearly. However, a significant number of candidates were unsure about the type of particles involved in fusion or fission, often describing them as atoms, elements or even nuclides rather than nuclei. A number of candidates used the words collision, fuse or fusion when describing nuclear fusion without mentioning that fusion involves a joining together of the nuclei. Candidates should be encouraged not to use words that are part of the process they are describing. Some candidates wrote at length, for example on fission, mentioning the involvement of neutrons. This was rarely wrong but was not necessary.

(ii) High temperature was the most common condition mentioned for nuclear fusion to take place. High pressure or a high density of particles was also mentioned. Many candidates also discussed what happens in the Sun as part of their answer.

PHYSICS

Paper 5054/31
Practical Test

There were too few candidates for a meaningful report to be produced.

PHYSICS

Paper 5054/32
Practical Test

Key messages

- In order to give good responses to the questions, candidates should be reminded to make careful observations and make accurate measurements.
- Repeat measurements should written down, and the working for any averages calculated should always be shown.
- Units for quantities should also be stated and measurements and final answers given to an appropriate degree of precision.
- Readings from analogue instruments, such as some ammeters and voltmeters, should always be written down to the precision of that instrument.
- In the case of answers where the unit required is printed on the answer line on the question paper, candidates should ensure that their response is given in that unit.

General comments

This examination tested practical physics skills such as following instructions safely and accurately, making measurements using simple equipment, collecting sets of data and processing them, and making comments or drawing conclusions about the experiment performed.

Stronger candidates were able to read the question and perform the tasks requested by following the instructions accurately, making accurate observations and taking measurements carefully to an appropriate degree of precision using the equipment provided

It is in the interest of the candidates that a complete set of results for each set of apparatus is provided with the Supervisors' reports.

The plotting of graphs would have benefited from further focus. Many otherwise good responses to questions involving the plotting of graphs used impractical scales based . The plotted points on graphs should be marked with small, fine, but visible crosses which are accurately placed. The Cartesian axis system should be used. The best-fit straight line or curve should be a carefully drawn, thin line. A line drawn from the first plotted point to the last is rarely a best-fit line.

Comments on specific questions

Question 1

A rectangular block was used to investigate the reflection and refraction of a light ray. In order to obtain good, accurate measurements is important for ray diagrams to be drawn carefully, using thin lines, in pencil. Identifying letters (D, E, G) should have been placed close to the point to which they referred (within 1 cm would have been suitable).

(a) Stronger candidates showed that the refracted ray would have followed a path from point **C** to point D and on to point E where it would have met line **FF** on the left-hand side of the diagram. The reflected ray would have followed a path from point **C** to point G where it would have met line **FF** on the right-hand side of the diagram. In a correct diagram, for most blocks, CDEG would have been a quadrilateral with DE as the shortest side and EG the longest. Weaker responses were often poorly drawn, often with incomplete diagrams with lines absent and either or both of points E and G off the line **FF**.

(b) The length *d* (from point E to point G) along line **FF** should have been recorded in cm with a precision of +/– 0.2 cm. Stronger responses with a correct diagram obtained values in the region of 15 cm. In some other responses it was impossible to identify the points E and G.

(c) Candidates were required to place a 'normal' to the surface of the block at point **C**. It is a requirement for a correct normal that the line is extended on both sides of the interface and be of sufficient length to permit angles to be measured accurately.

Some candidates recorded the angle to an unrealistic precision of one hundredth of a degree. Some weaker candidates labelled and measured the incorrect angle (e.g. between the block and the incident ray or a used the ray within the block).

(d) Stronger candidates recorded the observation that as the incident angle increased, the length *d* decreased. This part of the question only required the relationship between *i* and *d* to be described in words.

Weaker candidates often provided insufficient detail, e.g. the response just stated that as one quantity changed the other quantity also changed.

Question 2

The electrical circuit comprised of a power supply, an ammeter, a LDR, and LED in series and a voltmeter placed in parallel with the LDR. Candidates were required to switch the circuit on and record the voltmeter reading and observe the effect of moving their hand over the LDR. There were many good responses to the question.

