PHYSICS

Paper 5054/01
Multiple Choice

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

General Comments

The number of candidates sitting the examination in June 2008 was 9703. The mean score was 26.9 out of 40 (67%) and the standard deviation was 17%.

The results showed that the candidates had thoroughly covered all sections of the syllabus. Candidates found **Questions 1**, **6**, **16** and **40** particularly easy.

Comments on Individual Questions

Question 13

Most of the lower-scoring candidates chose option **D**, possibly because it was the only option for which the pressure value was lower than the volume value.

Question 35

Some of the better candidates opted for **A** rather than **D**. The rotating magnet arrangement is probably less well-known than the rotating coil.

Question 39

The greatest number of candidates chose **B**. Apart from the penetrating properties of beta-particles, **B** would be unsuitable for use in a treatment source because of its short half-life.

PHYSICS

Paper 5054/02

Theory

General comments

The overall standard of written English was, in many cases, excellent and in almost all cases adequate. The Examiners were particularly encouraged by the quality and amount of explanation produced by the candidates, particularly in ***Section B***. However, in a number of questions, candidates merely wrote out all that they knew about a topic without actually answering the question, for example in **Question 3(b)**. A little more time spent in planning a question would often have been very useful. Many of the Examiners were impressed by the knowledge and understanding shown by the candidates in general.

Calculations were performed well and it was a feature of this particular examination that many questions asked specifically for a formula to be quoted before carrying out a calculation. The vast majority of candidates were able to give the correct formula, either in words or, more usually, with the correct symbols. There were still some candidates who failed to give a unit for their final numerical answer and lost a mark as a consequence.

Where a question asks for one answer, candidates should think carefully before giving a whole list of possible answers. For example, in **Question 1(b)** where an environmental problem was asked for, some candidates gave an acceptable answer and then spoilt their answer with an additional wrong statement. Where one answer is required, candidates should be advised to give only one answer - the one that they consider most likely to be correct.

The paper appeared to differentiate well between candidates of differing ability. Good candidates were able to score as highly as ever but there were fewer very easy marks available for the weaker candidates in this examination.

It appeared that candidates from some Centres had only a little knowledge of the basic ideas of thermionic emission in **Question 8**.

Question 9 was a slightly more popular question in ***Section B*** for most Centres.

As in last year there were a few Centres where, in ***Section A,*** candidates wrote their answers on additional paper. The spaces provided with each question should be used to write answers to ***Section A***. ***Section B*** should be answered on the lined pages provided at the end of the question paper. When these lined pages are filled then extra paper can be used. There was rarely a need for a large booklet to be supplied as this extra paper.

Comments on specific questions

Section A

Question 1

(a) This question proved harder than expected. One mark was available for placing the turbine in the first box or for placing the transformer in the last box. As many candidates included a motor to drive the generator, it seems that the parts of a power station are not well understood. It may be that the function of the turbine itself is not widely understood.

(b) Many possible answers were accepted, such as global warming, acid rain or air pollution. Some candidates were very vague, merely saying that carbon dioxide is emitted without suggesting why that is a problem, or wrongly stating that the ozone layer is affected.

(c) In **(i)**, statements such as "oil cannot be replaced" or "will run out" were accepted and common. Many candidates spoilt a correct answer by suggesting that "oil cannot be used again". In **(ii)** there were many possible renewable energy sources that could be quoted. It was encouraging to see answers such as biomass and geothermal mentioned. However, many candidates failed to earn the mark by merely stating "water", without suggesting how the water was used, for example in a hydroelectric, tidal or wave energy source.

Question 2

(a) Candidates found it difficult to visualise and apply the principle of moments. Distances to the pivot were often not used, even though the diagram is clearly drawn with a pivot.

(b) The formula for pressure was well-known and applied well, although weaker candidates were unable to handle the powers of ten and produced an answer of 2.6×10^{-5} Pa.

(c) Newton's third law was often successfully quoted as "action and reaction are equal and opposite". Better statements suggested that when body A exerts a force on body B, then body B exerts an equal and opposite force on body A.

Question 3

(a) This question asks for an explanation of evaporation in terms of molecules. Those candidates who attempted to explain that the fastest molecules leave the surface, or that energy received by the molecules allows them to escape, scored well. Weaker candidates did not mention molecules at all. In **(ii)** candidates needed to explain that hot air has a lower density and thus rises. Many candidates merely stated that convection occurs, without explaining why convection occurs.

