PHYSICS

Paper 5054/01
Multiple Choice

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

General Comments

The mean score for this paper was 27.3 out of 40 (68%) and the standard deviation was 19%.

The responses showed that the candidates had all been well prepared across the whole syllabus.

Candidates found **Questions 4** and **35** very easy, while **Questions 3** and **28** were the most difficult.

Comments on Individual Questions

Question 3

More than half of the candidates chose option **D**.

Question 5

A large number of the lower-scoring candidates chose option **D**, missing the reference to Newton's third law.

Question 28

Similar numbers of candidates opted for **A**, **B** and **C**. The better ones chose correctly, the lower-scoring ones chose **A** (the 'standard' I/V graph) and the others thought it was a V/I graph instead of I/V.

Question 39

The statistics suggest that, apart from the better candidates, this was a question for guessing.

PHYSICS

Paper 5054/02

Theory

General comments

As in previous years, the majority of candidates expressed themselves clearly, legibly and grammatically. Calculations were very encouraging and generally included clear working with the correct quotation of formulae. Numerical answers were usually expressed using appropriate units and were given to a sensible number of significant figures. Some candidates failed to give a unit for their final numerical answer and lost a mark as a consequence. Expressing an answer to a wrong number of significant figures was not an important feature of this examination. However, a number of candidates wrongly rounded their answers and lost a mark; e.g. in **Question 1**, some candidates gave an answer of 7.2 whereas the answer is 7.27 to three significant figures and the answer to two significant figures is 7.3.

Although the syllabus seemed to have been adequately covered by most Centres, the question on radioactivity in ***Section A*** and the detailed knowledge required of the transformer in ***Section B*** revealed a lack of knowledge in some Centres.

The questions in ***Section B*** required more descriptive writing this year, yet there was little evidence of candidates running out of time. Where this may have happened, candidates gave inordinately long and irrelevant descriptions in ***Section B***, for example of transformer turns ratios, leaving less time to actually answer the question. There were some instances where candidates answered all three of the ***Section B*** questions. This is not to be encouraged. **Question 9** was slightly more popular than the other two questions in ***Section B***. Where candidates obviously understood the transformer and electrostatics, the marks obtained in the three questions in ***Section B*** were similar. It was possibly harder to score full marks on **Question 11** because there was no calculation involved.

Some Centres did not appear to have made any A4 paper available for answer to ***Section B***. Candidates are only provided with one ruled page on the question paper, which is not generally sufficient to answer two questions from this section. In ***Section A***, candidates should be encouraged to give their working in the spaces provided and not to use additional paper for this section, unless it is necessary.

Comments on specific questions

Section A

Question 1

(a) Candidates found this section difficult. It was expected that they would make reference to an initial acceleration and then to the constant speed of the athlete. Many candidates failed to notice the change in the motion from curve to straight line and stated incorrectly that the athlete accelerates for the whole 8 s or did not recognise that the constant speed portion of the graph starts at 4 s. Because the transition to a constant speed is difficult to see on the graph, any time between 2 and 4 s was accepted for this transition. Many candidates stated incorrectly that the initial acceleration was increasing during the initial period.

(b) Most answers were correct although a minority of candidates misread the scale on the graph.

(c) The formula for speed was usually quoted, even when candidates misread the coordinates on the graph.

Answer: **(b)** 7-8 m **(c)** 7.3 m/s

Question 2

(a) It was encouraging to find so many sensible and correct answers which described the increased kinetic energy of the molecules at higher temperature leading to an increased escape of molecules from the surface, particularly as the molecules overcome the attractive forces. In **(ii)** the question asked for a statement of one change that would cause an increase in evaporation. Weaker candidates merely stated, for example, “the surface area” rather than stating “increased surface area”.

(b) There were many correct answers. Even when candidates incorrectly quoted a formula involving specific heat capacity they were able to score one mark if they clearly used a mass of 40 g.

Answer: **(b)** 92 000 J

Question 3

(a) Candidates were required to suggest that a thermometer is calibrated by insertion into melting ice, into steam above boiling water and then by marking the 100 internal divisions. Most candidates earned one or two marks, sometimes stating that the thermometer was just placed in ice, which is not necessarily at 0ºC or omitting to mark the divisions between the two fixed points.

