PHYSICS

Paper 5054/11
Multiple Choice

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

General Comments

The results show that all parts of the syllabus had been covered well.

The candidates found **Questions 20** and **38** to be easy. None of the questions appeared to be especially difficult.

Comments on Specific Questions

Question 5

Many candidates chose option **C**. The horizontal acceleration of the aeroplane is $2\,m/s^2$ and so the thrust must be less than the weight of the aeroplane. There is no vertical acceleration, so there can be no resultant vertical force. This allows the correct answer **D** to be deduced.

Question 6

Options **A**, **B** and **C** were almost equally popular, suggesting a degree of guesswork.

The forces on the road and on the wheel must be in opposite directions. At the contact point, the wheel is trying is trying to move backwards (to the left) so the frictional force on the wheel must be to the right.

Question 12

A popular incorrect answer amongst weaker candidates was **A**, which gave the smallest volume change. Candidates need to recall $p_1V_1=p_2V_2$ to answer this type of question, and work through each of the options before selecting the correct answer. All the syringes start at the same pressure, so the smallest pressure change comes from the smallest value of V_1/V_2, syringe **B**.

Question 26

The stronger candidates were split on whether the response was **C** (correct) or **D**.

Question 35

Across the whole range of candidates there was an equal choice between options **B** and **C**. The induction produced tries to oppose the change causing it; so the polarity of X repels the N-pole of the magnet approaching it and attracts the N-pole as it moves away.

PHYSICS

Paper 5054/12
Multiple Choice

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

General Comments

All parts of the syllabus had been covered and the candidates had been well prepared.

The candidates found **Questions 1** and **8** to be easy. **Questions 4**, **14** and **21** were the hardest.

Comments on Specific Questions

Question 4

The most popular choice was **B**. This was the average acceleration from 0 to 30 s, not the acceleration at 30 s. Candidates should be encouraged to read the question carefully and pay attention to the way it is worded.

Question 12

Candidates can answer this question by remembering $p_1V_1=p_2V_2$. If V is decreased by a factor of 4, then p must increase by a factor of 4. Weaker candidates often chose **B** or **C**, indicating they were looking at the difference in volumes rather than the ratio of volumes.

Question 14

This question highlighted a problem when candidates calculate "work done". A large number of candidates opted for **B** or **D**, forgetting to check the directions of the force and the movement. The vertical height above the floor does not change so the distance moved in the direction of the weight is zero, and the work done is therefore also zero.

Question 21

Many candidates chose **C**. The reflected waves must appear to come from the position of the image, which gives **A**.

Question 37

Many weaker candidates chose **A**, having confused the horizontal and vertical controls of the oscilloscope. Candidates would benefit from either using or seeing demonstrations of a c.r.o., to become more familiar with its controls.

Question 40

The most common choice was **B**. Candidates choosing **B** correctly subtracted the background count at the beginning, but then forgot to add it on at the end. The background count is always present and a detector will count the background radiation as well as the emission from a source.

PHYSICS

Paper 5054/21
Theory

Key Messages

- To gain full credit, 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. One significant figure is not penalised where the final answer is exactly correct to one significant figure (e.g. 2.0 / 5.0 = 0.4), but an answer of 0.40 in this instance is better.

- A few candidates write some answers out in pencil before writing over the pencil in ink. This frequently leads to the answer being less legible and, when combined with crossings out and uncertain expression, the answer can be extremely difficult to interpret.

- The number of marks shown and the amount of space provided give a guide to the length of 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. Sometimes, the need arises to cross out an answer to part of a question and replace it with a new answer elsewhere. If this is done, candidates should make a simple reference to the location of the new answer. Candidates must not, however, write answers on the front cover sheet.

- A small number of candidates ignored the rubric for ***Section B*** and answered all three questions. Candidates should be reminded that they cannot score additional credit for answering three questions, so they should spend the time available for ***Section B*** answering two questions carefully rather than rushing answers to three questions.

General Comments

The questions were accessible to all candidates and there was no section of any of the questions where a correct response was not seen, although **Question 2** almost invariably produced very low scores, indicating the unfamiliarity of candidates with the thermocouple thermometer. **Question 9 (b)(ii)** also produced only a handful of correct responses. The standard of written English was high and there was little evidence of a language problem, even for the weaker candidates. The quality of expression, even among the weaker candidates, was good, even if the underlying physics was sometimes inaccurate.

Where a question calls for extended prose, candidates should take time to plan their answer, and not list everything that they know about a topic. For example in **Question 10 (d),** most candidates produced an unconnected list of methods of insulation without explaining why their chosen method(s) would be effective. The more able candidates expressed themselves eloquently and succinctly, confining their answers to the question asked, and scoring full marks effortlessly.

Calculations were generally carried out well, except in **Question 2 (a)(ii)**, and most candidates were able to quote a relevant formula, either in words or symbols, and substitute correctly into it.

Comments on Specific Questions

Section A

Question 1

(a) Most candidates deduced correctly that because the parachutist travelled at constant speed, the size of the resistive force was equal to the weight of the parachutist, and its direction was opposite to that in which motion was taking place.

(b) Many candidates were unable to use a graphical method to determine the size of the resultant velocity of the parachutist, and resorted to sketching velocity-time graphs of the motion. Of those candidates who drew correct scale diagrams, many lost marks needlessly by ignoring the request to state the scale used. Many otherwise correct answers lost credit because the unit for the resultant velocity was given in N instead of m / s.

Question 2

(a) (i) Only the most able candidates were able to state what was meant by a *linear output* for a thermocouple thermometer. All that was required was to state that the output (voltage/e.m.f.) was proportional to the temperature (difference).

(ii) This was found to be the most difficult calculation on the whole paper, with only a minority of even the most able candidates obtaining a correct answer. Candidates who calculated the change in voltage per °C and could proceed no further were awarded partial credit.

(b) Candidates performed better on this part of the question, with many being able to give a sensible reason as to why a liquid-in-glass thermometer would not be suitable to measure the temperature inside the furnace.

Question 3

(a) (i) The work done lifting the bricks was calculated correctly by about half the candidates. Most made an attempt to find the increase in potential energy of the bricks or to multiply the force used by the distance travelled. Many candidates who used the expression force × distance substituted the mass of the bricks instead of the weight of the bricks into the expression, and their answers were subsequently out by a factor of ten.

(ii) The useful power output was generally calculated correctly.