(b) This section produced a great range of answers and marks. The most common mark earned was awarded for the realisation that shiny surfaces reflect heat or emit less heat, or, better, reflect radiation or emit less radiation. The effect of the blanket in reducing convection currents was often explained, and sometimes the poor conduction caused by a trapped layer of air earned more of the marks. However, many answers were muddled and amounted to definitions of the terms *conduction*, *convection* and *radiation*, these terms not being applied to the situation of the question.

Question 4

(a) Both liquid nitrogen and liquid oxygen change state in this question from liquid to gas. Many candidates did not make clear the change of state that occurs and often just stated information from the question, e.g. that the liquid nitrogen boils at -196 °C. Better candidates described the start of the process at 1 minute, when the nitrogen changes state, finishing at 4 minutes and then later the oxygen changing to gas at about 5 minutes.

(b) The formula for specific heat capacity was well-known but sometimes expressed poorly, for example as $\theta = mc\,\theta$. The majority of candidates also used a temperature change of 9 °C. Better candidates found the energy required to warm each gas separately and then added the two values. Weaker candidates used an average specific heat capacity or added the two specific heat capacities, but the average rarely worked as there is more liquid nitrogen then oxygen and so the simple average is not valid.

Question 5

(a) Most candidates scored at least one mark for recognising that infra red is used as a remote control or that gamma rays were emitted from a radioactive source. A number of candidates also stated that alpha and beta rays were emitted from a radioactive source. This may be true, but these rays are not part of the electromagnetic spectrum.

(b) (i) A number of detectors can be used to detect X-rays, such as a fluorescent screen or photographic plate but also accepted were more modern detectors, which were rarely given as an answer. The Geiger-Müller tube is more often used to detect gamma particles but it can also detect X-rays and many candidates used their knowledge of radioactivity and the electromagnetic spectrum to make this link and earn the mark.

(ii) The property that allows an image of a bone to be produced is the penetration of the X-ray through flesh but not through bone. The X-ray is absorbed more by the bone than the flesh. It was encouraging to see so many reasonable accounts of this common medical procedure. The major mistake was for candidates to think that the X-rays are reflected by bone.

Question 6

(a) Almost all candidates knew the formula for resistance and its unit.

(b) In this section all that was required was an understanding that when resistance rises, the current will fall and eventually becomes constant. Many candidates did not show this basic understanding and often just described what the graph demonstrated about resistance, without making any link between the increased resistance and the current.

(c) Each difference in the question paper started with the phrase "The filament in the second lamp is …" This was to help the candidate who merely had to say longer, thinner, hotter or made from a different material of poorer conduction. Unfortunately many candidates did not understand the format and gave contradictory answers, such as 'longer' for the first difference and 'shorter' for the second difference.

Question 7

(a) Most candidates knew the direction of the magnetic field, but far fewer knew the direction of the force on the wire. The arrow drawn to represent the force was frequently not shown in contact with the wire, but since the question only required the direction and not the point of action, a remote arrow in the correct direction was awarded the mark. In **(ii)**, weaker candidates, rather than drawing in the force on the wire in Fig. 7.1, drew instead **lines** to represent the magnetic field, from left to right between the poles.

(b) (i) The magnetic field diagram around each wire on its own was correctly attempted by most candidates, but incompleteness lost marks by either missing out the outer "dog-bone" shape of the field or an outer circle that surrounds both wires. The direction of the field was generally shown correctly as clockwise. A few candidates treated the question as an electrostatic field, with the lines going from one "charge" to the other, even though the question asks for a magnetic field.

(ii) Many candidates successfully drew arrows to show the attraction force between two wires carrying currents in the same direction.

Question 8

(a) Many candidates recognised the need to heat the filament to produce electrons or alternatively stated that thermionic emission was occurring.

(b) (i) There was often a failure to explain the high speed of the electron. The force of **attraction** towards the anode was often omitted.

(ii) Many suggestions were accepted, such as the possibility of collisions between electrons and atoms of air. Reference to the possibility of electrons ionising the air molecules was insufficient unless an answer also indicated that this would disrupt the path of the electrons.

(c) This question required thought and understanding rather than the application of the formula $Q = It$. Powers of ten errors were quite common, perhaps indicating the misuse of a calculator.