(a) There were many good responses, with acceptable voltage values of 2.7+/– 0.5 Volts.

(b) Strong responses described how the brightness of the light emitted by component Y (the LED) decreased as the candidate's hand progressively covered component X (the LDR) and less light reached the component. Other good responses gave an explanation in terms of what was happening to the current flowing in the circuit, the change in resistance within the circuit and its components, or the distribution of potential difference across the two components.

(c) There were many correct diagrams, but others were not carefully drawn. The placing of the LED with the incorrect polarity was accepted if the LED was otherwise placed correctly in the circuit i.e. in series with the LDR, ammeter and power supply. Some weaker candidates showed confusion about the symbol for the junction of conductors.

Question 3

A system of a pulley with masses at each end of a string (thread) was used to measure the power produced as one mass descended.

(a) Stronger candidates listed two sensible and effective precautions which would have enabled the height, h, of the elevated mass to be measured accurately. Weaker candidates were often too vague and often made simple, insufficient statements such as "repeat the readings".

Some candidates suggested using a set square but did not state how the set square should be used correctly to check that two surfaces are at right angles to each other.

(b) Stronger responses showed evidence that the time for the mass hanger to fall was measured at least twice.

Some weaker candidates demonstrated an inability to transcribe the time displayed on a stopwatch into a time in seconds and wrote down unrealistic times, for example, as a fraction of a second. It should be noted that values for time (of the fall or any other quantity in any other experiment) should not be written in the format of a stopwatch display unless there is a specific instruction to do so.

(c) Stronger candidates listed the total mass of the mass hanger and the lump of modelling clay. Weaker candidates wrote down the mass of just the hanger, the clay alone or the mass of two hangers. Some candidates wrote down the mass in grams even though the unit had been given.

(d) The strongest candidates calculated the power correctly using the given equation and obtained a value in the region of 0.25 W. Weaker candidates often made incorrect substitutions in the formula.

Question 4

A ball was released from various starting points along an inclined track and its average speed was calculated.

(a) (i) The majority of responses were awarded at least partial credit.

(ii) Stronger candidates described two features, each one referring to a different component of the apparatus. A few candidates described how the glass ball had a low enough mass that it did not push the rules apart. Others noted that the metre rules were rigid and straight so that once they were pressed into the clay their height and separation did not vary.

Weaker candidates referred to only the modelling clay or adhesive putty, answering by rephrasing the question rather than give a description of the property of the item.

(b) The average time, in seconds (and not in minutes) of travel down the track from the 100 cm position should have been calculated using two recorded measurements and the working for the calculation shown and many candidates did this.

(c) (i) Many candidates omitted the unit, cm or centimetres, for *d*.

(ii) Weaker candidates often showed times which did not show consistent decreases, indicating poor practical technique, or unrealistic times produced as a result of errors in calculation or inconsistent significant figures for a quantity.

(d) Stronger candidates drew axes and labelled them with both the quantity and the unit, and used sensible scales. The selection of a suitable scale should have been based firstly on the ease of use and secondly, maximisation of the area occupied by the plots.

Weaker candidates frequently used non-integral scales which reversed these priorities. Other candidates used scales that were too small or too large, or were based on odd or prime numbers, making the scales difficult to use.

The graph plotting should have produced a reasonable best-fit straight line. Stronger candidates showed points lying close to and scattered either side of the best fit line, but weaker candidates often showed wider scatter because of the lower quality of the practical work. Some weaker candidates demonstrated poor choice of placement of their best fit straight line.

(e) (i) The strongest candidates showed the correct substitution into the formula and the correctly calculated value (rounded to an appropriate number of significant figures).

(ii) To make a valid comparison, the average speeds were required to be in the same unit, making it necessary to convert one of the values. This conversion was often ignored or the necessity of it not recognised.

Stronger candidates showed the correct conversion, listed the two values, now both with the same unit, to be compared and then made the decision whether the two values were close enough for the proposed theory to be correct or not close enough.

It was not a requirement to calculate percentage differences, but the strongest candidates gave explanations in terms of whether or not the values were within a suggested percentage (typically 10 per cent) of experimental error.