(b) Many candidates realised that the electrical power supplied to the motor was greater than the output power and gave reasons such as heat loss or friction for the difference. Full credit for this part was rarely achieved because candidates were reluctant to state <u>where</u> the heat loss occurred or between which parts of the moving system friction occurred. A small minority of the most able candidates also realised that energy would also be needed to lift the rope and the platform on which the bricks were stacked.

(c) Most candidates completed the circuit correctly and quoted the correct formula which would enable the power to be calculated.

Question 4

(a) The mass of fuel in the tanker when full was generally calculated correctly, but the question stem was often ignored and the <u>total</u> mass of the tanker when full was not deduced. A surprising number of candidates did not add the mass of the empty tanker to the mass of petrol to find the total mass of the tanker.

(b) A majority of candidates were able to deduce the deceleration of the tanker by dividing the resultant force on it by its mass.

Question 5

(a) (i) Many candidates adopted the correct approach, and measured a number of wavelengths and then divided by the number that they had taken, in order to determine the wavelength of the waves in the deep water. Although a range of correct answers was allowed, many candidates were outside this tolerance, because their use of a ruler to measure the distance had been imprecise.

(ii) The wave equation $v = f\lambda$ was used correctly by most candidates to determine the speed of the waves in the deep water. Surprisingly, a large number of candidates who had performed the calculation correctly gave their answer in m/s, when they had measured the wavelength in centimetres and had used this value in the equation.

(b) The constancy of frequency and the decrease in speed when water waves travel from deep to shallow water was not well known. Many answers appeared to be guesswork.

Question 6

(a) All candidates were able to list at least one error in the teacher's notes. A majority of candidates were able to list all three errors. The order of wavelengths in the electromagnetic spectrum was well known. Where candidates failed to spot all three errors, the one most often missed was the fact that ultrasound does not belong to this family of waves.

(b) Many candidates ignored the instruction to state one application of X-rays in engineering, and gave a medical use and obtained no credit. Candidates who gave a correct engineering application often ignored the instruction to explain it, and lost one of the two available marks.

Question 7

(a) Despite the instruction to draw the pattern of the magnetic field inside and outside the solenoid, more than half the candidates did not show the magnetic field pattern inside the solenoid. The shape of the field outside the solenoid was well known, but the general standard of the drawings was low.

(b) Only the more able candidates appreciated that the direction of conventional current flow was opposite to the direction in which the beta particles were travelling. The direction of the path followed by the beta particles in the magnetic field was not well known. Of those candidates who knew that the path would be curved, about half had the beam curving in the wrong direction – much guesswork was evident here. A number of otherwise correct solutions were spoiled because candidates did not realise that the magnetic force, and hence the curving of the path, began immediately the beta particles entered the magnetic field and not when the beam had travelled some distance through it.

Question 8

(a) The calculation of the reading on the voltmeter was done well, but the deduction of the resistance of the thermistor proved to be more troublesome. Many candidates were unable to deduce the value of the potential difference across the thermistor having correctly calculated the potential difference across the 600 Ω resistor.

(b) The effect of an increase in temperature on the resistance of a thermistor was not well known. Many candidates who correctly predicted a decrease in the resistance of the thermistor were unable to state correctly the consequence of this decrease in resistance on the ammeter and voltmeter readings.

Section B

Question 9

(a) Most candidates recalled the correct formula and were able to calculate the pressure due to the sea water at a depth of 120 m. The extra step of calculating the total pressure at this depth presented no problems to the majority of candidates, although many candidates failed to provide a unit for their answer.

(b) (i) The downward force acting on the hatch proved to be more difficult, as many candidates were unsure as to which pressure value to use in their chosen equation.

(ii) This proved to be a difficult question. The majority of candidates had little idea why the actual force needed to lift the hatch would be different from their calculated value. All that candidates were required to realise was that the hatch would have weight, or that there would be friction at the seal/hinge. A handful of the most able candidates realised that there would also be a pressure exerted upwards by the air in the submarine.

(c) (i) Most candidates were able to state what was meant by the term *ultrasound*, but its lower frequency limit was frequently misquoted.

(ii) The method of transmission of (ultra)sound through water was not well understood. Few candidates made reference to the water molecules/particles and how these particles were responsible for passing on the ultrasound vibrations. Credit was awarded to candidates who stated that the wave was longitudinal, or that the energy was transmitted by compressions and rarefactions.

(iii) Only a minority of candidates realised that, in order to determine to distance of the obstacle from the submarine, the velocity of sound (in water) would need to be known. Even fewer candidates were aware that, because the sound was reflected back to the submarine, the time between emission and detection of the pulse would need to be halved in order to calculate the distance.

(iv) The majority of candidates were able to state one other correct use of ultrasound.

Question 10

(a) The calculation to evaluate the thermal energy supplied to the bricks was generally successful. Where marks were lost, candidates usually forgot that there were 16 bricks and used an incorrect mass, or neglected to include a unit with their answer.

(b) (i) Candidates found the calculation of the average release of thermal energy by the bricks to be very demanding. A large proportion of candidates misunderstood what was required, and tried to calculate the average rate of fall of temperature instead. Of those candidates who realised what was required, there was much confusion over what unit of time to use. Answers expressed in J / h, J / min or J / s (W) were all acceptable.

(ii) Although many candidates realised that at the beginning of the day the bricks would be hotter, few could go on to explain that, since there was now a greater temperature difference between the bricks and their surroundings, the bricks would release thermal energy at a greater rate.

(c) There were some excellent, well written answers which described in detail how the thermal energy from the heater was transferred throughout the room. Most candidates realised that the main agent of transfer was convection and its mechanism was well known. Where steps were omitted, it was usually the fact that the heated air <u>expands</u>, thereby becoming less dense and rising.

(d) Answers to this part tended to lack structure and planning. Many candidates wrote about thermal insulation, but did not address the question asked. Even when a correct method of thermal insulation used to keep a room warm was stated, the instruction to explain why the chosen method was effective was generally ignored.

Question 11

(a) (i),**(ii)** The correct distribution of charge was usually marked on the diagram. Most candidates knew that those parts of the tree nearest to the cloud would be negatively charged. Only the most able candidates were able to explain how the tree became charged in the way that they had drawn on the diagram. Electrostatic induction was rarely mentioned, and many candidates thought incorrectly that the negative charge travelled down to the tree through the air.

(iii) The calculation was poorly done because candidates could not decide which parts of the given information to use. Few candidates realised that the required answer could be deduced by dividing the charge passing by the electronic charge. Many candidates tried to incorporate the time taken into their calculations.