Section B

Question 9

(a) Most candidates scored one mark for realising that the energy of the car starts as kinetic energy, but only the best candidates earned two marks by then stating that this energy is transformed into heat (or heat and sound), without mentioning any wrong transformations, such as to potential energy. Many appeared to think that kinetic energy is always transformed into potential energy. Some candidates included the energy change within the driver himself as the brakes are applied. This often led to confusion unless a full explanation was given.

(b) Most candidates knew all of the equations tested in this section but generally only the better candidates obtained the correct numbers from the graph to use in those equations. A common mistake was to take the time of slowing to rest to be 5 s rather than 4 s.

(c) Although there were many excellent and well expressed answers, many candidates lost at least one mark by not answering the question, which asks for the effect on the braking distance, and a clear statement of this was required; for example many candidates stated that the time to stop would be longer while skidding but did not mention that the distance travelled is larger. Many candidates also stated that a new tyre has less friction than a badly worn tyre. It was surprising that so many candidates thought that using new tyres make a car much more difficult to stop and increases the braking distance. In **(iii)**, although many candidates realised that more mass increases inertia, they thought that increased friction would then cause the car with added passengers to stop in a shorter distance. Few candidates were able to follow the simple argument to state ‘increasing mass decreases acceleration, thus braking distance increases’.

Question 10

(a) (i) The major difference between longitudinal and transverse waves lies in the difference in the direction of oscillation relative to the direction in which the energy or the wave itself is travelling. Although most candidates recognised this difference they were not able to express it well enough to gain both marks. The major difficulty was recognising that there was an oscillation rather than just a movement. For example, answers such as “a transverse wave moves at right angles to the movement of the wave” did not make clear the principles involved. The question asked for diagrams and these were very often correct. Where the diagrams showed an oscillation, they added considerably to the quality of the answer and allowed the marks to be awarded.

(ii) Although almost all candidates recognised that something was closer together at a compression, or that the pressure was higher there, many candidates stated that it was the waves or the wavefronts that were closer, rather than the actual particles or layers of air.

(b) Diagrams of a ripple tank were disappointing. All that was required was a tank of water with a vibrator and a means of viewing the waves, for example a lamp and screen. Where the reflection of waves from a plane barrier was drawn carefully using a ruler or even a compass (if circular waves were drawn), then the result was good. However many candidates drew poor freehand sketches that did not seem to show sensible plane or circular waves reflecting from any obvious barrier.

(c) The diagram shows four complete waves next to the log in a distance of 6.0 m. Many candidates mistakenly used five waves in this distance, to obtain a value of 1.2 m for the wavelength. The frequency is best obtained using the basic definition, i.e. the number of waves per second. Many candidates were unhappy in dealing with a frequency less than 1 Hz and obtained 2 Hz as their answer. Almost all candidates scored at least one mark in determining the frequency for using the wave equation $v = f\lambda$ somewhere in their answer. There are alternative methods of obtaining the correct answers and these were accepted, and of course if a wrong answer for the frequency was given, then full marks for the speed of the waves could still be obtained.

Question 11

(a) (i) The knowledge for this answer was generally good, but many candidates merely gave a factual account of what materials stopped the three types of radiation and did not describe an actual experiment at all. A diagram was required, and this often omitted the detector, although the detector was sometimes mentioned in the description. In a full account the most common omission was an indication of the thickness of aluminium needed to stop or significantly absorb the beta particles. Thin foil will not stop beta particles. Full explanations were not always provided, for example the statement that "gamma rays are stopped by lead", fails to make clear that these particles are able to penetrate both paper and aluminium. A few candidates gave far too much detail in how the equipment was to be used, giving an explanation of the working of a Geiger-Müller tube.

(ii) Safety precautions were usually correct. References to lead suits and lead-lined walls, although indicating a lack of an awareness of actual practical experience, were accepted. General references to wearing laboratory coats or protective covering were not accepted.

(iii) While the idea of the source decaying quickly was generally appreciated, it was rarely made clear that a source with a steady emission rate would be needed to make the readings meaningful. Otherwise one would not be able to decide whether a decreased reading was due to the absorption of an intermediate sheet or due to the decay of the source, or that the decay would be complete before the experiment even began.