(b) In **(i)** it was encouraging to find many correct answers, either stated as 120ºC or as between -10ºC and 110ºC. The linearity of the scale is best described in **(ii)** as being due to the same distance between each division along the scale. Many candidates made sensible and acceptable attempts.

(c) Two equally spaced markings at 10ºC and 20ºC were required further up the thermometer than in the original diagram. A considerable majority of candidates drew a thermometer which was less sensitive. This may reflect the confusion which is often apparent between a sensitive thermometer and a thermometer which has a greater range.

Question 4

(b) Candidates found difficulty in explaining total internal reflection. Many candidates merely stated that total internal reflection occurs when the angle of incidence is greater than the critical angle. This, alone, did not score the mark but better candidates went on to answer the question by stating that in total internal reflection all of the light is reflected and none escapes into the air. Weaker candidates merely stated that the ray was reflected and their explanation could have equally applied to any reflection.

(c) There were many acceptable advantages of optical fibres, including the ability to handle more telephone calls, faster transmission of data, better quality, less power loss or the greater difficulty in tapping a telephone call on an optical fibre. The majority of candidates produced an acceptable advantage but many suggested that the actual telephone signal itself travelled faster.

(d) The formula $v = f\lambda$ was generally known. However, many candidates either failed to deal with the powers of ten correctly or did not give the final unit.

Answers: **(d)** 3.3×10^{14} Hz

Question 5

(a) Two rays were required from the top of the object in the ray diagram. A significant number of candidates failed to draw the ray, initially parallel to the principal axis, that passes through the principal focus, 3.0 cm from the lens. However, candidates with wrong diagrams were able to earn full marks in **(b)** with the diagram they had drawn in **(a)**.

(b) Candidates had difficulty in defining linear magnification, as either the ratio of image to object height or image distance to object distance. Many candidates merely suggested that an object was magnified if the image was larger than the object. However in **(ii)** they were often able to calculate the magnification of the image that they had drawn.

(c) The majority of candidates correctly drew rays that appeared to converge behind the retina.

Answer: **(b)(ii)** 0.6

Question 6

(a) Many candidates failed to recognise that the question was asking for the magnetic field of a solenoid. Often the diagram was interpreted to require an electric field between positive and negative charges. Those candidates drawing a magnetic field often drew field lines that crossed or appeared to come from one point on the tube. However there were a reasonable number of well drawn and correct magnetic field patterns.

(b) Definitions of frequency in general terms or definitions applied to the actual situation were accepted and were well produced in **(i)**. However in **(ii),** many candidates incorrectly thought that the magnet was being moved and an induced e.m.f. being created in the coil. Some candidates even suggested that the diagram was of a microphone rather than a loudspeaker. The best answers suggested that the coil was acting as an electromagnet and that as the a.c. in the coil reverses, the poles of the electromagnet also reverse, causing the coil to vibrate left and right.

Question 7

This question was frequently well answered. Weak candidates found difficulty towards the end of the question but very few candidates scored less than half marks.

(a) The simple addition of resistance in a series circuit was very well known. A common mistake in **(a)(ii)** was to use an incorrect formula $R_T = 1/R_1 + 1/R_2$ giving an answer 0.5 Ω. However, if this incorrect answer was then used in **(b)** there was no further penalty.

(c) Many candidates used the current they had calculated in **(b),** assuming incorrectly that the same current was flowing in both arms of the circuit. Few correct answers used the principle of the potential divider, instead calculating the current in the lower branch of the circuit and then using the equation $V = IR$.

Answers: **(a)(i)** 6Ω **(ii)** 2 Ω **(b)** 6 A **(c)** 8 V

Question 8

(a) A pleasing number of candidates were able to correctly explain how an element may have different isotopes. Reference to a different nucleon number was not sufficiently clear unless no change in proton number was also mentioned.

(b) Far fewer candidates scored both marks. Most candidates correctly stated that half-life is a "time taken to halve", but what was halved was often wrong or vague, such as the mass or amount of the isotope. Candidates should be encouraged to give the definition of half-life as the time taken to halve the number of nuclei or the activity, but not the radioactivity, of the sample.

(c) Many candidates scored both marks. The question asked for candidates to show how they obtained the half-life on the graph and a significant number failed to mark the graph in any way.