Candidates coped better in finding the average current in the lightning strike, and an attempt was made to determine the ratio of charge to time, even if the resulting mathematics proved too difficult.

(b) (i) The direction of the electric field between two parallel oppositely-charged plates was not well known. Where correct vertical lines were drawn, their spacing was generally haphazard because the general standard of drawing was poor. The lines were rarely evenly spaced in between the plates. Only the most able candidates deduced that the upper plate was negatively charged, and so the field direction was frequently incorrect or, more usually, not given.

(ii) To obtain full marks here, candidates had to realise that for a charged oil droplet to move upwards between the plates, it would need to be positively charged. This deduction was rarely made. Only a very small number of candidates realised that because the drop was accelerating upwards, there would need to be a resultant force acting on it and so the electric force is greater than the weight of the droplet.

(iii) Of the small number of candidates who realised that the oil drop would become negatively charged upon striking the top plate, far fewer could explain why. All that was required was to state that the oil drop would gain electrons from the negatively-charged plate.

PHYSICS

Paper 5054/22

Theory

Key Messages

- To gain full credit, 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. One significant figure is not penalised where the final answer is exactly correct to one significant figure (e.g. 2.0 / 5.0 = 0.4), but an answer of 0.40 in this instance is better.

- A few candidates write some answers out in pencil before writing over the pencil in ink. This frequently leads to the answer being less legible and, when combined with crossings out and uncertain expression, the answer can be extremely difficult to interpret.

- The number of marks shown and the amount of space provided give a guide to the length of 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. Sometimes, the need arises to cross out an answer to part of a question and replace it with a new answer elsewhere. If this is done, candidates should make a simple reference to the location of the new answer. Candidates must not, however, write answers on the front cover sheet.

General Comments

The examination produced, as in previous sessions, a wide range of marks with some candidates being well versed in the topics examined and having a clear and accurate way of expressing their answers. Others, of course, found the paper more challenging and inevitably scored fewer marks.

There were some instances of candidates losing credit in simple algebraic manipulations. Candidates should take particular care when rearranging equations, to avoid careless errors such as when $A = BC$ is rearranged to give $B = C/A$.

Comments on Specific Questions

Section A

Question 1

(a) Only a small number of candidates described an experiment that would verify the principle of moments completely. Many marks were scored from the diagrams with many candidates showing a balanced metre rule with weights placed appropriately. Very few candidates repeated the experiment or varied the weights and so the last mark was only scored occasionally.

(b) The majority of candidates obtained the correct final answer and included the correct unit. It was unfortunate that some candidates who clearly understood what was required gave N / m as the unit.

Question 2

(a) (i) This was usually correct but there were some who multiplied by 10 rather than dividing by it.

(ii) This question was often well answered with many candidates scoring full credit. Some candidates used non-linear scales with labels such as 0, 1.0, 1.5, 2.0 placed uniformly across the paper.

(b) Many candidates used their own graph, as instructed, to obtain the correct answer and most did so carefully and scored the mark. The question instructed candidates to use the graph, so candidates who calculated the answer were only credited when this answer coincided with the value that could be read from the candidate's graph.

Question 3

(a) (i) Many candidates were extremely familiar with this part of the course and this was very commonly correctly answered.

(ii) This part of the question was less straightforward but it was most encouraging to see how many candidates were able the deal with this and score full marks. A few tried to apply a formula such as $s = v / t$. This was rarely done successfully.

(b) A few candidates described accurately what was happening to the energy here but many resorted to the more familiar: GPE to KE to thermal energy.

Question 4

(a) (i) This question relied on a rearrangement of the standard definition of pressure and many candidates received full credit here. Some candidates confused the area and the distance, both of which were given in the question, and others attempted to use the definition of work done.

(ii) This tested another standard formula and, again, a very large fraction of the candidates scored both marks.

(b) (i) This was less commonly correct. Many candidates tried to use the heat capacity as though it were the specific heat capacity and were unable to determine a value for the mass of gas. Others multiplied by 0.27 rather than dividing by it.

(ii) The answer "heat is lost" was not credited as more detail was required here. The answer "heat is lost to the surroundings" was sufficient to score the mark, but many candidates omitted the additional detail.

Question 5

(a) This part was often correctly answered, with many stating that there is a vacuum between the Earth and the Sun. Some candidates then went on to state that, as a consequence, thermal energy is transmitted by radiation. This, however, does not answer the question asked and no further credit was available for this detail.

(b) This was, in many ways, a question that required clear thinking. Many candidates scored all three marks. There was a certain amount of confusion from some candidates between emission and absorption and a small number of candidates referred erroneously to the "absorption of cold".

Question 6

(a) (i) This was commonly correct with a just a few candidates suggesting alpha-particles or beta-particles or more rarely other particles.

(ii) The phrase *thermionic emission* is used in the question but only a minority of candidates stated that it is thermal energy that is responsible for the emission of the electrons.

(iii) Only a minority of candidates showed that they understood what was being asked for here.

(b) There were some correct answers here but, although many candidates were able to state the relevant formula $Q = It$, a very much smaller number applied it and obtained the final answer. The reciprocal of the correct answer was commonly offered despite its extremely small numerical value.

Question 7

(a) Many candidates scored one or two marks here but only a minority went on to obtain all three marks. Some answers were not sufficiently detailed. An answer such as "if the count rate is reduced when a lead block is used between the metal and the GM tube, then it must be emitting gamma-rays" is not correct. More detail is needed.

(b) Most candidates were able to suggest one or two suitable safety precautions.

Question 8

This entire question tested the familiarity of the candidate with the structure of the atom and the nuclide notation for the nuclei of different atoms. It was extremely encouraging to see that all parts of this question were very well answered by the vast majority of candidates. Just a few candidates confused nucleons and neutrons in parts **(b)(i)** and **(ii)**.

Section B

Question 9

(a) Most candidates used the correct formula and calculated these two pressures correctly. Incorrect answers tended to arise from arithmetic difficulties encountered in multiplying or adding numbers expressed in standard form.

(b) (i) This part was often correct but some candidates assumed a direct rather than an inverse proportion between pressure and volume.

(ii) Many candidates struggled with this part with only a few candidates limiting the answer given to the pressure inside the balloon. Some candidates made no reference to the air molecules inside the balloon and so were unable to score many marks here.