(b) Virtually all candidates realised that gamma particles are undeviated and that alpha and beta particles are deflected in opposite directions, but failed to make clear that alpha particles are deflected into the plane of the paper. Most candidates suggested incorrectly that "alpha particles are attracted towards the N pole and beta particles towards the S pole". A few candidates even suggested that the N pole is positively charged and the S pole negatively charged.

(c) This section produced some very good answers. Most candidates knew that isotopes have the same number of protons and a different number of neutrons, but some candidates were unable to understand the diagram and did not realise that **A** and **C** are isotopes of the same element.

PHYSICS

Paper 5054/03

Practical Test

General comments

Overall, the paper was a similar standard to last year. In June 2008, the optics question was more straightforward than the double lens arrangement used in June 2007. Also, the electrical question this year was more straightforward than that used in June 2007, because the candidates did not have to deduce the value of an unknown component in the circuit. These two slightly easier questions were balanced by a more difficult density question in June 2008. The thermal energy transfer question was of a comparable standard to the bouncing ball question of June 2007.

The Principal Examiner was particularly impressed by the graph work of the candidates this year. A higher proportion of candidates chose a suitable scale such that the data occupied most of the page, accurately plotted points, and drew a smooth curve through the points.

Comments on specific questions

Section A

Question 1

(a) Generally, the candidates did not use the techniques that were expected of them. The majority of candidates either took the measurements of a single coin or measured all five coins singly. The best technique to determine the average thickness of a coin would have been to stack the coins and then measure the total thickness of five coins. This value would then have been divided by five to obtain the average thickness of one coin. Some of the better candidates used this technique. Equally, to determine the average value for the diameter, the coins could have been placed in a line so that they were touching each other. The total length of the line divided by five would then have been the average diameter of one coin. Such answers were very rare.

(b) Examiners expected candidates to obtain a reasonable value for the density to two or three significant figures. If candidates had taken single values for the thickness and diameter they could still obtain a reasonable value for the density. However, problems included:

- Using an inappropriate number of significant figures
- Using incorrect units for the density. Often this was the result of an incorrect conversion to kg/m^3. In the practical examination, candidates may quote density values in g/cm^3. There is no need to attempt a conversion which may lead to an arithmetic error
- Making calculation errors, e.g. not squaring the diameter

(c) Many candidates talked about the inaccuracy of the metre rule, but failed to mention the variable thickness of the coin due to engraved images, etc.

Question 2

(a) There were a number of problems in this first section. They tended to fall in the following three categories:

- The unit of temperature was quoted as ° (i.e. an angle) rather than °C
- The temperature rise was sometimes greater than the temperature fall. If the experiment had been carried out carefully, this should not have been the case
- The above point was often caused by the mis-reading of temperatures, e.g. 23 °C was sometimes read as 20.3 °C.

(b) Only the very best candidates successfully calculated the thermal energy changes. The errors included the following:

- 50 g of hot water cooled down and 50 g of cold water heated up. However, many candidates tried to use 100 g in at least one of the calculations
- Candidates confused the temperature changes. They thought that the hot water cooled to room temperature or that the cold water rose in temperature to the initial temperature of the hot water. Examiners felt that candidates had done little practical work in this area.

(c) A sensible comment about heat loss to the surroundings could only be made if the previous calculation had been correct. Candidates were discussing heat lost to the surroundings, when, in fact, their results indicated that heat had been gained from the surroundings.

Question 3

(a) The answers to this question were disappointing. There were three main causes of error:

- Some candidates were forming a diminished rather than an enlarged image in the first part of the question
- Candidates were instructed to leave the object and the screen at the ends of the metre rule but it became clear from their measurements that these had been moved
- Candidates quoted x values to the nearest cm and did not include a unit with the value.

All the above points led to many candidates not achieving the mark for the value of x.

(b) This question has been asked in previous years and usually a high percentage of candidates have given the correct answer. The image should have been inverted, but quite a high proportion of candidates said that it was upright. The test of covering the lower part of the object and seeing the upper part of the image covered was very rarely described.

(c) The measurement of y produced similar problems to the measurement of x.

(d) Quite a number of candidates obtained a reasonable value for f. Even if the position of the object and screen had not been set as described in the instructions, it was still possible to obtain a correct value of f provided a clearly focussed image of the object was formed on the screen.

