PHYSICS

Paper 5054/12
Multiple Choice

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

General comments

Many candidates performed well on this paper. However, many needed to read the questions more carefully as they sometimes selected an answer that might have looked familiar or plausible but did not answer the question as it had been set.

Candidates need to be aware that in numerical calculations, the wrong options are derived from the incorrect manipulation of the numbers supplied. It therefore follows that combining the numbers in the question until one of the options is found is more likely to lead to an incorrect choice that a correct one.

On this paper, **Question 1** was correctly answered by many candidates, and **Question 25**, **29** and **32** were also quite frequently answered correctly.

Comments on specific questions

Question 8

Many candidates answered this question correctly but option **A**, which would have been the direction of the frictional force, was often chosen. This could have been because the word *frictionless* was overlooked by candidates.

Question 10

This question gave no information about the structure of the object except to describe it as non-uniform. Therefore, the location of its centre of mass could only be deduced from its behaviour. Stronger candidates gave the correct answer of **D** recognising that the weight of the object produces a clockwise moment about the pivot that cancels the moment of the added weight. However, **C** was more commonly chosen than **D**.

Question 11

Option **C** was a more popular answer than the correct option: **D**. The question required a certain amount of work before the correct option could be chosen. In the second situation, the tension is no longer shared between two springs but each spring supports the full weight of the load. Furthermore, the two springs are joined end to end and so the total extension is the sum of the two individual extensions. Both effects double the extension and so the correct option is **D**.

Question 13

There is an inverse proportionality between the pressure of a gas and its volume at constant temperature. Hence, the correct option was **C** and this was the most commonly selected option. However, a number of candidates chose option **A**, possibly because a graph with a straight line through the origin was familiar.

Question 14

This question assessed familiarity with the equation for kinetic energy in terms of the value of a ratio. Option **A** was rarely chosen and the correct option **D** was the most popular choice, but both **B** and **C** were selected by a number of candidates. Some candidates had possibly not considered the increase in the mass and others might not have considered that the effect of the speed depends on the square of its value.

Question 17

Stronger candidates generally answered this well but a number of other candidates selected **C**. The scale on this thermometer had been misplaced and all readings were 1°C too great. However, as the question was about a temperature increase, and since both the initial and final temperature readings were too great, the difference between them was correct.

Question 23

Although none of the incorrect options was chosen by more candidates than the correct option **D**, each of the options was chosen by a significant number of the candidates. In general, there appeared to be a great deal of uncertainty concerning wavefronts.

Question 28

Either option **C** or **D** was chosen by the majority of the candidates. Option **C** is a factor of two too small. This might have been chosen by candidates who did not realise that the return journey is double the distance of 80 m given in the question. Some candidates may have used the time in the question (one second) as the time for the return journey, when a more careful reading of the question indicated that the relevant time is half of this value.

Question 31

The correct option, **C**, was chosen by more candidates than any other option but other options were all popular choices. Only stronger candidates were able to show understanding of the problem caused by lightning.

Question 35

This question was essentially concerned with resistance and current. The correct option was the most frequently chosen, but option **D** was nearly as popular. Clearly the greatest power is developed when the current is greatest which, in turn, is when the resistance is the least. It is then only necessary to arrange the resistor combinations in order of decreasing resistance.

Question 37

A large number of candidates selected the correct option which stated that the transformer decreases the current in the transmission cable and increases the potential difference. However, both option **A** and **D** were commonly chosen. Some candidates did not fully understand what was happening when a step-up transformer was used at the beginning of a transmission cable. Some candidates did not apply the equation $V = IR$ correctly and believed that since the current decreases, the potential difference must too. Another misunderstanding was the belief that the current must increase in order to force its way more effectively through to the far end.

PHYSICS

Paper 5054/22
Theory

Key messages

In order to perform well on this paper, a candidate must understand all the rest of the syllabus thoroughly and to expect questions from any part to appear.

Candidates should pay attention to the exact question that is asked and ensure that it is answered in the way demanded. When a question includes a phrase such as *in terms of molecules*, answer which make no reference to molecules are unlikely to be awarded full credit. Similarly, where a question includes two commands such as *state and explain*, it is important that the second command is not ignored. There are occasions when the second command word appears in a second sentence.

The context of a question must always be considered when it is answered. Candidates sometimes produced lists of facts or properties that had been learnt by them even though some of the items were not relevant to the question that had been asked.

General comments

Candidates should take care not to contradict themselves when writing an answer. If a candidate makes two opposing statements within one answer space, credit cannot be given for that point.

Candidates should take care to present their answers as clearly as possible so that they are legible and well set out.

Comments on specific questions

Section A

Question 1

(a) Only a very few candidates answered this question directly and full credit was rarely awarded. However, a larger number of candidates made some relevant comments and obtained some credit. Many candidates stated or implied that the absence of an atmosphere on the Moon resulted in the absence of any gravity but most of these candidates made further references to the downward acceleration of the hammer and feather.

(b) (i) Many candidates obtained the correct answer by the correct method and were awarded full credit. However, a noticeable minority of candidates tried other approaches and did not gain any credit. These approaches varied from simply dividing the acceleration by the time, to rather more complex calculations involving v^2. Acceleration was not always thoroughly understood.

(ii) Many candidates drew a straight line of positive gradient from the origin but an appropriate value was not always marked on the *y*-axis at the correct position. Lines and curves of other shapes were also seen. The most common of these was a straight line of negative slope that intersected the *x*-axis at a time of 1.5 s.