(c) This was very commonly correct and those candidates who mentioned the forces acting usually tended also to discuss the two molecular arrangements.

(d) (i) Very few candidates scored all three marks here. Some candidates mentioned only pressure and did not refer to forces. Those who discussed the resistance acting on the balloon most commonly referred to air resistance rather than water resistance or drag. Many candidates, however, realised that there is no resultant force acting when it is travelling at constant speed.

(ii) There were a variety of attempts here and many candidates scored two marks, but only the strongest candidates were able to obtain full credit.

Question 10

(a) This part was very commonly completely correct, with many candidates giving the correct answer with the correct unit. The candidates who lost marks here did so in a variety of ways. This was a question where the formula $c = f\lambda$ was regularly rearranged incorrectly, especially when an unusual version of the formula was quoted (e.g. $s = w\lambda$). The number of candidates who did not give a unit was also higher here than elsewhere in the paper. Again the manipulation of numbers expressed in standard form caused some difficulty.

(b) This question asked for an experimental description and marks were commonly lost by candidates who merely stated the law of reflection. Details such as marking the line of the incident and reflected ray on paper or the need to measure angles (with a protractor) were often omitted from the less highly scoring answers. A very few candidates discussed refraction rather than reflection.

(c) (i) Many candidates scored this mark, whilst those who did not seemed to produce a wide variety of answers.

(ii) A significant number of candidates stated correctly what was happening at P but some did not offer an explanation.

(d) (i) Only a minority of candidates obtained full credit here, but most had some idea of what was happening. In some cases, marks were lost by diagrams which were not carefully drawn.

(ii) This was quite frequently correctly answered.

(iii) This question was an application of the topic which was unlikely to have been learnt in advance by candidates; it was most encouragingly tackled with many candidates being able to apply what was already known.

Question 11

(a) (i) Although this part was very commonly correct, marks were lost by candidates who did not rearrange $V = IR$ correctly or who used 4.5 Ω or 0.30 Ω for the resistance value.

(ii) Many candidates stated that the current could be increased, but only a small number explained that this could be achieved by reducing the resistance offered by the variable resistor.

(iii) It was surprising that only a few candidates gave answers that were related to the force produced by the motor effect. Many gave answers in terms of electromagnetic induction.

(b) (i) The correct answer was very commonly given here and full marks were frequently obtained by a wide range of candidates.

(ii) Many candidates realised that there would be a high current in this circuit but not all of these stated that the heat generated would be less of a problem when thick wires were used.

(c) A large number of candidates described exactly how a relay works and received full credit. Some candidates made a few relevant points and were able to score one or two of the available marks. Others were unable to answer this part and left it blank, whilst some who attempted this part were unable to offer any appropriate descriptions.

PHYSICS

Paper 5054/31
Practical Test

Key Messages

- Candidates should be aware that it is important to record measurements to the correct precision. In particular, measurements from a metre rule should be given to the nearest millimetre to gain full credit. Measurements of time from a digital stopwatch should be given to 0.01 s.

- A common cause of lost credit on this paper is the omission of units, or use of inappropriate units (e.g. kg when g was intended). Candidates should be encouraged to ensure that all answers are provided with units where needed, and to check that the unit is appropriate for the measured or calculated quantity.

- If asked to determine an accurate value for a particular measurement, then the measurement should be repeated and an average should be taken. The repeat measurements should always be shown, even if they are identical to the original measurement. Time measurements are generally less accurate so at least 3 measurements should be taken.

General Comments

It is important for candidates to be familiar with the laboratory apparatus that is likely to be used in the practical examination. Many weaker candidates' responses suggested that they would benefit from further experience of using common apparatus. There is a list of apparatus in the practical assessment section of the syllabus as well as suggested experiments in the subject content section.

When values are calculated from measurements, candidates need to ensure that the formula has been read correctly and should use an appropriate number of significant figures in the answer. This is generally 2 or 3 significant figures but the number of significant figures in the answer should be the same as the number of significant figures to which the measurement is made.

More able candidates need to improve their ability to draw conclusions from results and to describe clearly how procedures are carried out. The key messages for these candidates include:

- If asked to comment on results, ensure that the comment includes all the results that have been taken. For example, in **Question 2**, the ratio of cross-sectional areas should have been compared with the ratio of resistances and a conclusion should have been drawn, i.e. whether the suggestion is true, false or needs further investigation.

- Remember that when describing experiments or precautions, a diagram can sometimes make the procedure much clearer than prose.

Comments on Specific Questions

Section A

Question 1

Most candidates had acceptable values for the temperatures, calculated the mass of ice correctly and found correct values for Q_1 and Q_2. The only area of difficulty was in **(d)** where there were two common problems:

- A number of candidates used values of θ rather than values of Q in the formula that was given.

- Many candidates either omitted or used the wrong unit for *L*. A popular incorrect unit was the unit of specific heat capacity rather than specific latent heat.

Question 2

(a) The majority of candidates measured the p.d. across the wire and the current through the wire correctly. Weaker candidates made the following errors:

- Omission of units from either the current or the potential difference readings or both.
- Use of the wrong unit for current, e.g. current measured as 120 mA but answer written as 120 A.
- Incorrect precision for either the current reading (e.g. 0.1 A rather than 0.10 A) or the potential difference reading (e.g. 0.6 V rather than 0.60 V). Measurements should always be taken to the precision of the instrument used and both instruments should have had a precision of 0.01.

(b) Those candidates who recorded the potential difference in volts and the current in amps generally obtained a correct value for the resistance. However some candidates who recorded the current in mA forgot to convert this to amps and obtained values for the resistance that were incorrect by a factor of 1000, e.g. $R = V / I = 0.65\,\text{V} / 140\,\text{mA} = 0.0046\,\Omega$, rather than $4.6\,\Omega$. Other mistakes here included:

- Omission of the unit of *R*.
- The use of only 1 significant figure for the value of *R*, e.g. $0.75\,\text{V} / 0.15\,\text{A} = 5\,\Omega$. The voltage and current have both been measured to 2 significant figures so the answer for the resistance should be to 2 significant figures.

(c) Those candidates who were successful in **(a)** and **(b)** were generally successful here.

(d) Only the more able candidates were successful in this section. Many candidates did not attempt the question, or did not show their calculated value for the resistance ratio or the cross-sectional area ratio that had been given by the Supervisor.

Question 3

(a) (i) Only the strongest candidates could describe the technique that was used to obtain an image that was in sharp focus. The best technique is to approach the sharply focused image from both directions, i.e. moving the lens away from the object and moving the lens away from the screen. This technique was very rarely described.

