PHYSICS

Paper 5054/11
Multiple Choice

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

General comments

While some candidates performed very well on this paper there were others who found the content challenging.

It is important for candidates to ensure that they spend sufficient time on each question and work through all parts of the question methodically.

Comments on specific questions

Question 3

The correct option was not the most commonly chosen. Candidates who selected option **A** had taken into account the effect of the force of friction, but continued by subtracting it from the resultant force. The friction opposes the driving force and the resultant force is their difference. These candidates had possibly confused the resultant force with the driving force. This was also a confusion that could lead to candidates selecting option **C** which was equal to the resultant force.

Question 4

That the direction of a force and the direction of the acceleration it causes, are in the same direction might be considered obvious. However, here the parachutist is moving downwards and so the effect of the upward resultant force is to reduce the magnitude of the downward velocity. Although this is still an upward acceleration, there were candidates who did not recognise this and who selected option **C**.

Question 10

This question tested the definition of the quantity *moment of a force*. Some candidates did not recognise that the understanding of the expression *perpendicular distance from the pivot* was being assessed.

Question 13

Most candidates selected either option **A** or option **B**. Both involved p_0 and hrg. It was necessary to refer to the diagram to see that the atmospheric pressure had pushed the liquid level in the manometer up towards the gas. Thus, the pressure of the gas was less than that of the atmosphere and so the option with the negative sign was correct.

Question 14

When there is a current in a resistor, then thermal energy is generated and the internal energy of the resistor increases.

Question 22

Most candidates selected one of the first two options. This indicates that the increase of molecular kinetic energy with temperature was very widely known and understood. However, the effect on the potential energy of the molecules was less well known.

Question 23

The correct answer here was **C**. . When ice melts or when water boils, there is no change of temperature although there is a transfer of energy.

Question 29

The light that passes through the optical centre of the lens continues along the same path after leaving the lens. The majority of candidates realised this. It was the other ray that generated confusion. Since the ray was not parallel to the principal axis, it did not pass through a principal focus (focal point). In the correct option, **C**, the rays that were parallel to each other axis, on the left of the lens, met at a point in a plane that was perpendicular to the principal axis and which included a principal focus. This is the way that rays that are parallel to each other behave after refraction. It is probable that many candidates confused rays that were only parallel to each other with rays that are, in addition, parallel to the principal axis. These rays would converge at the principal focus.

Question 34

More candidates selected the correct option than any other and it was clear that the definition of electric field direction was known and could be used by many candidates.

Question 36

In this two-stage question, candidates first needed to work out the resistance of each of the individual resistors. Having calculated this value, many candidates gave this as the final answer. However, there was a second step as the two resistors were then connected in parallel, and the total resistance of the parallel combination needed to be determined. A considerable number of candidates failed to carry this out.

Question 37

The incorrect options presented in this question illustrated several misconceptions concerning current. Most candidates chose an option in which the current in the battery was larger than the other currents but it was the way in which this current divided between the two parallel branches of unequal resistance that led to confusion.

Question 39

All four options in this question were versions of the equation $E = VIt$. The challenge was in selecting the calculation that produced an answer in kW h. Both option **B** and **D** used the time unit *hour* and these were the two most popular choices. However, only option **D** took into account the need to covert watts into kilowatts.

PHYSICS

Paper 5054/12
Multiple Choice

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

General comments

There were a few candidates who answered every question or nearly every question correctly but a number of candidates found the paper challenging.

Candidates should ensure they consider every option given in multiple choice questions. There are incorrect options that may seem correct at first but which after a more careful consideration, are clearly incorrect. Whilst the time available is restricted, candidates need to spend enough time on each question to ensure that the option chosen is the correct one.

Comments on specific questions

Question 1

This question was one that could be answered very easily by the candidates who concentrated on the fact that the nail is fixed and is therefore in equilibrium. The three forces acting on the nail must combine to produce no resultant force and so the arrows on the lines that represent the forces must all be in the same direction (anticlockwise or clockwise around the triangle). This is only the case for triangle **A** which is the correct option. Option **C** was also commonly chosen which showed that many candidates realised that the tension in the string had to act along its length in a direction that was away from the nail.

Question 5

The correct option was not the most commonly chosen. Candidates who selected option **A** had taken into account the effect of the force of friction, but continued by subtracting it from the resultant force. The friction opposes the driving force and the resultant force is their difference. These candidates had possibly confused the resultant force with the driving force. This was also a confusion that could lead to candidates selecting option **C** which was equal to the resultant force.

Question 8

Only the strongest candidates answered this question correctly. The difficulty in this question centres on a spring balance that is calibrated to read in kilograms. Although such a balance seems to display a mass, it is the weight of the object that stretches the spring and moves the pointer. Since weight is affected by the gravitational field strength, the reading obtained on the Moon is not the mass of the object. The spring balance was calibrated on Earth. Option **B** was chosen by those who did not take this into account. There were also candidates who considered the factor of five that the different gravitational field strength causes but who used it incorrectly and gave option **A** as the answer.

Question 13

As the ball accelerates towards Earth, the gravitational potential energy is transferred to kinetic energy and in the absence of air resistance, no energy is transferred to thermal energy in the air. Thus, the total energy stored in the ball does not change; it is merely transferred from one form to another. Therefore, the correct option was **A**. Candidates who chose option **B** or option **D** were possibly considering either the gravitational potential energy or the kinetic energy alone. Few candidates chose option **C**.

Question 27

Some candidates only considered one half of the journey. The fish are 6000 m below the boat and so the return journey taken by the sound is 12 000 m. Some candidates confused the order of events. Pulses are sent out 2.0 s after the previous one is received and so this time has to be added to the journey time in order to obtain the interval between the transmission of pulses.

Question 30

The correct answer was selected by more candidates than any other. However, option **D** which is twice the size of the correct answer was also frequently chosen, indicating that some candidates did not notice that there were two headlamps in parallel.

Question 31

The incorrect options presented in this question illustrated several misconceptions concerning current. Most candidates chose an option in which the current in the battery was larger than the other currents but it was the way in which this current divided between the two parallel branches of unequal resistance that led to confusion.

Question 33

Here there was a three-stage process that generated the answer. The equation $P = VI$ enabled the equilibrium current in a single lamp to be worked out. However, it was the initial current that was needed and this was four times larger than the calculated value. Finally, there were eight of these lamps in parallel and so the initial current supplied by the mains could be obtained. Candidates who omitted one or more of these steps selected an option that was not the correct one.

Question 36

The strongest candidates answered this correctly, but the less confident candidates were distracted by the incorrect options equally. The output of a transformer always has the same frequency as the input current.

Question 38

Only the strongest candidates answered this question correctly. That the two resistors originally had equal resistances might have been overlooked by some although without this information, the question would not have been possible. It is probable that candidates who selected option **D** had deduced that the original potential difference across the upper resistance was 6.0 V and then simply halved it to give a change of 3.0 V. It is the ratio of the resistances that is significant.