PHYSICS

Paper 5054/41
Alternative to Practical

Key messages

- Candidates should be reminded to include units when quoting the values of physical quantities. They should be encouraged to check that the unit they have provided is appropriate for the calculated or measured quantity.
- Candidates should be made aware that it is important to record measurements to the correct precision
- Candidates should be advised to avoid using set phrases, such as, "to make it more accurate" or "to avoid parallax error". These comments need to be linked to the practical situation being considered, and candidates should state why the accuracy has improved or how parallax error was avoided.
- Candidates should be reminded that, when plotting a graph using data obtained from practical work, there will almost always be some scatter about the line of best fit. Forcing the line through all points will often produce a curve that is not smooth, and candidates should be discouraged from doing this.

General comments

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

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

There were a number of strong performances from candidates. However, some candidates approached this paper as they would a theory paper and not from a practical perspective. Some candidates did not appear to be equipped to take accurate measurements. Stronger candidates were able to follow instructions, record observations clearly and perform calculations accurately. However, some candidates were unable to round their numerical answers correctly or to give an answer a sensible number of significant figures. Units were generally well known and were usually included where needed. The standard of graph drawing was sometimes not strong. Most candidates attempted all the questions and there was no evidence of candidates suffering from lack of time.

Question 1

(a) Candidates were asked to identify a factor which must be the same for a comparison to be made and most candidates realised that the thickness of the wire must be that factor. Some candidates suggested the material of the wire be kept the same but the question had already stated that this was the case.

(b) Candidates were asked to add a voltmeter to the circuit diagram to measure the voltage across the wire. The correct symbol for a voltmeter was almost always seen but many candidates placed it in series in the circuit rather than in parallel across the wire (or across the power supply which would have been acceptable in this case).

(c) The wire was given as 40 cm and so the suitable piece of apparatus to measure this in **(i)** was either a metre rule or a measuring tape. Some candidates incorrectly suggested a ruler which would not have been long enough. In **(ii)**, most candidates read the meters correctly.

(d) Again, most candidate added their values into the table and calculated the resistance of the wire using the equation given. However, a few did not correctly round their value of 6.1818… to 6.2 and so could not be awarded credit. The standard of graph drawing varied. Stronger candidates used sensible scales, labelled the axes with quantity and unit, plotted the points correctly and drew a straight best fit line (using a ruler and sharp pencil) through their points. Weaker candidates either neglected to label the axes fully, had scales going up in intervals of 3, omitted points or plotted points incorrectly and finally drew a poor line.

In **(iii)** the graph was a straight line going through the origin, so candidates were expected to state that the resistance was directly proportional to the length of the wire. Many did not do this. In **(iv)**, candidates were asked to use their graph to determine the length of wire needed to give a resistance of 14Ω and to show how this was done. Candidates who wrote down a value without showing the working on the graph could not be fully credited.

(e) Candidates were asked to suggest a reason for turning off the power supply between readings. There were many sensible answers relating to the heating of the wire but also many strange ones about current being lost or zero errors.

Question 2

(a) The question was about finding the focal length of a convex lens and a diagram was given. Candidates were asked to make two measurements. The units given on the answer line were cm so those measuring in mm gave incorrect answers. Candidates were told that the diagram was drawn to one quarter of full size and were asked to give the actual distances in **(ii)** which most candidates did successfully, and many went on to use their values correctly in the equation given in **(iii)**. However, some made rounding errors or failed to give their answer to two significant figures as instructed.

(b) Only the strongest candidates were able to give a good reason, e.g. “the values agree because they are within 10 per cent (of each other) and so within the range of experimental error”. Many candidates gained partial credit for saying the values were close.

Question 3

(a) The question was about an investigation into the effect of insulation on the cooling of hot water. A diagram was given showing a beaker of hot water with a thermometer. Candidates were asked to suggest a reason why the student waited a short time before recording the temperature. Stronger candidates knew that this was to allow the liquid in the thermometer to come to thermal equilibrium with the water but most did not express it in this way.

(b) Most candidates correctly read the temperature on the thermometer as 84 °C.