(ii) If the candidate had set up the apparatus correctly, the distance $u + v$ should have been equal to 100 cm. This is because only the lens should have been moved. The cross-wire object and the screen should have remained at the ends of the metre rule. Also, because the image was smaller than the object, *u* should have been greater than *v*. Only the strongest candidates obtained such results. Many candidates obtained results such that $u + v$ was less than 100 cm, indicating that the object or screen had been moved. Others obtained results such that *u* was less than *v* which would have meant that a magnified image was formed on the screen. There were also errors of:

- Omission of units for *u* or *v* or both.
- Recording of *u* or *v* to the nearest cm rather than the nearest mm, e.g. $u = 80$ cm rather than $u = 80.0$ cm. Candidates should always use the precision of the instrument used and a metre rule has a precision of 1 mm.

(b) The same points apply to **(b)** as apply to **(a)(ii)**; $u + v$ should still have been equal to 100 cm and *u* should have been less than *v* because a magnified image should have been formed on the screen. Stronger candidates achieved this with answers in the correct range but weaker candidates made the same mistakes as in **(a)(ii)**.

Section B

Question 4

(a) The majority of candidates were able to check that AB was horizontal, either by aligning the string to a horizontal surface in the room or by measuring the height above the bench in two or more places.

(b) This section was relatively straightforward and the majority of candidates obtained correct values for the heights above the bench and the horizontal distance between the centres of the two holes.

(c) (i) The Examiners expected y to be calculated (the word 'calculate' is used in the question) by using $y = h_2 - h_1$, but it was clear that a number of candidates had measured the value from their apparatus. Others had calculated y by measuring the separation of the holes in the metre rule and had then used Pythagoras' theorem to calculate y. Unless these alternative methods yielded the same answer as $y = h_2 - h_1$, they were not given credit.

(ii) Some candidates made a similar error in **(ii)**. Most candidates successfully calculated x / y, which was the value of $\tan\theta$. However they then went on to find θ, which was not a requirement of the question.

(d) Because candidates had confused θ and $\tan\theta$ in the previous section, the units of these were not checked in the table, and candidates who used θ for $\tan\theta$ both in the table and the graph were not additionally penalised. This resulted in good marks being obtained for both the table and the graph.

(e) Graph plotting was generally good, but the following mistakes led to the loss of marks:

- Omission of units from the mass axis.
- A scale based on 3, particularly by those candidates who did not include the mass hanger so that the mass values were spread from 0 g to 50 g. In this case many candidates used a scale of 3 cm to 10 g, which is not appropriate.
- Misplotting of points, for example a $\tan\theta$ value of 0.406 being plotted as 0.46.
- Lines that are too thick or plotted points that have a diameter of 2 mm rather than being fine points. It is always best to draw a fine cross rather than a fine dot, because fine dots tend to get lost in the body of the line.

(f) (i) The first mark was given for a correct calculation of the gradient and the second mark was given if a large triangle had been used. This second mark was only given if the calculation was correct. If a candidate did not know how to calculate the gradient correctly, then no credit was awarded. One mark could be obtained if the candidate knew how to calculate the gradient but used a small triangle.

(ii) Only the most able candidates obtained a value for M that was in the allowed range. Many candidates made errors such as using θ instead of $\tan\theta$, or in measurements and calculations, which led to an M value that was outside the range.

PHYSICS

Paper 5054/32
Practical Test

Key Messages

- Candidates should be aware that it is important to record measurements to the correct precision. In particular, measurements from a metre rule should be given to the nearest millimetre to gain full credit. Measurements of time from a digital stopwatch should be given to 0.01 s.

- A common cause of lost credit on this paper is the omission of units, or use of inappropriate units (e.g. kg when g was intended). Candidates should be encouraged to ensure that all answers are provided with units where needed, and to check that the unit is appropriate for the measured or calculated quantity.

- If asked to determine an accurate value for a particular measurement, then the measurement should be repeated and an average should be taken. The repeat measurements should always be shown, even if they are identical to the original measurement. Time measurements are generally less accurate so at least 3 measurements should be taken.

General Comments

It is important for candidates to be familiar with the laboratory apparatus that is likely to be used in the practical examination. Many weaker candidates' responses suggested that they would benefit from further experience of using common apparatus. There is a list of apparatus in the practical assessment section of the syllabus as well as suggested experiments in the subject content section.

When values are calculated from measurements, candidates need to ensure that the formula has been read correctly and should use an appropriate number of significant figures in the answer. This is generally 2 or 3 significant figures but the number of significant figures in the answer should be the same as the number of significant figures to which the measurement is made.

More able candidates need to improve their ability to draw conclusions from results and to describe clearly how procedures are carried out. The key messages for these candidates include:

- If asked to comment on results, ensure that the comment includes all the results that have been taken, e.g. if the p.d. across a resistor and the p.d. across an LED have been measured and the current through a circuit has been determined, then the comment should include reference to all of these quantities. If asked to comment on a suggestion, candidates should refer to the results that they have taken and then state whether the suggestion is true or false or needs further investigation.

- Remember that when describing experiments or precautions, a diagram can sometimes make the procedure much clearer than prose.

Comments on Specific Questions

Section A

Question 1

Similar skills were required for **(b)**, **(c)** and **(d)**. In each of these sections, marks could be lost in the following ways:

- Measuring *x* and *y* to the nearest cm, e.g. *y* = 11 cm. Candidates should always measure to at least the precision of the instrument being used. For a metre rule the precision is 1 mm, so a reading such as *y* = 11.0 cm should be recorded.

- Units were omitted from the values of *x* and *y*.

- The ratio *x*/*y* was calculated rather than the ratio of *y*/*x*.

- The ratio of *y*/*x* was given units of cm but should have had no units, since the units of *y* and *x* cancel.

- The ramp was of fixed length so, if the results are repeated, a greater value of *y* should give a lower value of *x*. Most candidates' results showed this effect, but the results of the weaker candidates did not.

- A small number of weak candidates did not know how to work out an average value. For such candidates, the sum of the two values was often given as the average.

- Part **(d)** stated that **(b)** and **(c)** should be repeated, but a number of candidates only showed one pair of values in **(d)**.

(e) Stronger candidates realised that the 2 average values were approximately the same so the ratio did not depend on the total mass of the block. Other candidates realised that they should be commenting on the ratios but did not draw a conclusion, e.g. "the ratios were different".