PHYSICS

Paper 5054/21
Theory

Key messages

- Candidates should always give units when giving the final answer to numerical questions. They should also be encouraged to give answers to an appropriate number of significant figures (usually at least two), and for this reason, fractions are not accepted.
- A carefully drawn diagram can often show what candidates intend to convey much more accurately than just words. Whenever a diagram is asked for or suggested, it is usually worth drawing it carefully and neatly and then labelling it, so that its intention is clear.
- The number of marks shown, and the amount of space provided give a guide to the length of the answer required, and candidates who exceed the space provided may be wasting time giving unnecessary or irrelevant detail. It is helpful if candidates confine their answers to the space provided.

General comments

The majority of questions were accessible to all candidates. The standard of written English was high and the quality of expression, even among the weaker candidates was good, even if the underlying physics was sometimes inaccurate.

Calculations were generally performed well. Most candidates were able to quote a relevant formula, either in words or symbols and substitute correctly into it. Occasionally, candidates who had performed a correct calculation omitted a unit or gave an incorrect unit.

A minority of candidates ignored the rubric for ***Section B*** and answered all three questions.

Comments on specific questions

Section A

Question 1

(a) (i) Although the graph was a distance-time graph, with its axes clearly labelled, many candidates were confused here and interpreted the graph as if it were a velocity-time graph. Of those candidates who realised that the skydiver was accelerating at first, few went on to state that the acceleration decreased, and that the skydiver attained a constant speed.

(ii) Many candidates ignored the instruction given in the question to explain the motion of the skydiver in terms of the *forces* acting on him. A few candidates stated that the air resistance acting increased as the speed of the skydiver increased. More candidates correctly stated that the resultant force becomes zero or that the air resistance force eventually became equal to the weight of the skydiver.

(b) Only a minority of candidates were able to use the graph to determine the terminal velocity of the skydiver. Few candidates realised that they needed to use the linear portion of the graph only. The most commonly-seen incorrect method was to choose one point on the graph and divide its *y*-coordinate by its *x*-coordinate.

Question 2

(a) The difference between a scalar quantity and a vector quantity was known by most candidates.

(b) Most candidates identified and correctly underlined the two vector quantities in the given list.

(c) (i) A small number of candidates were able to explain how the motion of the satellite shows that a resultant force is acting on it. Only the strongest candidates stated that the direction of a satellite in a circular orbit is continually changing and therefore its velocity must be continually changing.

(ii) Many candidates realised that the cause of the force acting on the satellite is gravitational attraction/gravity of the Earth.

Question 3

(a) (i) The moment of the force P about the hinge was usually calculated correctly. Some candidates did not give a unit for the moment of the force about the hinge.

(ii) Although most candidates knew how to calculate the work done by a force, fewer were able to calculate the correct distance moved by the force when the door rotated about the hinge by 90°.

(b) Candidates who stated that the moment due to force P was greater than that of force F obtained partial credit. Some of these candidates went on to state that this was because the distance of force P to the hinge was greater than that of force F.

Question 4

(a) (i) Many candidates knew that the wavelength of light decreases when it passes from air into glass.

(ii) Only stronger candidates knew that the frequency of the light does not change when it passes from air into glass.

(b) (i) Many candidates were able to recall the formula for the critical angle of a medium in terms of its refractive index. Most were then successful in determining the value of the critical angle for light in glass. Occasionally, there were rounding errors or a unit was not given.

(ii) Stronger candidates were able trace the path of the given ray through the right-angled prism. Most attempts had the light ray emerging from the hypotenuse of the prism instead of being totally internally reflected at this face.

Question 5

(a) Only the strongest candidates answered this question correctly. These candidates were able to suggest appropriate materials for the wires of the thermocouple. Many answers named insulating materials or just stated “metal” instead of naming suitable metals.

(b) (i) Few candidates knew that the physical property that varies with temperature when a thermocouple is used to measure temperature is electromotive force/voltage.

(ii) There were few correct answers to this part. Candidates did not understand the term linearity when applied to a thermocouple thermometer. The expected answer was that the output voltage of a thermocouple is directly proportional to the temperature difference (between the junctions).

(c) Candidates answered this part of the question well, with many candidates able to give at least one advantage of a thermocouple thermometer over a liquid-in-glass thermometer.

Question 6

(a) Many candidates were unable to sketch a diagram to show the structure of a step-up transformer. Diagrams were usually drawn without a ruler. Despite the instruction to draw a labelled diagram, labels were frequently omitted. Many candidates thought that the core of the transformer could be made from any metal.

(b) Only a few candidates followed the instruction to describe the principle of operation of a transformer. Most answers consisted of a description of what is meant by a step-up or a step-down transformer. Very few candidates mentioned magnetic fields and electromagnetic induction to explain how the output voltage is generated.

(c) The advantages of transmitting electrical energy at high voltage were not well understood. Of those candidates who stated that thermal energy losses in the wires would be lower, few stated that this was because at high voltage the current in the wires is reduced. Many candidates incorrectly thought that the resistance of the wires changed at high voltage.

Question 7

(a) Some candidates knew that nuclear fusion is the joining together of nuclei, but few went on to state that energy was released in the process. Many candidates incorrectly stated that the process was the joining together of atoms.

(b) Only a minority of candidates knew that the nuclear fusion reaction that occurs in the Sun is the joining together of hydrogen nuclei to produce helium.

(c) (i) Only the strongest candidates knew that the source of energy responsible for the thermal energy produced when a cloud of gas in space collapses is the gravitational potential energy of the gas molecules.

(ii) Only the strongest candidates answered this question correctly. These candidates realised that the temperature of a star eventually reaches a steady value when the energy emitted by radiation becomes equal to the energy produced from the fusion reaction.

Section B

Question 8

(a) Most candidates were able to define the term pressure.

(b) (i) Those candidates who started with the formula p = $h\rho g$ were usually successful in calculating the pressure due to 25 m of water. Candidates who attempted to divide a force by an area were unsuccessful.

(ii) Some candidates were unsure whether to add or subtract the value they had calculated in **(i)** from the total pressure at the given depth to determine the atmospheric pressure.

(c) (i) Many candidates made some progress in explaining why the piston moved into the cylinder as the depth gauge was lowered into the water. Most realised that as the gauge was lowered further into the water, the pressure on the outer face of the piston became greater than that on the inner face. Few candidates went further than this. The obvious statement that pressure increases with depth was usually missing, as was the fact that there was a resultant force inwards on the piston, which caused the piston to move into the cylinder.

(ii) Most candidates realised that the pressure of the air in the cylinder increased as the piston moved into the cylinder. Far fewer gave a satisfactory answer in terms of molecules as to why the pressure increased. Although many candidates realised that the pressure inside the cylinder was due to the collisions of the air molecules inside it with its walls, few stated that the frequency of these collisions would increase.

(iii) Completely correct answers to this more demanding part were rare. Most candidates thought that the volume of the trapped gas would decrease linearly as the gauge was lowered into the water. Only stronger candidates drew a curve with a negative gradient of decreasing magnitude, starting from V_0.