(c) The temperature of the water was recorded every minute for 5.0 minutes and a table of results was shown. Candidates were asked to use these results to describe how the rate of cooling changed over the 5.0 minutes. Most candidates just gave a general response and did not use the data given. A comparison of (84 – 76) in the first minute to (62 – 61) in the final minute or similar was expected but few responses showed this. In **(ii)**, candidates needed to use the equation given to calculate the average rate of cooling and to give a suitable unit. Many did the calculation correctly but did not give the unit of °C/min.

(d) The beaker was now covered with a layer of insulation and the experiment was repeated with the results given in a table. Most candidates could see that the rate of cooling had now decreased and suggested how the apparatus could be changed to decrease this further.

Question 4

(a) The question was about investigating the magnetic field between two bar magnets with south poles facing. Most candidates knew that the adhesive putty was needed because these magnets would repel each other.

(b) Candidates were then asked to describe how to use plotting compasses to plot the pattern of the magnetic field. There were some good responses, but many candidates did not clearly explain the idea of the dot in the direction of where the needle is pointing, followed by moving the compass on to the dot for the next point to be plotted. Credit for joining the dots at the end and repeating at a new starting point was rarely awarded. Stronger candidates were able to give a clear diagram. There were some candidates who incorrectly described the use of iron filings despite the question asking for the use of a plotting compass. Many candidates did not put arrows on the field that they drew to give the direction of the field.

PHYSICS

Paper 5054/42
Alternative to Practical

Key messages

- Candidates should be reminded to include units when quoting the values of physical quantities. They should be encouraged to check that the unit they have provided is appropriate for the calculated or measured quantity.

- Candidates should be made aware that it is important to record measurements to the correct precision

- Candidates should be advised to avoid using set phrases, such as, "to make it more accurate" or "to avoid parallax error". These comments need to be linked to the practical situation being considered, and candidates should state why the accuracy has improved or how parallax error was avoided.

- Candidates should be reminded that, when plotting a graph using data obtained from practical work, there will almost always be some scatter about the line of best fit. Forcing the line through all points will often produce a curve that is not smooth, and candidates should be discouraged from doing this.

General comments

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

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

There were a number of strong performances from candidates. However, some candidates approached this paper as they would a theory paper and not from a practical perspective. Some candidates did not appear to be equipped to take accurate measurements. Stronger candidates were able to follow instructions, record observations clearly and perform calculations accurately. However, some candidates were unable to round their numerical answers correctly or to give an answer a sensible number of significant figures. Units were generally well known and were usually included where needed. The standard of graph drawing was sometimes not strong. Most candidates attempted all the questions and there was no evidence of candidates suffering from lack of time.

Comments on specific questions

Question 1

(a) (i) The scale of the voltmeter was read correctly by the vast majority of candidates. When the reading was incorrect, the most common answer was 2.6 V.

(i) Again, most candidates calculated the reciprocal of *V* correctly, and entered their value in the table, as requested. Candidates were instructed to enter their value of 1/*V* in the table to an appropriate number of significant figures. A minority of candidates entered a value of 0.714, instead of 0.71. Some weaker candidates rounded 0.714 incorrectly and entered a value of 0.72 in the table.

(b) Strong candidates were able to make a sensible suggestion about why the switch is opened each time a reading is taken and recorded. Most candidates thought that the switch was opened to avoid electrocution or to allow the voltmeter to reset before taking the next reading.

(c) The graph question was done well, but the labelling of the *y*-axis caused much confusion. The label was almost always present, but even in stronger answers, the unit was often missing. The label on the *y*-axis was usually correctly written as 1/*V*, but candidates sometimes did not add the unit 1/V as well. Most candidates chose sensible scales and followed the instruction to start both axes from the origin.

A few candidates used scales on their axes that were multiples of 7 etc. Using such scales makes it difficult for candidates to plot their points accurately.

Most candidates plotted the points accurately, but the plot at l = 60.0 cm caused problems. Many candidates plotted a 1/*V* value of 1.01, instead of 1.1. Lines of best-fit were usually very good.