Question 2

The first 4 marks in this question were relatively straightforward and many candidates scored all 4 marks. Those who did not made one or more of the following mistakes:

- Omission of units from the *V* values or the *I* values.

- Only quoting *I* to 1 significant figure. There was confusion here between significant figures and decimal places. For example, 0.004 A is 3 decimal places but only 1 significant figure.

- A small number of candidates had incorrect values for the voltages, suggesting that the voltmeter had been connected across the incorrect points. For example, the voltage across the resistor was in the region of 3 V and the voltage across the LED was in the region of 0 V, suggesting that the voltmeter had been connected across the power supply.

(c) Only the strongest candidates scored this mark. Those who did made a comment on all three quantities, e.g. the p.d. across the resistor increases, the p.d. across the diode decreases and the current in the circuit decreases. There were no comments about the constancy of the supply voltage or about resistance changes in the LED. A number of candidates simply commented on the current, e.g. the current decreases as the resistance increases, but this was not sufficient.

Question 3

This was a different type of question from those in previous years that produced very good differentiation between candidates. Supervisors were asked to provide a piece of modelling clay formed around the lower half of an S-hook. The total mass of the modelling clay and the S-hook was to be in the range 118 g to 122 g. Candidates should have obtained answers in the range 100 g to 130 g. The lower top limit took account of the fact that the springs are pre-stressed and require a small force before the turns start to separate. Strong candidates obtained an answer in the correct range by the correct method and often scored full credit for the question. Weaker candidates made mistakes in measuring the extension that led to values outside the range and scored very few marks.

(a) The best candidates drew the correct position of the set square on the diagram and immediately gained the mark. Those who attempted a description often failed because there was not enough detail, e.g. "use a set square" was not enough. To gain the mark by description, candidates had to refer to the two perpendicular sides of the set square with one side on the bench and the other side touching the metre rule. Those who drew a diagram sometimes did not gain credit because there was a gap between the set square and the metre rule.

(b) Typical dimensions for the type of spring specified should have been: length of the coiled part of the spring 2.0 cm, diameter of the ring at each end of the spring 1.5 cm and total length of the spring 5.0 cm. When a 200 g mass was suspended from the spring, the extension should have been 8.0 cm. Because of the pre-stressed nature of the spring a range of 5.0 cm to 9.0 cm was allowed. To measure the extension correctly, the change in position of the lower end of the bottom ring should have been determined when the 200 g mass was added to the spring. It was clear that a large number of candidates had not measured the extension correctly. Common errors included:

- Measuring the new total length of the coiled part of the spring (without subtracting the original length) giving an answer of 8.0 + 2.0 = 10.0 cm.

- Measuring the new total length of the coiled part of the spring and the lower ring (without subtracting the original length of these) giving an answer of 8.0 + 1.5 + 2.0 = 11.5 cm.

- Simply using the scale reading on the metre rule, giving a random answer e.g. 39.0 cm.

Such answers did not gain the mark.

(c) The majority of candidates could calculate *C* correctly. On this occasion, the Examiners did not penalise missing units for *C*, although candidates should remember to think about units for all calculated quantities. Those candidates who lost the mark here either quoted the answer to only 1 significant figure or used $C = m/e$.

(d) The same comments apply as in **(b)**, and incorrect extension values led to an incorrect value for the mass of the modelling clay and the S-hook. An additional problem was that some candidates obtained a correct value for this mass but then added 200 g to their value to obtain a final answer of 320 g.

Question 4

(a) The Examiners expected a minimum of three readings to be taken to determine the average time in order to gain full credit. A number of candidates took only two readings. The only other common mistake was incorrect reading of the stopwatch, e.g. candidates had answers of 0.0235 s, rather than 2.35 s.

(b) Candidates often described a stop (e.g. set square or ruler) at $x = 90.0$ cm, but to be awarded credit they also had to explain that the ball was placed behind the stop and that the stop was removed as the stopwatch was started to gain the mark.

(c) The majority of candidates gained the mark for the calculations. Some candidates calculated $2v$ or $\sqrt{v}$ instead of v^2.

(d) Most candidates obtained a value of *h* in the correct range, but there were some common mistakes, such as omission of a unit or answers given to the nearest cm rather than the nearest mm.

(e) Most candidates had correct values for *x*, *h*, *t* and t_{av}. Many had difficulty in the calculation of *v* and v^2. The *v* values often had a systematic error, and examples include:

- $v = x / t_{av}$ rather than $v = 2x / t_{av}$,
- $v = h / t_{av}$,
- $v = 180\,\text{cm} / t_{av}$,
- as stated in **(c)**, $2v$ or $\sqrt{v}$ used instead of v^2.

Good values for *x*, *h*, *t* and t_{av} should have led to a trend that showed that as *x* decreases, *h* decreases and v^2 decreases. Those candidates who had obtained inaccurate values for t_{av} had some values of v^2 that did not follow the correct trend and lost marks according to how many results did not follow the trend.

(f) Those candidates who started their graph at the origin often lost the scale mark because the plotted data occupied less than half the page in either the *h* direction or the v^2 direction. Axes were generally labelled correctly and points were plotted correctly. Candidates were instructed to draw a **straight** line of best fit, but lines were not always straight. In some cases the lines were not the best fit to the data, with many more points on one side of the line compared with the other.

(g) The question asked candidates to determine the gradient of the line of best fit. Points that are on the line of best fit should be used to do this. Many candidates used data from the table that is not on the line and gained no credit for the gradient determination.

Data taken from the line must be read to within ½ a small square (1 mm) of the correct value. Many candidates took approximate values from the line and so were not awarded the gradient marks. Teachers should advise candidates to take accurate values from the line of best fit.

PHYSICS

Paper 5054/41
Alternative to Practical

Key messages

- When drawing lines of best fit, candidates should consider the position of all points. If the trend is linear, simply joining the first and last points on the line does not usually give the line of best fit. If the trend is curved, joining adjacent points does not usually give a smooth curve.

- Candidates should be encouraged to draw diagrams as part of the explanations of experimental methods, in particular where this is explicitly noted in the question. The accuracy of straight lines on diagrams could be improved by using a sharp pencil and a ruler.

- Candidates should be discouraged from giving vague responses when explaining the reason for an experimental procedure. For example, several periods of an oscillation are measured to reduce the effect of reaction time error, rather than simply 'to improve accuracy'.