(iv) Only the very strongest candidates were able to offer a satisfactory explanation as to why the needle on the depth gauge must be reset to zero at the surface of the water each time the gauge is used. Candidates did not realise that the atmospheric pressure and temperature vary continually and so the gauge must be zeroed before each use.

(v) Only stronger candidates stated that water molecules cannot be compressed. Despite the instruction to explain the answer in terms of the molecules of the water, most candidates quoted the equation for density and tried to use this equation to explain why the density of the water remained constant.

Question 9

(a) Only a few candidates were aware that the hotter that a body is, the greater is the loss of thermal energy from the body to the surroundings, and the quicker it cools.

(b) Most candidates stated correctly that as the oil cools, the kinetic energy of its molecules decreases. Many candidates did not follow the instruction in the question to state what happens to the level of the oil in the measuring cylinder as the oil cools.

(c) (i) Many candidates were able to inspect the cooling curve for the oil and deduce its melting point from the information provided.

(ii) Only stronger candidates were able to make meaningful attempts at explaining why the temperature of the oil remained constant as the oil solidified. The term latent heat was only mentioned by a small number of candidates.

(d) (i) The energy transferred from the oil as it solidified was calculated correctly by many candidature. Other candidates did not realise that the temperature remained constant while the change of state occurred and attempted to apply the equation $Q = mc\Delta\theta$ to the situation.

(ii) The calculation of the average rate of energy transfer from the oil as it solidified was challenging for most candidates. All that was required was to divide the answer in **(i)** by the time taken to solidify.

(e) Of those candidates who stated correctly that the specific heat capacity of the oil in the liquid state was smaller than the specific heat capacity of the oil in the solid state, very few could support this assertion with a correct explanation.

Question 10

(a) (i) Only a minority of candidates stated that the resistance of a wire is directly proportional to its length. The majority of answers were too vague e.g. “as the length of the wire increases, the resistance of the wire increases”.

(ii) As in **(i)**, only a few candidates could state that the resistance of a wire is inversely proportional to its cross-sectional area. The majority of answers were too vague e.g. “as the thickness of the wire increases, the resistance of the wire decreases”.

(b) Only the strongest candidates answered this question correctly.

(c) (i) The standard definition of the term electromotive force was not well known. Some candidates knew that it is related to the work done in driving electrical charge around a circuit but only a small number of candidates stated that it is the work done per unit charge.

(ii) This standard calculation of the potential difference across a component in an electric circuit was challenging for many candidates. Most candidates made no attempt to find the total resistance of the circuit and hence the current flowing. Once the current was known, the potential difference across the wire could be deduced.

(iii) Only the strongest candidates had any understanding of how to use an oscilloscope. Candidates needed to understand what the Y-gain setting of an oscilloscope meant. The fact that the setting was given as 0.20 V/cm was usually ignored. Despite being told that the oscilloscope had a horizontal trace across the middle of the screen, most candidates stated that the trace observed would be a (sine) wave.

(d) (i) Most candidates were unable to give an advantage of using two cells in parallel rather than a single cell. Candidates were unaware that the battery would last twice as long. Most candidates incorrectly stated that the battery would supply double the current.

(ii) The effect on the oscilloscope trace of adding the second cell in parallel was only understood by stronger candidates. These candidates realised that the addition of this second cell would have no effect.

PHYSICS

Paper 5054/22
Theory

Key messages

- Candidates must be familiar with all sections of the syllabus if a good performance is to be achieved. It is not possible to make up for a poor answer on one part by a much better and more detailed answer to another.
- Candidates should note the marks available for each question .This will guide them in the sort of answer that is required and how detailed it needs to be.
- Candidates need to be certain that the answer supplied is the answer to what has been asked and that every part of what is asked for is dealt with.
- The syllabus includes a glossary of the terms that are most commonly used and candidates need to be aware of the significance of words such as *State*, *Explain* and *Describe* and how the answer expected is influenced by the choice of words.
- Candidates should be reminded to include an appropriate unit in answers.

General comments

There were many strong performances on this paper and these were often characterised by a logical approach. The strongest answers were clear, targeted and direct. Some weaker candidates would have benefited from structuring their answers in clear separate sentences to make the meaning clearer.

In some cases candidates answered a question well but then went on to add additional information which contradicted what had already been stated. This was sometimes due to the simple omission of a word such as *not*.

Comments on specific questions

Question 1

(a) This calculation was well answered by many candidates and full credit was commonly awarded. A small number of candidates either did not add the mass of the beaker to the mass of the liquid or in a few cases subtracted it.

(b) (i) A few candidates gave answers that were clearly expressed and exact and these answers gained credit. However, many candidates gave answers that were less well expressed but which were not sufficiently clear for credit to be awarded.

(ii) Only a minority of candidates were able to supply the final answer although many candidates were able to gain partial credit for identifying a relevant distance or by applying the principle of moments to the ruler and beaker. A small number of candidates tried to answer the question using proportionality in a manner that suggested that the weight divided by its distance from the pivot was equal on the two sides.

Question 2

(a) (i) (ii) Both parts were answered well with the majority of candidates being awarded full credit. Those who were not awarded full credit sometimes gave N as the unit rather than J or used both distances (0.60 m and 2.0 m) in **(ii)**.

(iii) Only a few candidates recognised that this question concerned the consequence of the action of resistive forces and made any reference to friction. Answers such as “because they are different quantities” did not include a reason for the difference and were not awarded any credit.

(b) (i) Many candidates gave answers in the form of output/input which were too vague. Credit was awarded to answers that included the term “useful output” and which made reference to energy or power.

(ii) There were few correct answers given here. The possibility of the wheelbarrow falling from the plank was not a relevant consideration.

Question 3

(a) (i) Many candidates realised that this part of the question concerned convection and gave answers that were awarded either full or at least partial credit. The most common omissions or misunderstandings concerned the initial thermal expansion of the water. This was not always referred to or, more frequently, it was suggested that the molecules themselves expand.

(ii) This part was only answered well by the strongest candidates. Many candidates repeated, at least in part, the answer to **(i)** and explained the process of convection without adding that the convection cannot heat the water beneath the heater X.

(b) Credit was most commonly awarded for pointing out that either plastic or air are poor conductors or that this is because of the lack of free electrons in these substances. The idea that these two substances were good insulators was not credited as this did little more than repeat the question and did not include a specific reference to specific transmission mechanisms (i.e. conduction or convection). However, a few candidates made reference to the suppression of convection.

Question 4

(a) This part was quite well answered and nearly all candidates were awarded at least some credit. The question asked about the structure of a solid and comments about the intermolecular forces were not relevant to the question asked.

(b) (i) This part was very well answered and many candidates gave the correct numerical answer with the correct unit. A few candidates confused the specific heat capacity and the thermal energy transferred in the equation.

(ii) This was generally well understood but quite a large number of candidates omitted the very last stage temperature and gave the temperature increase as the final answer. There were also candidates who attempted to use the same equation that was used in **(i)** and in some cases, obtained a value that had already be given in the question.