Answer: **(c)** 12 s

Section B

Question 9

This was a popular question in ***Section B***. Surprisingly the first two sections proved to be the most difficult for weaker candidates.

(a) The majority of candidates realised that when the car was moving at constant speed, the two forces are equal and opposite and that when accelerating, the forward force is larger than the backward force. Weaker candidates described the changing size of these forces and did not compare force the two forces at all.

(b) Only a minority of candidates suggested that the force on the car is towards the centre of the circle.

(c) The calculations in this section produced good marks. In **(iv)** weaker candidates did not attempt to use the area under the graph or to use an average speed to find the distance, but such errors were uncommon. It was encouraging to find most statements of the energy change in **(ii)** to be correct and to be actual energy transformations. The car was assumed by most candidates to initially have chemical energy and this either changed to heat (thermal energy in the burning fuel) and then to kinetic energy or was directly transferred in the engine to kinetic energy and then to heat due to air resistance. Many correct possibilities were awarded full marks.

(d) There are many factors that affect the distance travelled by a car whilst braking, such as the speed of the car, friction with the road, friction in the engine, the condition of the tyres, the mass or inertia of the car or even the slope of the road. Those candidates who failed to score both marks usually suggested as a factor the force produced by the brakes (this was excluded in the question) or made vague statements about "the condition of the road".

Answers: **(c)(i)** 0-8 s **(iii)** 1.6 m/s^2 **(iv)** 3.3 x 10^7 J **(iv)** 20 m

Question 10

(a) Most candidates realised that energy or power was lost in the transmission line but many candidates incorrectly suggested that current was lost along the line. Only the strongest candidates suggested that the long length of the line produced a high resistance.

(b) When candidates suggested that the first transformer increases the voltage and the second transformer reduces the voltage to 230 V, high marks were scored. Many candidates were unable to apply their knowledge of transformers to this new situation. A common misconception was that the second transformer steps up the voltage to account for any "lost volts" along the transmission lines.

(c) The structure of a transformer was generally well known and most candidates earned some credit for a description of its function, involving a changing magnetic field and the induction of an e.m.f. in the secondary coil. Few candidates stated that an alternating current in the primary coil is the source of the changing magnetic field.

(d) Calculations of the current and energy supplied were most encouraging with only a minority of candidates unable to earn any credit at all. In some answers there was no conversion of 10 minutes into seconds before the application of the formula for the energy supplied.

Answers: **(d) (i)**3.0 A **(ii)** 414 000 (J)

Question 11

Considering that electrostatics is often considered to be a topic which students find difficult to understand, the answers to this question were frequently very good. There were fewer confusing explanations than expected. Although candidates were often able to describe what happened in each section, they did not always fully explain their answers.

(a) The majority of candidates realised that electrons (or negative charge) move from the cloth to the rod. There were only occasional references to the movement of positive charges, which were not accepted, and some candidates stated that the cloth and the rod were pre-charged and merely exchanged charge during rubbing.

(b) Although in **(i)** candidates often correctly suggested that electrons would move to the right of the sphere, they did not always make clear that this was due to repulsion from the negative rod. In **(ii)**, although most answers correctly referred to the attraction between the positive charge on the sphere and the negative charge on the rod, very few made reference to the weaker repulsive force between the negative charges. Some candidates incorrectly referred to the movement of positive electrons.

(c) Descriptions of what was meant by earthing often did not mention a connection to the earth or ground. Earthing was simply considered to be a process of neutralisation. When free electrons were described as moving to earth, this was rarely described in terms of being due to the repulsion between the electrons and the negative rod. The diagram in **(iii)** usually had positive charges spread all over the sphere, even though the negatively charged rod was still close to the sphere. In the actual question the rod has not been removed from the side of the sphere and thus the expected diagram should have positive charge only on the left side of the sphere.

(d) The most common devices quoted by candidates where electrostatic charging is involved were electrostatic precipitators and paint sprayers, with occasionally a photocopier, a gold-leaf electroscope or a Van de Graaff generator being suggested. Marks were lost due to lack of clarity in explaining how the charges were produced initially or how they were important to the operation of the device being explained. With the electroscope, diagrams often omitted the correct charge distributions and explanations were muddled as to what the device was indicating. A few weak candidates confused electrostatic charging with electromagnetism.