General comments

The general level of competence shown by the candidates was sound although, as in previous years, some candidates approach this paper as they would a theory paper, and not from a practical 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 lack of time. Many candidates dealt well with the range of practical skills being tested. The 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, writing was legible and ideas were expressed logically. The standard of graph plotting continues to improve.

Comments on specific questions

Question 1

(a) (i) Less than half of the candidates were able to draw in the position of the vibrating mass at its highest position after release. Many candidates did realise that the mass would rise as far above its original position as it was pulled down below its original position, and might benefit from more experience of this type of experiment in practical work.

(ii) The most suitable position for the eye when timing the oscillations was not well known. Candidates were expected to mark an eye position level with the bottom/middle/top of the oscillation. Many incorrect diagrams had the eye looking down on the oscillations or even looking in a direction away from the apparatus.

(b) Many candidates realised that if the mass were pulled down a large distance before release, there would be a danger of the load jumping off the spring, or the spring becoming slack. Other creditworthy responses referred to the spring becoming permanently stretched or its elastic limit being exceeded.

(c) The reasons for timing twenty vibrations instead of just one were not well understood. Many candidates merely said that it would be more accurate, without further explanation of why this would be the case. Candidates were able to gain credit here by stating that the time *T* for one oscillation was too small or that timing twenty oscillations would yield an average value. The stronger candidates made reference to the fact that timing twenty oscillations would reduce the (percentage) human reaction error in *T*.

(d) The calculation of the average value of *T* was well done by most candidates. Where errors occurred, it was usually due to candidates forgetting that the five given results were the times for twenty oscillations and that, when the mean of these was found, this mean also needed to be divided by twenty.

(e) (i) This was done well, with only the occasional candidate ignoring the instruction to use a suitable number of significant figures for their value of *T*.

(ii) The standard of graph plotting continues to improve. Most candidates had correct, labelled axes, and had used sensible scales that maximised the use of the given grid. Points were generally accurately plotted. Although the instruction to draw a smooth curve of best fit was given, many candidates tried to draw a straight line of best fit through their plotted points. Other reasonable attempts at drawing a smooth curve were spoiled by candidates forcing their curves to go through the origin.

(iii) This demanding part proved to be the most difficult question on the paper, with only a small number of the most able candidates understanding what was required. Credit was awarded to candidates who stated that they did expect their graph to pass through the origin because when there is no added mass there are no oscillations. Credit was also awarded to candidates who stated that they did not expect their graph to go through the origin because, even with no added mass, there would be some extension due to the mass of the spring itself.

(iv) Approximately half of the candidates were able to describe the relationship between *T* and *W*. All that was needed here was to state that as *T* increased *W* increased (non-linearly). Many candidates who stated this fact went on to spoil their answers by stating that the quantities were therefore proportional.

Question 2

(a) (i) Most candidates scored full credit here, by stating that the lamp would light. A number of candidates thought that there would be sparks when the crocodile clips made contact.

(ii) About half of the candidates were able to describe one possible fault which would prevent the circuit from working correctly. The most common correct answers were that there was a poor connection or that the cell was run down.

(b) (i) Most candidates realised that the lamp would become dimmer as the crocodile clips were moved further apart.

(ii) Few candidates could link the changing of the length of wire between two contacts with the function of a rheostat in a circuit. Even fewer candidates were able to explain that although there is a long length of wire in a rheostat, the component can be made small by coiling the wire.

Question 3

(a) Only a small number of the most able candidates were able to state why the bell-jar had thick walls. The expected answer was so that the bell-jar could withstand the high force/pressure due to the outside air when the air inside it was evacuated.

(b) Most candidates were unable to give an acceptable reason as to why a layer of grease is placed between the bell-jar and the metal plate. The most common incorrect answer was to reduce the friction between them. The purpose of the grease is to prevent air from entering the bell jar. A significant number of candidates thought that the grease was to prevent air leaving the bell-jar.

(c) (i) Most candidates gained one of the two marks available by stating that the sound would become quieter. The second mark proved to be more difficult to obtain because candidates ignored the instruction to explain this observation.

(ii) This was well answered, with most candidates knowing that light can pass through a vacuum. A common incorrect answer was that light travels faster than sound.

(d) Candidates found this part demanding, with many candidates thinking that the bell was hung by string from the top of the bell-jar so that the candidates would have a better view of what was happening. Only the more able candidates realised that if the bell stood on the metal plate, the vibrations could travel through the plate.

Question 4

(a) Most candidates were unable to explain why the end of the board was lifted slowly. All that was required was to state that this was to enable the height at which the shoe started to move to be determined accurately.

(b) The angle between the board and the bench was measured accurately by the majority of candidates.

(c) (i) Candidates had difficulty in stating a valid practical difficulty encountered when trying to measure the angle. A common incorrect response was to avoid parallax error. Sensible suggestions such as the protractor is small or has an edge, or the difficulty of holding the board with one hand and trying to measure the angle with the other, were seldom seen.

(ii) Many candidates realised that trigonometry could be used to determine the angle if no protractor were available, but many found difficulty in expressing how they would go about this task.

(d) Many candidates showed a lack of understanding of what was required, because they incorrectly assumed that both shoes would slide down the slope together and that the shoe with the better grip would slide more slowly. The more able candidates realised that the shoe with the better grip would stay stationary on the board for longer as the board was lifted through a larger angle.

PHYSICS

Paper 5054/42
Alternative to Practical

Key messages

- When drawing lines of best fit, candidates should consider the position of all points. If the trend is linear, simply joining the first and last points on the line does not usually give the line of best fit. If the trend is curved, joining adjacent points does not usually give a smooth curve.
- Candidates should be encouraged to draw diagrams as part of the explanations of experimental methods, in particular where this is explicitly noted in the question. The accuracy of straight lines on diagrams could be improved by using a sharp pencil and a ruler.
- Candidates should be discouraged from giving vague responses when explaining the reason for an experimental procedure. For example, several periods of an oscillation are measured to reduce the effect of reaction time error, rather than simply 'to improve accuracy'.

General comments

Candidates taking this paper need to have experienced practical work as an integral part of the course. An appreciation of the practical difficulties experienced in setting up equipment and in taking readings in a variety of situations is required. The candidate also needs to be able to record and analyse the data, perform calculations and plot graphs.

Practical situations used in the paper may be from standard experiments that the candidate has experienced during the course or from ones new to the candidates. In order to answer these questions the candidates must be able to apply their understanding to the new situations.