Question 5

(a) Many candidates did not recognise the sequence of events. Most knew about the fuse melting, and a large proportion knew about the surge of current in the earth wire, although it was not always explained very clearly. There was confusion between earthing of charges in static electricity and the operation of the earth wire in a device that is carrying a current. Few candidates mentioned the case becoming live. The phrase “overflow of current” occurred quite commonly but it was not always clear what this meant in answers.

(b) (i) This was usually correctly answered with relatively few candidates choosing either the earth wire or the neutral wire. Where credit was not awarded, candidates were most likely to have not used the name of any wire and to have provided one of a large range of terms including: copper wire, insulated wire and connecting wire.

(ii) Most candidates gave answers in terms of the live wire supplying the current. There is, of course, current in both the live wire and the neutral wire in normal operation. Few candidates stated that the live wire is the wire with the large voltage.

(c) (i) This was answered well and the majority of candidates were awarded full credit.

(ii) Many candidates were able to state why this hairdryer did not need an earth wire. However, the most frequently given incorrect answer suggested that the current in a hairdryer was not large enough to justify an earth wire.

Question 6

(a) (i) Due to an issue with the paper discovered after the examination was sat, full marks have been awarded to all candidates for this question to make sure that no candidates were disadvantaged. The published paper has been amended and the mark scheme reflects the marking originally intended for **6(a)(i)**.

(ii) Due to an issue with the paper discovered after the examination was sat, full marks have been awarded to all candidates for this question to make sure that no candidates were disadvantaged. The published paper has been amended and the mark scheme reflects the marking originally intended for **6(a)(ii)**.

(b) (i) There were very few entirely correct answers here. Some candidates supplied part of the complete answer and usually stated that there was one more proton in the nucleus of sulfur but the effect on the number of neutrons was rarely mentioned. Other answers were too vague.

(ii) Many candidates correctly plotted the point for t equalling 2.0 weeks but fewer candidates plotted any other points correctly. A commonly-seen incorrect answer showed the number of sulfur atoms decreasing with time from an initial value of 4.0×10^{11}.

(c) Many candidates were able to supply one correct precaution and others gave two answers that were awarded full credit. Answers referring to not eating nor drinking in the presence of radioactive samples were not accepted.

Question 7

(a) This was usually answered well. Most candidates correctly stated that the bus was accelerating between t = 0 and t = 10 s. Some candidates stated that between t = 35 s and t = 40 s the bus was decelerating. Some candidates interpreted this part of the graph to suggest a decreasing acceleration to a constant speed rather than as a deceleration to rest.

(b) Only a few candidates obtained full credit for both parts of **(b)**. There was some confusion between the two parts with many candidates supplying the average speed in **(i)** rather than the maximum speed. Many candidates did not relate the question to the steepest section of the graph. Many candidates answered **(ii)** better and approached the question in the correct manner, at least initially. There were some errors with the use of a time such as 60 s, which is merely the final time coordinate on the graph rather than when the bus arrives at the second bus-stop. The word average resulted in some candidates halving their calculated answer.

(c) (i) This part was well answered and most candidates were awarded full credit. A small minority of candidates gave an answer such as “Velocity has a magnitude and direction”. This did not make clear whether it is a magnitude, a direction or both which the quantity speed does not have.

(ii) Many candidates recognised the two time periods when there was a non-zero resultant force on the bus when it was travelling in a straight line, but the direction of this force was not always clearly stated. Fewer candidates were able to state the third time period required. However, those who did do so very commonly stated its direction correctly.

(d) (i) This part was well answered with many candidates stating in some way that the variation in the speed of the bus was the cause of the variation in air resistance.

(ii) Many candidates marked an acceptable point on the graph although a very large proportion chose a point at t = 10 s or t = 35 s. Candidates should be advised to mark points carefully.

Question 8

(a) (i) This was a challenging calculation but even so it was very commonly carried out accurately and the correct answer was supplied. A few candidates did not supply a unit (°) with the answer.

(ii) This was quite often correct but despite the wording, a large number of candidates marked a tick in more than one box.

(iii) There were many correct answers to this part and this was well understood. The most frequently supplied incorrect response suggested that the frequency decreased on entering the glass. There was possibly some confusion with the speed or wavelength.

(b) (i) There were many candidates who drew the positions of the focal points correctly in **(ii)** but who could not explain in words what is meant by focal length. The distance between the image and the optical centre was often given as the answer

(ii) This was often well answered. Even candidates who were uncertain about what else was needed, were often able to draw a straight line from the top of the object through the optical centre of the lens. Full credit was commonly awarded.

(iii) The distance of the image from the lens was sometimes incorrect even when the diagram in **(ii)** was well drawn. A common error was to misinterpret the scale on the grid. A distance of, for example, 3.4 cm was sometimes expressed as 3.2 cm. Although many candidates understood what was meant by magnification, there were other candidates who gave the reciprocal of the correct value. There were some candidates who calculated the ratio of the height of the image to the distance from the lens of the object.

(c) Many candidates obtained some credit here but full credit was rarely awarded. Film or a digital detector of some sort was rarely mentioned and candidates often referred to images produced on a screen. It is light that is converged rather than an image.

Question 9

(a) This part was very often answered correctly. The most common cause of inaccuracy was the underlining of iron rather than or in addition to steel. The answer mercury was very occasionally selected.

(b) Many candidates were familiar with what was being asked for here and full credit or nearly full credit was often awarded. However, some candidates described an appropriate method clearly but omitted any reference to how the direction of the magnetic field surrounding the magnet could be plotted.

(c) (i) The direction of the conventional current was very often correctly stated but few candidates could explain, in terms of the electrons, why there is a current in the wire. It was perhaps the presence of the magnetic field that led some candidates to supply incorrect answers in terms of electromagnetic induction.

(ii) Credit was commonly awarded for referring to the Fleming's left-hand rule but many candidates did not explain how to use it. Those who did, sometimes did not specify the force direction. Some answers were lacking in detail.

(iii) Although there were some good answers, most candidates did not relate the question to magnetic screening. A wide variety of effects on the force were described.

(d) This part proved challenging. Few candidates made any reference to a moment or any turning effect and even references to the forces acting were not particularly frequent.

PHYSICS

Paper 5054/31
Practical

Key messages

- It is important that repeat measurements are made and averages taken whenever appropriate.
- Working for calculations should always be shown, the units for quantities always recorded and calculations should be checked and final answers correctly rounded if necessary.
- Numerical data should be recorded to a sensible level of precision and the final answers given to an appropriate level of precision.
- Readings from analogue instruments such as some ammeters and voltmeters should always be written down to the precision of the instrument used.
- In some questions the required unit (e.g. Amps / Amperes / A) was given and in such cases the candidate should ensure that their response is given in that unit and not a related unit (e.g. milliAmps / mA).
- It is important (and beneficial to the candidates) that each set of equipment used conforms to the equipment specified in the Confidential Instructions which are sent to centres.
  It is in the interest of the candidates that a complete set of results for each question, as performed by the supervisor using the apparatus that has been provided to candidates, is provided with the supervisor's report.