Candidates should be reminded that they need to plot to the nearest **half** square, so plotting all the points on grid intersections will sometimes mean an error in the plot.

(d) (i) Some candidates made errors here by choosing points for the gradient calculation were too close to each other. Candidates should use at least half the space between the plotted points at the extreme of the graph line when calculating the gradient of a line. Many candidates did not make it clear on their graphs which points they chose, despite being asked to do so in the question. Occasionally, candidates chose not to use the graph, as instructed, but chose their values from the table of results, even when the points they chose did not lie on the line of best fit they had drawn.

(ii) The best-fit line was usually extrapolated backwards to cut the *y*-axis and the intercept recorded. Most candidates recorded an intercept which was within the allowed tolerance of ± ½ of one small grid square.

(e) The value of k/c was usually calculated correctly. Occasionally the value of this ratio was incorrectly rounded.

(f) Only a few candidates were able to supply a practical reason as to why the e.m.f. of the cell calculated in this experiment may not be the true value. Most candidates described problems with the graph they had just drawn, e.g. difficulties in drawing the line of best fit or accurately determining the intercept on the *y*-axis. Stronger candidates focused on reasons associated with the carrying out of the experiment. Expected responses included difficulties involved with placing the crocodile clip at the exact length of the resistance wire, problems with the resistance wire heating up and zero error on the voltmeter.

(g) Only a few candidates were able to demonstrate an understanding of the meaning of the term "inversely proportional". Of those candidates who did, most stated that the quantities V and l were not inversely proportional because the product Vl was not constant or that the graph of 1/V against l that they had just drawn, did not pass through the origin.

Question 2

(a) (i) Most candidates chose a measuring tape to measure the distance of 120 cm along the slope. No credit was given if a metre rule was chosen. Another common incorrect answer was a trundle wheel.

(ii) Most candidates chose a protractor to measure the angle of the slope. A common incorrect answer was compass.

(b) (i) Most candidates realised that the difference in the three timings of the trolley over the 120 cm was due to the variation in reaction time of the candidate.

(ii) Only stronger candidates produced a correct diagram showing the position of the trolley after travelling 120 cm. Most candidates lined up the back wheels of the trolley with the finishing line instead of lining up the front wheels. A large number of candidates did not give an answer to this question.

(iii) Most candidates calculated the average of the three times correctly. However, some candidates did not know how to calculate an average. Many of these candidates merely added up the three times.

(c) Most candidates substituted their value for *t* into the equation correctly, but few went on to evaluate the acceleration of the trolley correctly. Common errors were incorrect rounding of the final answer, neglecting to square the value of *t*, giving the unit of the answer as m/s^2, when all the values were in centimetres. If a candidate correctly converted to m/s^2 then full credit was obtained. Common incorrect units for acceleration included cm/s, s^2/cm, cm^2/s.

(d) Many candidates suggested a suitable modification to the experimental set-up, so that a more accurate value for the acceleration of the trolley down the slope would be obtained. The most common correct answers were to enlist the help of a second student or to increase the distance travelled by the trolley so that the effect of human reaction time was diminished. The most common incorrect answer was to increase the angle of the slope.

Question 3

(a) (i) The majority of candidates compared the image with the object and stated two differences between them. A common incorrect answer was that the image was virtual.

(ii) The measurements were almost always correct and were given to the nearest millimetre.

(b) Most candidates evaluated and rounded the value of the magnification correctly. However, occasionally answers were given in centimetres.

(c) The focal length of the lens was usually calculated correctly.

Question 4

(a) Most candidates gained partial credit for their descriptions of using a plotting compass to plot the pattern of the magnetic field around a current-carrying wire. Many answers lacked structure and missed out important details of the plotting process. Few candidates stated that when the dots were joined to complete the first magnetic field line then the same process of plotting would continue at different starting points so that the whole pattern of the magnetic field could be seen. Some candidates did not follow the instructions in the question and described the method of drawing the magnetic field for a bar magnet or described how iron filings could be used to map the field.

(b) Only stronger candidates were able to state that the direction or the strength of that the magnetic field can also be deduced from the plotting exercise.