PHYSICS

Paper 5054/03
Practical Test

General comments

All candidates made a good attempt at the electrical circuit measurements in **Question 4**. Weaker candidates used the single resistors to obtain some results; better candidates used all series combinations of the resistors. The work on density in question was also particularly pleasing. The three areas of concern were;

- The inability of candidates to produced a focused images in **Question 1**. It was clear from the measurements of some candidates that a sharp image had not been formed on the screen.
- The inability of candidates to repeat readings. This was particularly the case in **Question 3**, where Examiners expected several measurements of the rebound height to be made and the majority of candidates gave only one measurement.
- The inability of the more able candidates to see that in the last part of **Question 4**, if the current was halved then the value of the resistor R and the value of the resistor X were the same.

As a result of the good work of the weaker candidates in the first part of **Question 4** and the inability of the more able candidates to solve the last part of the question, the spread of marks for the paper is less than in the previous year.

Comments on specific questions

Section A

Question 1

(a) The confidential instructions stated that a lens of focal length 15 cm was required. Allowing for a 10% uncertainty in this value, the value of v should have been in the range 40.0 cm to 53.0 cm. Good candidates obtained a value in this range but weaker candidates obtained a value for v that was well outside this range. In some cases it was evident that a diminished image had been formed on the screen. In other cases it was evident that the image was not focused. Some candidates actually stated this in their answer to part **(b)**. Weaker candidates also tended to omit units or quote values to the nearest cm. Each of these errors was only penalised once in the whole of **Question 1**, e.g. if lack of precision was penalised here, it was not penalised in part **(b) (ii)**.

(b) (i) Good candidates clearly carried out the operation of inserting the diverging lens successfully. They often referred to a larger magnified image and that the fact that the image was less intense. Those candidates who referred to a blurred image had probably not moved the screen back to the 100 cm mark.

(ii) The confidential instructions stated that the focal length of the diverging lens could be of any value between 15 cm and 90 cm. Allowing for this wide range the value of x had to be less than 43.0 cm. The results of most candidates met this criterion and the only candidates who lost marks here tended to be those who quoted the answer to the nearest cm or omitted the unit. Allowing for the range of object distances, the value of $x + y$ had to be greater than 70.0 cm but less than 83.0 cm to match the range of focal lengths. This was another good indicator that the apparatus had been set up correctly. As expected good candidates obtained an answer in the range, whilst weaker candidates obtained values well outside the range.

(c) The focal length mark was dependent on the candidates having the correct set up.

Question 2

(a) In most cases the measurements on the stack of slides were carried out successfully. The values of density which followed the measurements sometimes indicated that one of the measurements was wrong. A popular error involved candidates giving *T* as 1.5 cm, when it was clear that 1.05 cm would have given the correct value for the density. A disappointing point here was that the mark for repeat readings was very rarely awarded.

(b) Density calculations were generally carried out successfully. Weaker candidates gave the incorrect unit, e.g. g/cm. Also candidates should note that it is not necessary to convert from g/cm^3 to kg/m^3 in the practical paper. Often when candidates attempt this conversion, an arithmetic error is made.

(c) Most candidates obtained a correct value for *N,* although there were some who gave answers of 11 or 13. Most candidates could use a correct technique for determining *t* and *m,* but significant figures and units posed a problem. *t* was often quoted to 1 s.f., (e.g. 1.2 cm/12 = 0.1 cm) whilst *m* was often quoted to 4 s.f. (e.g. 52.6 g/12 = 4.383 g). Ideally the number of significant figures should correspond to the number of significant figures in the data. Thus, *t* should have been quoted to 2 s.f. and *m* should have been quoted to 3 s.f., but Examiners allowed 2/3 s.f. in both values.

Question 3

(a) To obtain the mark for the diagram, candidates had to show the rule, the bench and the set square with the sides of the set square up against the bench and the rule. Many candidates did not show the bench.

(b) The disappointing aspect of this question was the lack of repeat readings when the value of h_2 was determined. Most candidates gave a single result which meant the loss of 2 marks. Some candidates talked about repeating readings but no values were given and no credit was given for this.