Question 4

(a) Centres used a large variety of LEDs. The result was that Examiners had to allow a wide range of current and potential difference values. Hence, most candidates were awarded full marks for the first part. Those who did not made one of the following errors:

- Units were omitted from either I or V. If units of I were not omitted then they were frequently wrong, e.g. a current of 9.0 mA was read as 9.0 A
- Values of I or V were not quoted to the correct precision, e.g. 9 mA rather than 9.0 mA

(b) Many candidates left the current in mA when they carried out the resistance calculation, so that a power of ten error was made, e.g. R = 2.1 V/ 7.0 mA = 0.3 Ω, rather than 0.3 kΩ.

(c) Good candidates used all seven possible combinations and obtained full marks for this part. Weaker candidates used the single values and obtain one or two marks, depending on whether units were given in the table or not.

(d) Graph work was good. Many candidates chose an acceptable scale for their graph, accurately plotted points on the grid and drew a smooth curve through the plotted data.

(e) The majority of candidates were awarded a mark for the idea that the resistance of the LED decreases as the current increases.

(f) Values were read off the graph correctly and because error carried forward from **(b)** was allowed, most candidates obtained an answer in the correct range.

PHYSICS

Paper 5054/04

Alternative to Practical

General comments

The full range of marks was available in this paper and candidates marks ranged from 30 to zero. A few candidates handed in a blank paper. The majority of candidates were able to demonstrate good practical skills and an understanding of the practical problems in taking readings.

Question 3 caused problems for candidates who tried to answer in terms of an experiment they had performed or observed and did not read the question carefully enough to appreciate what was being asked. This produced answers where candidates tried to remove the air from the room using a gas syringe in order to find its volume. Other candidates showed a lack of basic understanding by suggesting that opening a window would change the volume.

In describing experimental errors many answers just stated operator error, e.g. error in measuring length. Ineptitude on its own is an insufficient response and requires qualification. Errors such as incorrect calculation or error in using calculators are not acceptable responses.

The graph work was very good in this paper and many candidates scored full marks for the graph. The line was drawn as a smooth curve, with only a few candidates incorrectly joining the points. There were a few instances of missing labels on the axes and very few of plotting the given points on the major grid lines to give a straight line.

There was no evidence of candidates failing to complete the paper and many papers showed evidence of candidates checking their work carefully and improving answers.

Comments on specific questions

Question 1

The question was generally answered well with candidates gaining high marks. It involved bouncing a ball on a hard surface and measuring the bounce height. Some candidates confused measuring the height and timing the ball when describing the experimental procedure.

(a) Common incorrect answers here were radius, diameter or centre of the ball. The incorrect response 'top of the ball' was seen almost as often as the correct response 'bottom of the ball'.

(b) (i) A few candidates did not draw a ball. Generally the ball was drawn at the correct height vertically above the position of the ball given in the diagram. Most candidates drew a horizontal guideline from the ball to the ruler indicating the 66 cm mark consistent with their answer to **(a)**.

(ii) The eyeline was generally drawn correctly to the 66 cm mark on the ruler. There were fewer unusual representations of an eye on this paper. A small number of candidates lost the mark by drawing the eye between the ruler and the ball.

(c) (i) Most candidates were able to express the idea that the ball does not remain at the maximum height but falls back down. Many candidates had difficulty in expressing this clearly, so any indication that the ball continued to move was accepted.

(ii) A very common answer here was that they both measured the height and their results averaged. This was not accepted as repeat readings can be taken by one person. Many candidates thought that the ball was thrown rather than dropped but this was not penalised. Some candidates described timing the ball with a stopwatch rather than measuring the height on the ruler. Others used one candidate to catch the ball at the greatest height before releasing it again. Many excellent answers were seen with good explanations.

(d) (i) A simple average calculation caused some difficulty, with candidates forgetting to divide by 5, dividing by 4 or making an error in the calculation or in rounding. However, the majority of candidates gave the answer correctly and rounded it to two significant figures. Answers given to three significant figures were not acceptable due to the wide variation in the last significant figure in the data.

(ii) This calculation was generally well done. By carrying forward errors from **(d)(i)**, some surprising answers were given as candidates gave large values, e.g. 6725 m, with no apparent concern. There was no significant figure penalty here. A few candidates made it more difficult by expanding the bracket first rather than just substituting the value for *t*.