General comments

The strongest responses demonstrated that candidates were able to read and understand the questions set and could perform the tasks by following the instructions carefully. Many candidates were able to give concise descriptions of how they made measurements accurately or ensured apparatus was set up in a particular way. Most candidates were able to construct tables of results with appropriate headings, with the name of the quantity and the unit, for each column. The results obtained were used, according to the guidance provided in each part of a question, to perform calculations by substituting values into equations and plot line graphs or to make valid, accurate comparisons, predictions or other comments about their results. Some weaker responses gave comparisons that were too vague; for example, the terms "change", "are different", "vary" were often too vague whereas stronger responses used phrases such as "as A increases, B decreases" or "the values of X are close enough to say that they are the same" and were much more specific.

Attention is drawn to the advice on plotting graphs issued by Cambridge International. Many responses to questions involving the plotting of graphs used impractical scales based on the difference between the first and last values in the results table and comparing this with the number of squares on the grid. This led to difficulty deriving further information and errors in plotting and interpretation. The plotted points on graphs should be marked with small, fine, but visible crosses and placed accurately. The Cartesian axis system should be used. The best fit straight line or curve should be a carefully drawn, suitably placed, thin line.

Comments on specific questions

Question 1

(a) Stronger responses indicated candidates had followed the instructions correctly and observed five views of the modelling clay (the object plus four images) which were equally distributed across the 360 degrees view. Their measured angle was therefore $72 \pm 5°$.

(b) The important word that was often missed by weaker candidates in answering this question was 'how'. Candidates should be careful not to give a simple repetition of the wording given in the question, for which no credit can be awarded.

Weaker responses often gave a set of results rather than answering the question and describing the method by which they carried out the investigation. There were two approaches, based on varying one quantity and measuring the other quantity. Finding different numbers of whole images and measuring the angle between individual images in each set, or by varying the angle until a new whole number of images were seen and then counting the number of whole images. A graph of the number of images plotted against the angle between each image could also have been plotted. Credit was awarded for describing the basic method and further credit was awarded for describing suitable refinements to the method (placing the centre of the protractor at the exact junction of the two reflecting surfaces or ensuring that only whole, evenly spaced images were seen or testing the rule determining the number of images).

Question 2

(a) The strongest responses indicated that one end of the knob on the clamp's screw would have been marked in some way so it could be identified and a reference point or marker used so that one complete rotation could be correctly identified. The minimum acceptable response described how the screw was turned until the same end pointed in the same direction as it had started. Responses based on the height travelled after a given number of rotations were not accepted as each rotation could have produced a different height increase, for a number of reasons.

(b) (i) Heights of 9 to 15 (mm) were accepted.

(ii) The mass hanging by the thread should have been truly vertical, so the height gained was simply the old height subtracted from the new height using a ruler that had been placed vertically.

(c) This was answered well by candidates. The appropriate unit was required and a value rounding to 11 cm was seen in many responses.

(d) Stronger responses indicated that there could be some horizontal/lateral displacement of the mass as the jaw of the clamp rotated; the jaw follows a roughly circular path, or the mass may have moved a little due to the thread moving. That the rotation may have caused the mass to swing was credited but was a relatively weak response.

Question 3

(a) The value read from the scale of the metre rule should have been in the range 87–97 cm, and a generous tolerance, a maximum precision of 0.1 cm was allowed. Any higher precision was unrealistic on account of the thickness of the thread and whether it would lie perfectly at right angles to the length of the rule.

(b) (i) Many responses correctly recorded the distances moved as 5.0 cm for the large mass and 10.0 cm for the medium mass, with tolerances of 0.5 mm.

(ii) The weight of the medium mass was calculated using the formula and the values for *L* and *M*. The strongest responses obtained values close to 0.25 and the final answer to the calculation was correctly rounded.

(c) The strongest candidates described the two essential points: what to measure and the condition that meets the criterion for the rule to be horizontal. These responses stated that the height of the rule above the bench was measured in two places (preferably at each end of the rule or at least well-separated points along the rule) and those two heights were found to be equal if the rule was horizontal. Responses describing how the length of the rule was compared with a distant horizontal reference line (for example, the top of a door frame, or the level horizon or other line on a building known to be or accepted as horizontal when viewed out of a window) and found to be parallel (by measurement) with that reference line were also accepted. Weaker candidates frequently referred to checking that the rule was perpendicular to the upright part of a clamp stand, but this is an unreliable method as the uprights of many clamp stands are out of alignment. Many other weak responses suggested measuring the height of the rule in two places but did not complete their response with the second part, the comparison of the heights and finding them equal. The use of a spirit level was not accepted as these devices are not often available in physics laboratories and are not on the basic list of laboratory equipment.

(d) The ratio of the distances d_m and d_s should have been given as a decimal and not a fraction, with no unit and in the range 0.60 ± 0.05, obtained from correct values consistent with this number.

Question 4

(a) (i) The potential difference across the terminals of the power supply should have been 4.5 Volts, in accordance with instructions in the Confidential Instructions. Values in the region 4.0 V to 5.0 V were accepted as there was some variation in the readings given by some power packs**.**

(ii) The current recorded should have been in the region of 5.5 mA but values in the range1–20 mA were accepted, providing they were given to at least 2 s.f. The unit should also have been given and this could have been A or mA provided it was consistent with the magnitude of the current recorded in the answer space**.**

(iii) The resistance calculated correctly using candidates' own values for the current and potential difference and the formula provided should have been converted and then recorded in kΩ. Many responses showed that candidates experienced difficulty in using and converting units with a multiplier (e.g. A to mA, Ω to kΩ and vice versa) and would benefit from checking how to do this correctly and then revising and practising it in their study. Stronger responses using apparatus made to specification were in the region of 0.1 to 1.0 kΩ**.**

(iv) Headings for the columns were required, with the appropriate unit for the quantity measured. Stronger responses put the quantities in a sensible order.

(v) The important words in the question were 'how' and 'exactly'. There were many possible points of good technique in the filling and emptying of the syringe so that an accurate volume was delivered.

In terms of filling, comments referring to ensuring there was no air or liquid in the syringe at the start, checking the nozzle of the syringe was under the surface of the liquid, raising the plunger so that no bubbles get in and initially pulling up more than the required volume then releasing the excess, were made by stronger candidates.

In terms of delivering the liquid, comments seen in stronger responses referred to releasing the excess liquid until the syringe read exactly 1 ml or ensuring the scale was viewed with the eye perpendicular to the scale mark.

There were few responses that achieved full credit. Many weaker responses referred to the meniscus of the liquid in the syringe and this suggested incorrect use of the equipment.

(vi) Stronger candidates referred to either the readings taking some time to stabilise and changing more slowly after about one minute or that time was needed for the salt solution to mix thoroughly with the water. Weaker responses referred to allowing reactions or dissolving to occur.