(c) The best candidates had no difficulty obtaining the correct energy changes. Three common errors from the weaker candidates included;

- Leaving height measurements in cm so that a correct answer in joules was not obtained.
- Problems with the mass of the table tennis ball, e.g. even though Supervisors may have given the mass of the ball as 0.0021 kg, some candidates then used a mass of 0.021 kg in their calculations.
- An incorrect unit for the energy, a unit of N/m was a popular incorrect answer.

Section B

Question 4

(a) Good candidates drew a correct circuit diagram. Popular mistakes which led to the loss of the mark were;

- The omission of a component, the most common one being the omission of the gap in the circuit, although some candidates omitted the ammeter or the resistor X.
- The use of incorrect circuit symbols, e.g. a square box for an ammeter.

(b) In comparison to similar experiments in previous years very few candidates made a mistake in determining I_0. In previous years currents have been incorrect by factors of 10, units have been omitted etc.

(c) As in part **(b)**, for the majority of candidates, correct values for the resistors were stated and the measured currents were in the correct range.

(d) In was particularly pleasing to see that virtually all candidates obtained 2 marks in part **(c)** and 2 marks here for using all three resistors singly and correctly tabulating their results. The better candidates used all 4 possible combinations of the resistors in series and gained the extra 2 marks. In the majority of cases correct values for the currents were obtained.

(e) Virtually all candidates labelled the axes of the graph correctly and correctly plotted their data on the grid. A large number of candidates did not choose a suitable scale for their graph. The current axis often started at the origin so that the plotted data occupied less than half the grid in the vertical direction which meant the loss of the scale mark. An equally large number of candidates drew a straight line through their points despite the fact that the data indicated a clear curve. This led to the loss of the line mark.

(f) This was meant to be a discriminating section for the most able candidates. In the event no candidates scored the full 3 marks. When the current was I_0 the only resistor in the circuit was X. When the current was 0.5 I_0 a resistor of value R would have been in the circuit in series with the resistor X. Since the current had been halved, the resistance must have been doubled, hence R is equal to the value of X (i.e. the resistance of the circuit is 2x the value of X). No candidate explained this successfully. The best candidates determined the value of 0.5 I_0 and read off the value of R from the graph. This was often followed by an incorrect statement that the value of X was 0.5 R. Candidates were given credit for a calculation of the value of X based on (power supply voltage)/I_0. In these cases candidates made the reasonable (but not accurate) assumption that the power supply voltage was 6.0 V. The candidates who read off R and determined the value of X in the above way could thus score 2 out of the 3 marks for the section.

PHYSICS

Paper 5054/04
Alternative to Practical

General comments

The full range of marks was achieved by candidates.

Candidates were generally well prepared for the paper and their responses showed that they had experienced a variety of experimental work during their course. They were able to comment on practical procedures and how to reduce errors in practical work. However, many had difficulty in explaining why certain techniques, (such as repeating readings), were used, (as in **Question 1(b)**) or not possible, (as in **Question 3(c)**). The response 'to reduce errors' is often seen, and is invariably insufficient on its own.

In graphical work, the points were neatly marked and generally well plotted, but a large number of candidates lost the scale mark for not making the plotted points occupy more than half of the graph grid provided. It was not necessary to make the graph start from (0,0).

When testing computational skills, the calculation was well performed with the majority of candidates able to manipulate the equation given and quote their answer accurate to a suitable number of significant figures. An appreciation of an appropriate number of significant figures in measured quantities is required in all answers in practical work. When measuring quantities from diagrams on the paper, however, it is important that candidates are aware of the appropriate number of significant figures to give in their answer. This was the case in both **Questions 2** and **4** where some candidates gave answers accurate to too many significant figures e.g. angles given as 60.0° or weights as 4.70 N, which are not possible with the measuring instruments used.

A few candidates are still writing out the stem of the question in their answer and then finding that there is not enough space for them to write their answer.

Comments on specific questions

Question 1

This question carried 9 marks.

The question was about practical techniques used in timing experiments and involved explaining why standard procedures are used to increase accuracy. The candidates were then required to plot a graph of the results given.

Candidates found it difficult to differentiate between the responses required for **(a)(ii)** and **(b)**. They should be encouraged to read at least one response ahead before answering to ensure they do not confuse two parts of a question, and to avoid giving additional information in one section which is required in a latter part.