Question 1 was poorly understood by many candidates who mistakenly linked the question to a ripple tank demonstration that they may have observed. Candidates need to take time to read the question carefully and visualise the experiment as described so that they can consider any practical difficulties that may arise while carrying out the experiment.

In **Question 2** many candidates were unable to identify the relevant data to use in the calculation, and very few were able to identify the correct number of significant figures to give in the final answer.

Most candidates were able to draw tables of data accurately and the ray tracing in **Question 4** was generally neat and accurate.

Comments on specific questions

Question 1

(a) Many candidates did not use the information given in the stem of the question to help with their response. The fact that the wave takes about one second to travel across the tray was given to help the candidates. This is a short time so human reaction time would be large compared to the time measured. Timing five lengths gives a longer time and reduces the effect of reaction time error.

Most candidates gaining the mark answered that it can give the average time for one length.

Candidates who simply said 'to make it more accurate' did not gain the mark here.

(b) (i) Few candidates were able to state that the distance travelled by the wave (length of the tray) varies with the depth of water in the tray.

Some candidates did appreciate the difficulty in placing a ruler close to the water to measure the length and explained the problem clearly.

(ii) Candidates should be encouraged to use diagrams when offered the opportunity in a question. In this question drawing a diagram often led candidates to understand the difficulty involved in measuring the length. Many drew a ruler above the tray but it looked unrealistic because it was exactly the same length as the tray. Some excellent answers were seen with candidates drawing a ruler resting along the top of the tray and the eye of the observer drawn looking vertically down at the edge of the water at both ends.

Some candidates gained the mark by appreciating that a flexible device such as a tape measure could be placed close to the water in the tray.

No marks were given for candidates who changed the apparatus, e.g. by using a tray with vertical edges, by using a transparent tray or by using a ripple tank.

(c) (i) Many candidates noticed and commented on the dead space at the end of the rules below the 0 mark. However, many had not read the question carefully and thought the ruler was broken and too short. This was not credited.

(ii) There were some excellent answers here. Some candidates placed one ruler in the water, marked the water level and then measured the length from the end of the ruler with the second ruler. Others measured the dead space first and then added it to the reading obtained. It was unfortunate that some measured the dead space then subtracted it from the reading obtained on the ruler. This scored one of the two marks available.

The most common error was to use the two rulers to measure the depth at two places in the tray and then average the readings with no reference to the dead space. This would not have given an accurate value of *d*.

(d) (i) The graph to be drawn was a curve and the candidates were asked to draw a best-fit curve through the points.

Most candidates labelled the axes correctly with the correct orientation.

Some candidates did not gain full credit because they used scales that could be doubled.

Plotting the points is generally very good, although some lose this mark for inaccurate plotting – usually for forgetting the value of one division, by plotting 20.5 at 25, or by rounding the values to the nearest whole number. Some candidates lose credit because they plot 'blobs', i.e. mark the points with a dot that is too large. A neat cross is the preferred method for marking the points.

Drawing a smooth curve is challenging for many candidates. The best-fit line does not have to pass through all the points and in a graph of practical data is unlikely to do this. Many candidates forced the line to pass through all the points and so did not get this mark. Some incorrectly drew a straight line.

(ii) Many candidates gave clear answers here, explaining either that the tray was not deep enough to hold more than 3 cm water or that the water would spill out.

Weaker candidates had difficulty expressing their ideas clearly and some confused the length of tray with the depth.

Some candidates thought that a depth of more than 3 cm could not be used as the results would not fit on the graph. Candidates should be encouraged to think of the practical situation when carrying out the experiment.

(iii) The question asks the candidates to explain how the speed varies with depth for very large values of depth. Most candidates ignored the 'very large' and simply stated the speed increases as depth increases. Some excellent answers were seen with candidates explaining that the rate of increase of speed decreases or that the speed would eventually become constant.

Question 2

(a) Most were able to calculate the temperature change and score the first mark here.

Many were unable to extract the information correctly from the data given to find the correct power of the kettle to use. Some subtracted the two values and others averaged them.

Most candidates ignored the request to give their answer to a suitable number of significant figures. The final answer should be given to the least number of significant figures given in the data or one more. In this question, all the data was to at least 2 significant figures, so the final answer was expected to be to 2 or 3 significant figures.

(b) (i) Most candidates gained this mark for stating that either all the water was at the same temperature or the heat (energy) was spread around.

(ii) Most candidates gained the mark by stating that the base of the kettle was hotter than the water. Answers which simply stated that the thermometer would break were not credited.

(c) Stronger candidates gained this mark by appreciating that heat energy was lost to the surroundings or used to heat the kettle.

Some candidates used the equation and suggested an error in the readings. This was credited if well explained, e.g. the time measured was too large.

Many candidates had difficulty expressing their ideas clearly here.

Question 3

(a) (i) Most candidates were able to draw a table with headings of mass and time. The most common mistake was to omit the units in the headings. Units should not be written in the body of the table, and these were ignored by the Examiners. The mass values were required to be written in order, increasing or decreasing by 20. Some candidates lost a mark by not using the correct mass values.

(b) (i) Most candidates recognised that there was no pattern in the results and hence that *m* does not affect *t*.

(ii) The most common correct answer was to take readings with more or different values of *m*. The most common incorrect response was to measure or change the length of the string.

Weaker candidates simply stated that more readings should be taken, and this did not gain credit.

Question 4

(a) (i) Most candidates were able to draw a neat line with a ruler through the two points.

Some lost the mark by not continuing the line through the prism, and some by changing the direction of the line at the point P_2.

(ii) Most candidates gained this mark.

(iii) The instructions to the candidate clearly asked for the smaller angle between the two lines. Many lost the mark here by measuring the larger angle.

(iv) Most candidates who had drawn the rays correctly to the prism in **(a)(i)** and **(ii)** gained this mark. Some, however, did not draw a line inside the prism.

(b) Most candidates appreciated that it would be difficult to use white light as it splits into the colours of the spectrum. The most common incorrect answer was that the white light would be difficult to see.

(c) (i) Many candidates correctly and clearly stated that the normal must be perpendicular to the prism. The most common incorrect response was that the normal should be perpendicular to the incident ray.

(ii) Many candidates could not draw the correct normal here. The most common error was to draw a vertical line. Some of the candidates who drew a correct normal lost the mark by measuring the complementary angle (between the ray and the surface of the prism) rather than the angle between the ray and the normal.