(b) The columns for results were completed as the eight sets of results were obtained. Consistent significant figures should have been used for each quantity measured (i.e. down each column). As the volume added increased, the current should have increased and the resistance decreased. The potential difference across the power supply should have remained constant.

(c) A graph of current (along the *y*-axis) against volume of salt solution added (along the *x*-axis) should have been plotted as a line graph and the best fit line drawn. Candidates needed to read the question carefully and check that they had chosen the correct quantities to plot, particularly when there were quantities whose names are frequently abbreviated to the same single letter (e.g. volume / voltage). Some weaker candidates produced graphs of the wrong quantities. It should be noted that as this was a practical test and candidates had obtained their own data to use for plotting the graph, it was not expected that the graph produced would be a perfect straight line or perfect curve. Stronger responses had plots scattered either side of and close to the best line. These candidates labelled the axes carefully with the quantity and the correct unit, used a sensible scale for each axis, plotted the points accurately and neatly and then drew in pencil a neat fine single line of best fit. Weaker responses often omitted units or chose poor scales. Some plotting was very inaccurate and candidates sometimes used thick pen or pencil marks. Weaker responses showed, for example, thick plots placed inaccurately, 'dot-to dot' lines drawn with the result that smooth lines were not produced or poor choices were made for the position of the best line. The best line selected from a good set of data should have been linear or almost linear (a slight curve) and should have had no discontinuities.

(d) The gradient of the best fit line should have been calculated by the usual triangle method. For best fit lines that were linear, two points resting on the line should have been selected. They should have been far enough apart for the gradient triangle's hypotenuse to extend over at least half the distance between the first and last points plotted, assuming all the data was plotted. The coordinates of those points were then used to calculated the gradient. If the best fit line selected was a curve then candidates should have chosen a sensible point along the curved line, drawn a tangent to the curve at that point and then used the tangential line to select two points and form a large gradient triangle in that manner. The gradient should then have been calculated correctly using the coordinates of the two points, correctly rounded to 2 or 3 s.f.

PHYSICS

Paper 5054/32
Practical

Key messages

- It is important that repeat measurements should be made and averages taken whenever appropriate.
- Working for calculations should always be shown, the units for quantities always recorded and calculations should be checked and final answers correctly rounded if necessary.
- Numerical data should be recorded to a sensible level of precision and the final answers given to an appropriate level of precision.
- Readings from analogue instruments such as some ammeters and voltmeters should always be written down to the precision of the instrument used. In the case of digital instruments such as multimeters used to measure voltages or currents, the initial values should be recorded to a precision such that the final answers may be rounded to the requested precision or the usual precision required (2 or 3 s.f.).
- In some questions, the required unit (e.g. mm) is given and in such cases the candidate should ensure that their response is given in that unit and not a related unit (e.g. cm).
- It is important (and beneficial to the candidates) that each set of equipment used conforms to the equipment specified in the Confidential Instructions which are sent to centres. It is in the interest of the candidates that a complete set of results for each question, as performed by the supervisor using the apparatus that has been provided to candidates, is provided with the supervisor's report.

General comments

The strongest responses demonstrated that candidates were able to read and understand the questions and could perform the tasks by following the instructions carefully, making accurate observations and measurements to an appropriate level of precision using the equipment provided. These responses showed the candidates were able to give concise descriptions of how they made measurements accurately or ensured apparatus was set up in a particular way.

In some parts of questions candidates were asked to describe what happened when certain changes were made and it is recommended that candidates explore these changes very carefully and slowly and more than once when possible.

Stronger candidates were able to construct tables of results with appropriate headings, with the name of the quantity and the unit, for each column. The results obtained were used, according to the guidance provided in each part of a question, to perform calculations by substituting values into equations and plot line graphs or to make valid, accurate comparisons, predictions or other comments about their results. Some weaker responses gave comparisons that were too vague; for example, the terms "change", "are different", "vary" were often too vague whereas stronger responses used phrases such as "as A increases, B decreases" or "the values of X are close enough to say that they are the same" and were much more specific.

Attention is drawn to the advice on plotting graphs issued by Cambridge International. Many responses to questions involving the plotting of graphs used impractical scales based on the difference between the first and last values in the results table, comparing this with the number of squares on the grid. This led to graphs which were difficult to read clearly and candidates sometimes made errors in plotting and interpretation of them.

It is far better to choose a scale which produces a graph that occupies over half the grid in the *x* and *y* directions and is based on a scale of 2, 5, or 10 units corresponding to 10 small grid lines. Scales based on 3, 6, 7 and non-integers should be avoided.

The plotted points on graphs should be marked with small, fine pencil, visible crosses or dots and placed accurately. The Cartesian axis system should be used. The best fit straight line or curve should be a carefully drawn, suitably placed, thin pencil line.

Candidates should be careful not to give a simple repetition of the wording given in the body of the question, for which no credit can be awarded. Weaker responses often gave a set of results rather than answering the question and describing the method by which they carried out the investigation.

Comments on specific questions

Question 1

(a)(i) The unstretched length of spring A should have been recorded in mm to a maximum precision of the nearest millimetre . It was unrealistic to give a value to a higher precision for the task given.

(ii) The stretched lengths should both have been considerably larger that the unstretched length of Spring A and Spring C should have had the longest length. The majority of responses were accepted. Some weaker responses appeared to have confused the values for B and C.

(iii) The majority of responses gave correct answers to the calculations.

(b) Stronger candidates stated that the force exerted on Spring B was less than the force provided by the weight of a suspended 300 g mass because the extension of Spring B was less than the extension of Spring C (which had a 300 g mass directly attached underneath it.

(c) The response required here was to move the system of pulleys and Spring B to the same side as Spring C so they were both on the same side as the base of the clamp stand and this would make the apparatus more stable (or less likely to fall over). Weaker responses suggested interchanging the positions of the two spring systems or to add more masses.

Question 2

Some candidates gave a repetition of the wording given in the question. Many responses gave a set of results or quoted theory rather than answering the question and describing the method by which they carried out the investigation. There were few correct responses.

In order to investigate the shape of the magnetic field around the electromagnet, stronger candidates described how the plotting compass could be moved around the magnet whilst observing or recording the direction in which the compass needle pointed. These candidates described that in order to investigate the direction of the magnetic field of the electromagnet, the plotting compass needed to be placed at each end of the electromagnet whilst observing or recording the direction in which the compass needle pointed. Investigating the effect of reversing the current/voltage or winding of the coil was also an acceptable response but was rarely seen, perhaps because the equipment set up did not suggest this would be permissible.

Some stronger candidates described that in order to investigate the strength of the electromagnet the distance between the plotting compass and the electromagnet should be varied and the change observed or recorded in the magnitude of the deflection of the compass needle (a larger deflection indicating a stronger field) or the speed by which the deflection changed (a more rapid response produced by a stronger field). The apparatus was set up for candidates and should not have been changed, but candidates who suggested the resistance or current in the circuit could be increased or decreased and the change in response of the plotting compass noted, with a stronger field leading to a faster or larger deflection, were awarded credit.