(a) (i) The expected response was in the range 10 to 20 (whole number required). The majority of candidates gave either 10 or 20 oscillations. A few candidates, surprisingly, gave answers that were not whole numbers (e.g. 12.05).

(ii) Many candidates were able to suggest a suitable number of oscillations, but had difficulty explaining why, and simply stated 'to make it more accurate'. The mark scheme identifies a range of acceptable responses. Good answers explained that the time for one oscillation was too short to measure accurately, or that the effect of human reaction time is reduced as it is divided by the number of oscillations timed. Responses implying that one oscillation was timed several times were not acceptable.

(b) The majority of correct responses here stated 'the average will give a more accurate value for *T*', however, many different correct responses were credited, including explaining that the experimenter improves their technique with practice, or that it is important to check for errors in timing.

(c) This was well answered with many candidates simply stating that the chain is moving fastest at the centre of the swing. An alternative correct response – that the timing is taken as the chain passes the (fiducial) marker – was also credited. The most common incorrect response was that the oscillations start from the centre, so have to be timed from there.

(d) The expected answer here was that the oscillations would be too fast to count. Many candidates did not appear to have looked at the data in the table before answering. There was some evidence that candidates added this to their initial response after drawing the graph. A common answer given was that 'the oscillations would be difficult to count' which was insufficient. A few candidates gave responses concerning magnetism, and appeared to confuse this question with the strength of an electromagnet.

(e) The graph question caused some difficulty with few candidates gaining the full four marks. The majority of the candidates were able to label the axes correctly and plot the points accurately gaining two out of the four marks for the graph. The *y*-scale was often drawn from zero which made the plotted points occupy less than half the grid and was therefore not awarded the second mark. The candidates were asked to draw a smooth curve through the points. Many found this difficult, and the lines drawn often showed two distinctly different curves rather than a single smooth line. Many weaker candidates drew a straight line, while others looped the curve from point to point.

Question 2

This question carried 8 marks.

It was generally well answered with many candidates scoring full marks. Good quality lines were seen, drawn with a sharp pencil and a ruler. Few candidates drew free-hand lines. Angles were generally measured accurately, but a few candidates wrongly thought that they could use a protractor to measure 0.1°.

(a) (i) Most candidates were able to draw a line perpendicular to the mirror. Solid lines were accepted, although dotted lines are preferred. The commonest mistake was to draw a line vertically on the page, although lines were seen at a range of angles to the mirror.

(ii) The correct answer is 59° or 60°. Most candidates who had drawn the normal correctly were able to accurately measure the angle between the ray and the normal, although some gave 30°. A few candidates scored this mark without drawing a correct normal, by measuring the angle between the ray and the mirror then subtracting it from 90°.

(b) (i)and**(ii)** Very few candidates failed to gain both marks here for drawing the two rays through the pins.

(iii) The correct response should have been 40° ± 1°. Most candidates were able to measure the angle accurately.

(iv) Most candidates were able to divide their answer to **(b)(iii)** by 20° to obtain the correct answer, 2. The most common mistakes here were to give 40/20 = 20 or to include a unit in their answer, i.e. 2°.

(v) This part of the question was more challenging, and required the students to give sufficient information to score two marks. Some excellent answers were seen, with candidates explaining that the experiment needed to be repeated with a different value of *z*, or different mirror position and then checking that the same value of *c* is obtained. Many candidates did not score the second mark because they just repeated the stem of the question. Simply repeating the experiment is insufficient as it implies checking with the same value of *z*. Several candidates did not appreciate what was required for the second mark and scored the first mark by changing *z* but then found the average value of *c* from their results. The second mark could be gained by repeating the experiment for more than one additional value of *z*, or by plotting a graph of *z* against *y*.

Question 3

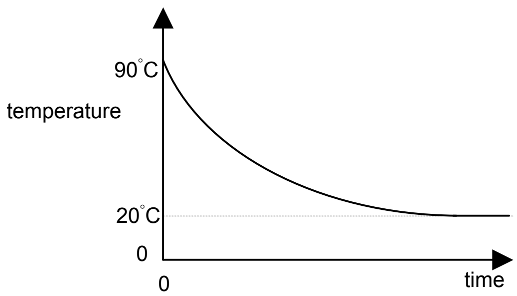
This question carried 8 marks.