(e) The graph was done very well with most candidates scoring full marks. A few lost a mark by omitting the labels on the axes and others by joining the points on the graph. On some scripts, it was possible to see that a correct graph had been drawn, but then erased and redrawn with a smaller scale to assist in answering **(g)**. A few drew both graphs on the same axes. This was not penalised.

(f) Very few candidates lost this mark. The simple statement that '*h* decreases as *N* increases' was given by most. Although the graph is not an inversely proportional relationship, this was not penalised here.

(g) The majority of candidates joined the last two points in a straight line to the N axis giving an answer of 6. The graph is a curve so the curve should be extrapolated to the axis. A few candidates simply gave the answer as 4 (largest value given) or 5 (edge of the graph grid).

Question 2

This question concerned the possible problems in a simple series circuit which could prevent a bulb from lighting. Vague answers were common and insufficient practical detail lost marks. Many candidates gave answers that repeated information given in the question.

(a) Most candidates were able to draw a circuit diagram with a voltmeter in parallel with either the cell or the bulb. A significant number drew the voltmeter in series and a surprising number drew pictures of the apparatus rather than using circuit symbols.

The explanation of how to tell if the cell had run down was often missing with the simple statement that the voltmeter was placed in parallel, often followed by 'check to see if there is a deflection'. Most candidates who scored this mark thought that the voltmeter would read zero when run down. The mark scheme allowed this to be accepted.

(b) Some excellent answers with good detail were produced by able candidates. However, many candidates did not give sufficient practical detail, and comments such as 'not enough I', 'not enough V', 'too much R in connecting wires' were often seen. Many stated that the cell or battery had run down, which did not score a mark as they were asked for 'other possible faults'. Some candidates wrongly thought the lamp and/or switch had polarity and it made a difference which way round they were connected.

Question 3

This question highlighted conceptual errors in the volume of gases. An understanding that the volume of air in the laboratory is equal to the internal volume of the laboratory was required. Many candidates described an experiment to measure the volume of gas in a syringe and then tried to multiply this up to the room size. There were answers relating to the use of manometers or barometers to measure atmospheric pressure, and then the equation for gas law was quoted.

(a) (i) Acceptable responses were tape-measure or metre-rule. The incorrect responses were varied and included use of a vacuum pump to remove all the air from the room.

(ii) Candidates who gained the mark in **(i)** usually went on to score well here.

(iii) Gas law equation, or *density* = *mass/volume*, were often quoted. A few good candidates did not give the simple answer ($V = lwh$) here, and made the question too difficult by including references to the fixtures and fitting here with $V_{air} = V_{room} - V_{cupboards}$ rather than in **(b)** as a source of error.

(b) Common correct responses seen were parallax error in reading the metre rule, zero error in rule and the volume occupied by fixtures and fittings in the room. Responses not credited include ‘human error’, ‘error in reading from the ruler’, ‘error in calculating the volume’ and ‘error in using the calculator’. Incorrect responses included changes in temperature or the opening of doors or windows affecting the volume of air.

Question 4

This question concerned the choice of suitable apparatus for an experiment and required the candidates to be able to explain why one item was chosen rather than another. In describing the use of a thermometer to give accurate readings, many candidates simply explained the experimental procedure rather than how accurate readings are obtained.

(a) The majority of candidates could read the thermometer accurately. Marks were lost by incorrect reading of the scale giving 20.3 ^{o}C, or by incorrect or missing units. Common errors here were C° and $\overset{\circ}{C}$.

(b) (i) The majority of candidates correctly identified thermometer B. They needed to justify their choice by considering the range and sensitivity. However, detailed comments were needed here such as ‘range is high enough to measure the temperature of the boiling water’ and ‘more sensitive than A’.

A common incorrect observation was that B could be read to 0.1 °C rather than 1 °C.

(ii) Many candidates simply described the experimental procedure, e.g. ‘take readings every 30 seconds’ rather than comments about accuracy. Again, a common response was to avoid parallax error when reading the thermometer. Other good comments seen were ‘stir the water’, ‘$\frac{1}{3}$ immersion in the water’, ‘thermometer bulb not touching the beaker’. A number of candidates still think that a laboratory thermometer should be shaken before use and that it is removed from the water in the beaker before reading.

(c) Most candidates answered this correctly. The responses seen included safety comments about breaking the glass or mercury being poisonous. Just ‘easier to use’ was not awarded the mark as more detail was required. Some candidates incorrectly thought that the strip thermometer was more accurate.