Question 3

(a) Values of 5 mm, 4.5 mm ,5.0 mm 5.5 mm were the only acceptable responses. Any higher precision was unrealistic using the equipment provided.

(b) Stronger responses found the spacing between the lines of the image to be in the range 9.0 to 15.0 mm.

(c) Stronger candidates used their values in a correct calculation and gave their answer as a decimal number and not a fraction. There should have been no unit. These candidates usually obtained values in the range of 2.0 to 3.0 but correctly calculated values using the candidates' data were accepted.

(d) The image of the lines became blurrier (or out of focus) and the separation of the lines initially increased but then decreased. The decrease of the separation of the lines was difficult to observe and required the lens to be moved very carefully and slowly and was only reported in a few responses. Many weaker candidates described the blurring of the image as the image becoming unclear or not clear, or fading. The most appropriate terms were "blurred" or "not in focus". The terms "unclear" and "faded" are ambiguous and should not be used as they could also refer to an image with defined features but which is faint or insufficiently bright.

Question 4

(a) (i) The time for 10 oscillations, t_{10} should have been in the range 13.5 $\pm$ 0.6 s. There was considerable variation in the times obtained and centre values were considered. Some responses demonstrated that sometimes candidates counted two whole oscillations as one or counted half an oscillation as one. The strongest responses repeated the timings and averaged them and although this was not required, this is good practice and produced a better set of results. Times should have been given to a greater precision than one significant figure, but more than 6 s.f. was excessive.

(ii) Good responses divided the value, t_{10} given in **(i)** and divided it by 10 to obtain the time, T, for one oscillation and then took the square of their T value. Many weak candidates used quite different values to calculate T and it was unclear from where they had obtained those values. Some weak candidates showed a lack of understanding of the meaning of T^2.

(iii) Headings with units for each column (*mass* / g, t_{10} / s, T / s, T^2 / s^2) should have been added and the first set of data written in the row underneath the headings. Mass in kilogrammes was acceptable provided the conversions were correct. Times in minutes, 'secs' or stopwatch notation were not accepted. Many responses gave an incorrect unit or no unit for T^2.

(b) Timings should have been obtained for a further seven additions of 100 g mass and the data entered into the table. As the mass increased, the times and values for T^2 should all have increased. The data in columns should have been reported to consistent levels of precision down each column. The strongest candidates gave correct, consistent significant figures. However, some weaker candidates demonstrated inconsistency or a lack of understanding of the concept of significant figures and precision to a given number of decimal places. The calculated values for T were scrutinised for the expected trend that as the mass increased T increased by progressively smaller amounts.

(c) Axes drawn on the grid should have been labelled with T^2 / s^2 on the *y*-axis and *mass* / g on the *x*-axis. The standard Cartesian system of axes should have been used, with values increasing from right to left on the *x*-axis and moving upwards along the *y*-axis. It was not expected that all plots would lie on the best line as the candidates' own data was used to plot the graph. Some candidates' values were rounded off to too few significant figures which made the points easier to plot but the best straight line was usually harder to judge and the plots were often more scattered.

(d) A large gradient triangle should have been constructed, and made clearly visible on the graph, using points located on the line, not just points from the table unless they were also exactly on the line. As a guide, the distance representing the hypotenuse of a large enough triangle should usually have been at least half the length of the line joining the first and last of the eight plotted points. Coordinates from the same large triangle were then used to calculate the gradient of the best fit line and the final value rounded to 2 or 3 s.f. The unit was not required. Whilst there were many good responses, some of the weaker responses showed a poor understanding of the method.

(e) Only the strongest candidates answered this question correctly.

Stronger candidates selected a difficulty which was specific to the measurement of the time for ten oscillations using the exact apparatus used for the investigation and then described an improvement which was also very specific to the difficulty they had just described. Many responses stated a difficulty but either the improvement suggested was not specific enough or would not help.

The strongest responses referred to difficulty in deciding when one oscillation had been completed and how this could be improved by counting oscillations when they passed through a point at their fastest speed, using a marker to reference that point. Another acceptable response referred to being consistent in making the initial turn of 90^{o} and using a reference marker for this. Problems encountered during the oscillation, such as slow times when the mass was large, were also acceptable. Some responses correctly stated a difficulty but gave no response for the improvement section.

Weaker candidates referred to human error, bad practical skills or used vague statements about reaction time. Statements relating to “repeating and averaging the results” or “turning off the air conditioning” were not adequate responses.

PHYSICS

Paper 5054/41
Alternative to Practical

General comments

The level of competence shown by the candidates was good, but some candidates approached 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. Only a very small number of candidates failed to attempt all sections of each of the questions and there was no evidence of candidates being short of time. Stronger 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.

Question 1

(a) The question required candidates to suggest why the coins were placed at the centre of the card bridge. Candidates were expected to suggest answers relating to ensuring a fair comparison or an explanation as to why this is where the load would be equally distributed on the card. Only the strongest candidates answered this question well. The most popular answer was that this was the centre of mass of the card.

(b) In **(i)**, candidates were asked how they could find the mass of the coins to the nearest 0.1 g. Only stronger candidates knew how to find the mass of a number of coins and divide by the number of coins. A few candidates just suggested that the average was calculated without explaining how this would be done. In **(ii)** the candidates were expected to find the average mass of coins that a particular width of card could support. Most candidates managed to score at least partial credit by finding the average number of coins supported but many then forgot to multiply that by the mass of each coin and give an answer to 2 sf.

(c) In **(i)** candidates were asked to suggest how a fair comparison could be made. This was only answered well by stronger candidates. The idea of keeping the control variables constant was poorly understood by many candidates. However, in **(ii)** the graph was often drawn well. Most candidates used a sensible scale, labelled the axes and plotted points precisely although some used large circular blobs to plot their points. Candidates should be encouraged to use a sharp pencil when plotting points and drawing best fit lines. In **(iii)** many candidates understood what was meant by extrapolating their curve and they gained credit for this even if their curve was not correct. However, many candidates did not read off the value correctly at 13 cm.

(d) This was well answered. The majority of candidates understood that moving the supports closer or using thicker card would allow the bridge to hold more coins.

(e) Few candidates could explain concisely why it would not be possible to obtain the full range of readings if they started with the smallest width and only one piece of card was provided.

Question 2

(a) Candidates needed to think of themselves carrying out the practical procedure presented to them to answer this question. Only stronger candidates correctly identified that the mass of the beaker would be required, or that the balance would need to be zeroed before the experiment began. Some gained partial credit for ensuring there was no water in the beaker at the start.

(b) In **(i)** some candidates correctly understood that it was necessary to wait until all the melted water had reached the beaker. Nearly all candidates answered **(ii)** well as they took readings from the meters correctly. However, **(iii)** proved more challenging as most candidates did not convert the five minutes into seconds and so their answer was incorrect. This was taken account of in **(iv)** and many candidates gained credit here with either a fully correct answer or a correct answer with error carried forward from **(iii)**. However, some candidates gave an incorrect unit.