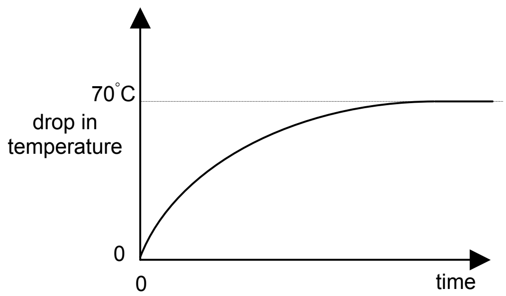
The question tested the candidates' understanding of a cooling curve. Many candidates had obviously performed this experiment in a laboratory and were able to give clear answers about the techniques involved. Others, however, gave answers which included lagging the test-tube to prevent heat loss, showing that they had not understood the experiment.

(a) Taking readings and writing them in a clearly headed table of results is an important practical skill. Many candidates scored both marks here, but common errors were:

'stopwatch reading' instead of 'time'
'thermometer reading' instead of 'temperature'
'temperature change' instead of 'temperature'
no units given
°C was often incorrectly given as C° and even as $\overset{\circ}{C}$

(b) Although 'temperature change' was not acceptable in **(a)**, it was accepted in **(b)**. Good graphs, scoring all three points, were not often seen, but some able candidates produced excellent sketch graphs like those shown below.





(i) Temperature (or temperature change) must be on the *y*-axis and time on the *x*-axis. Most candidates were able to label the axes the correct way round. A few weaker candidates plotted water temperature against room temperature.

(ii) The second mark was for the shape of the curve. This needed to be correct for their *y*-axis label.

Many candidates drew a straight line, or a curve in the wrong direction.
Change of state curves were drawn by some candidates.

(iii) This mark was for labelling the given values on the *y*-axis (either 90° and 20° or 0° and 70°)
The curve should start and finish on the correct values.

Common mistakes were:

to omit one or both values
to start the curve from 90° and fall to zero

(c) This part of the question proved to be challenging for the students. Many did not appear to relate their answer to a cooling curve situation. There were, however, some very good answers seen where the students recognised that both the temperature and the time are continually changing and hence no reading can be repeated.

Many candidates simply stated that the whole experiment would need to be repeated, and some gave explanations referring to change in room temperature, or loss of mass of the water due to evaporation.

(d) The mark scheme allows many possible answers for this part of the question. Many candidates gave a list of three, four or even five suggestions. This should not be encouraged as wrong answers will always lose a mark, even if two correct answers are also given.

Examples of responses which were not allowed:

starting and stopping the stopwatch for each reading, and making comments on human reaction time affecting the experiment
lagging the test-tube or adding a lid which would change the experiment
repeating the experiment which would not improve the accuracy of this one
repeating and averaging results was not accepted
waiting for the thermometer reading to become steady before taking a reading

Question 4

This question carried 5 marks.

Candidates were required to be able to take measurements from diagrams on the question paper and to perform a calculation using their values.

(a) (i) Many candidates did not appear to recognise the diagram of a newton meter. The terms 'spring balance' or 'force meter' were acceptable alternatives. Common errors included 'beam balance', 'weight balance' and 'spring weighing gauge'.

(ii) and **(iii)** Answers in the range 4.6 to 4.9 were acceptable for **(ii)** and 1.5 or 1.6 for **(iii)**.

Most candidates were able to read the values on the newton meters to the required accuracy. The most common error was to misread the direction of the scale on one or both meters, giving answers of 5.2 N and 2.5 N.

Some more able candidates gave answers to 2 decimal places, e.g. 4.80 N, which is inappropriate as the scale cannot be read to that degree of accuracy.

(b) The most common answer given was 6.9, which is correct.

The calculation was generally well done, with most candidates showing their working clearly. The candidates were required to correctly use their values from **(a)**. Arithmetic errors were penalised. There was no penalty for answers given to too many significant figures, but at least two were required as there are two s.f. in the data used.

(c) The majority of candidates were able to explain the problems of getting the block wet and therefore this affecting the weight in air, or having to allow time for the block to dry before weighing it in air. A statement that it would cause errors was insufficient. Some candidates thought that measuring W_2 before W_1 would give a negative answer.