(c) The question asked candidates to understand why their calculated value was less than the accepted value and to suggest practical improvements to the experiment. Many candidates found this challenging. Parallax error in the readings would not be credited in these circumstances but was a popular response. Methods of preventing heat loss were expected e.g. insulating the funnel or ensuring that the heater was fully immersed in the ice.

Question 3

(a) Some candidates were able to correctly draw a normal where the ray entered the glass block. Other candidates thought that a normal had to be vertical on the page (or at an obscure angle).

(b) In consequence, few candidates could then correctly measure the angle of incidence.

(c) Only some of those candidates who had correctly answered **(a)** and **(b)** then refracted their ray correctly and reflected it at the opposite face.

Question 4

(a) Candidates were given a scenario of a loud noise made some distance from a wall and waiting to hear the echo. They were then expected to explain how to use this to find the speed of sound. The majority of candidates knew that a tape measure or trundle wheel and stopwatch would be required and gained credit here. However, some candidates suggested a metre rule which would not be practical for measuring a long distance.

(b) Most candidates gained partial credit for explaining how the equipment would be used and there were some excellent descriptions. However, some candidates did not use the echo and simply had the sound going from one person to another. Some forgot to measure the distance to the wall and others forgot that the distance would be doubled and so they needed to use $v = 2s/t$.

PHYSICS

Paper 5054/42
Alternative to Practical

Key messages

- Candidates should be advised to avoid using general 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, with specific detail, and candidates should state why the accuracy has improved or how parallax error was avoided.
- Candidates should be made aware that it is important to record measurements to the correct precision. In particular, measurements made with a rule should usually be given to the nearest millimetre. If a measured length is, for example, exactly 2 cm, the value should be quoted as 2.0 cm.
- Candidates should take care and pay attention to detail when drawing or annotating diagrams. The accuracy of straight lines on diagrams could be greatly improved by using a sharp pencil and a ruler.
- 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.

General comments

The level of competence shown by the candidates was good. Candidates should be reminded that this is a practical paper and should approach questions from a practical perspective, not a theory perspective. Only a very small number of candidates failed to attempt all sections of each of the questions and there was no evidence of candidates suffering from a shortage of time. Stronger candidates were able to follow instructions, record observations clearly and perform calculations accurately and correctly. Units were well known and usually included where needed.

Comments on specific questions

Question 1

(a) (i) Most candidates were able to use the information presented in the diagram to deduce the distance *d* of the mass from the pivot correctly.

(ii) The reading *F* on the newton meter was almost always correct. The most common incorrect answer was 2.3 N.

(b) Few candidates scored full credit for the graph-plotting exercise. The instruction that the scale of both axes started from the origin was frequently ignored and this caused problems in **(c)(ii)** of the question.

The axes were usually labelled, and where axes were started from the origin, sensible scales were chosen. There were few examples of scales on the axes that were multiples of 3, 7 etc.

Most candidates plotted the points accurately. Candidates should be reminded that if dots are used to indicate the position of a plotted point, then these dots should be small, certainly no bigger in diameter than one-half the size of a small grid square. Candidates should also be reminded that they need to plot to the nearest half-square, so plotting all the points on grid intersections will sometimes means an error in the plot.

Many attempts at drawing a line of best fit were poor. Candidates should attempt to draw a line which passes through the middle of the data, with any plotted points that do not lie on the line equally scattered about the best-fit line.

Some candidates forced their best-fit line through the origin, when the trend of the plotted points made it obvious that there should be an intercept on the *F* – axis.

(c) (i) Although most candidates understood what the term gradient meant, there were many incorrect gradient calculations. Candidates often used data points from the table that did not lie on their best-fit line or chose points which were too close together.

The instruction to indicate on the graph the values chosen to calculate the gradient, was frequently ignored. As a consequence, many candidates could not be awarded the full credit available for this part.

(ii) Despite the instruction in the question, some did not extend their line as they were instructed.

(iii) The ratio c/m was usually calculated correctly, although some candidates rounded their answer incorrectly.

(iv) Credit awarded here was for the accuracy of point plotting and the positioning of the line of best fit. Credit was only awarded for answers within the range 1.3 ± 0.2 (N). Any answers to 2 or 3 significant figures were accepted.

(d) (i) Only a minority of candidates were able to suggest a reason why using a spirit level to check that the rule was horizontal before taking a reading, was not appropriate in this particular experiment. The idea that the weight of the spirit level would change the newton meter reading and/or that the rule would not remain horizontal, was not recognised by most candidates.

(ii) Many candidates were unable to offer a sensible method for checking that a rule is horizontal by measuring its height above the bench in two different places to see if the distances are equal. Some candidates suggested measuring the height of the rule above the bench in two different places, but did not go on to state that the distances should be equal if the rule is horizontal.

Question 2

(a) The majority of candidates gained partial credit by drawing the two lamps connected in parallel correctly. However, incorrect lamp symbols were often used, or lines were drawn through the component symbols. A significant proportion of candidates drew a voltmeter in parallel with each lamp, when only one voltmeter is required.

(b) (i) The instruction to compete the column headings in the table was not followed by many candidates.

(ii) Many candidates did not give correctly rounded answers for the resistance of each combination of lamps.

(c) Most candidates suggested a partly-correct conclusion about the combined resistance of the different lamp combinations by stating that the resistance of the parallel combination of the lamps was less than that of the same lamps connected in series. Stronger candidates went on to use their calculated values to state that the combined resistance of the lamps in parallel was (about) half that of the series combination of lamps.

Question 3

(a) The normal to the surface of the glass block at C was drawn correctly by almost all candidates.

(b) Although most candidates followed the instructions and drew the rays correctly, some candidates drew their rays through the labels next to each cross.

(c) (i) (ii) A number of candidates measured the wrong angles for incidence and refraction.

(d) The calculation of the refractive index of the glass was usually carried out correctly. Many candidates rounded the sine values too soon (to 2 significant figures) and introduced a rounding error into their calculation. A few candidates simply divided the two angles.

(e) A significant proportion of candidates were unable to identify the angle of reflection. When suggesting a practical reason why the measured angles of incidence and reflection were unequal, many candidates gave answers which were not specific enough.

Question 4

(a) (i) Nearly all candidates read the scale of the thermometer correctly. On the few occasions where the answer was incorrect, the reading was given as 80.3 °C.

(ii) Only stronger candidates realised why it is necessary to wait for a short while before taking the initial reading of the temperature of the hot water.

(b) Most candidates did not use the data in the table as instructed to explain how the results showed that the water in the beaker without the lid cooled more quickly. Of those candidates who attempted to use the data, only stronger candidates stated that there was a greater temperature drop in the beaker without the lid in the same time.

(c) Most candidates were able to state one quantity that needs to be kept constant in order to make a fair comparison between the speeds of cooling of the water in the two beakers.