(iii) Although many candidates obtained a fully correct answer or an answer that was obtained correctly using a previous erroneous value, the most common approach was to multiply the final speed by the time taken. Therefore, an answer that was double the correct value was quite common.

Question 2

(a) (i) This part was well answered and full credit was often awarded. A very small number of candidates rearranged a known equation incorrectly to obtain an expression such as the incorrect $F = p/A$. This led to an incorrect answer.

(ii) Only stronger candidates realised that air on the other side of the piston also exerted a force.

(b) This part was well answered with almost all candidates receiving full or nearly full credit. When full credit was not awarded, it was often because the answer given was too vague. Some candidates made no reference to collisions with the walls, whilst others referred to more collisions rather than to more frequent collisions. The only significant misunderstanding made by a small number of candidates was to refer to the increased speed of the molecules, despite the gas remaining at a constant temperature.

Question 3

(a) (i) This was often quite well answered although the rather ambiguous term *fusion* was used by some candidates. Candidates who were aware that the Sun is powered by a nuclear fusion reaction did not always describe the reaction in terms of small nuclei combining to produce larger nuclei. Other explanations offered included nuclear fission, chemical reaction and the transfer of gravitational potential energy to thermal energy.

(ii) Most candidates were able to supply an acceptable component of the electromagnetic spectrum or to simply state *radiation*.

(b) This part was well answered and most candidates were aware that black surfaces are good absorbers of infrared radiation. The fact that black surfaces are also good emitters was not relevant in this context.

Question 4

(a) Many candidates were awarded full credit here and most candidates produced at least one acceptable difference.

(b) There were many good answers and full credit was commonly awarded. There were a few candidates who, despite the wording of the question, made no reference to molecules in their answers.

(c) (i) This part was well answered although some answers made no reference to physics. The answer “to produce more salt” was not on its own sufficient.

(ii) This part was also well answered by many candidates although answers such as “it is too cold” were not sufficiently direct.

Question 5

(a) This was rarely well answered and a variety of misunderstandings and omissions was presented. Many candidates made no reference to vibration or to the particles of the medium. Other candidates supplied descriptions of transverse waves. A common incorrect answer stated that the waves move parallel to the wave direction. Of course, this is inevitably true for all waves.

(b) (i) The answer to this part was very commonly correct with the correct working included. Some candidates rearranged the equation $v = fl$ incorrectly and gave a variety of incorrect answers. There were also some answers that were too large or small by factors of ten.

(ii) This was generally well understood although some explanations lacked sufficient detail.

Question 6

(a) (i) Candidates who realised that the potential difference (p.d.) required could be obtained from the position of the trace on the screen of the oscilloscope usually gave the correct answer. However, candidates who tried to calculate the answer from other information obtained answers that ranged enormously from 0.017 V to 8400 V. The second value is greater than the electromotive force (e.m.f.) of the supply. Other common values included 12 V and 8.0 V.

(ii) The answer to this part was quite commonly correct or obtained by the correct use of an incorrect answer from **(i)**. Candidates who did not get as far as the answer often obtained some credit for the working shown. This question was omitted more often than others.

(b) A few candidates were awarded full credit and others gained some credit for making appropriate comments concerning the circuit. This was a part where unlikely answers were supplied by candidates who probably had no real understanding of the situation. Such attempts included the suggestion that trace on the screen became a sine wave or simply oscillated vertically.

Question 7

(a) (i) Only a minority of candidates were awarded full credit for this part. The presence of a current in a magnetic field was rarely mentioned.

(ii) Many candidates answered this question in an appropriate manner with full credit being awarded fairly often. An unfortunate source of uncertainty was the description of the current direction. The obvious indication, *B to A*, was rare and many other terms were unclear or inaccurate. References to the left-hand rule were often given although the right-hand rule was stated by some candidates.

(b) Only the strongest candidates answered this question correctly but many candidates clearly understood what was needed to some extent. Often candidates only supplied the moment due to one side of the coil. Candidates who realised that both sides contributed to the total moment often ignored the need to convert the distance from cm to m.

(c) (i) Some candidates are confused as to the difference between a *slip ring* and a *split ring*.

(ii) This was well answered with many candidates stating an appropriate change.

Section B

Question 8

(a) A very common error here was to answer in terms of the point beyond which the deformation becomes permanent. This point is the *elastic limit*, which despite not being a syllabus term, was used by many candidates in answers.

(b) (i) There were many good answers. A few candidates answered in terms of weight; e.g. $m = W/g$.

(ii) Most answers made some reference to gravity although fewer made it explicitly clear that weight is a force. There were many answers that were awarded full credit.

(c) (i) This was very commonly correct.

(ii) This part was rarely awarded credit. Although the calculation was often correct, the answer was very often supplied without a unit.

(d) (i) There were some candidates who made little progress here and obtained no credit. Others made some progress and the answer 3.7 kg was not uncommon. However, few candidates were awarded full credit.

(ii) This part was rarely awarded full credit. The overwhelming majority of answers included a straight line that passed through the origin rather than beginning above it. Some lines beyond the limit of proportionality began to curve back on themselves, which in these circumstances is not possible.

(e) There were many good answers to this question with most answers being awarded some credit and full credit was awarded quite often. Some answers did not make clear the direction in which the energy change was being made. Since both elastic energy and gravitational energy are forms of potential energy, the answer *potential energy* needed further qualification but this was quite commonly not supplied.

Question 9

(a) This was well answered. The most frequent reason for full credit not being obtained was that it was not clear that the boiling point is a temperature. A second common omission was to use the term *boiling* without any description of the phase change to which it refers.

(b) Many candidates referred, in some way, to the intermolecular forces and the need to overcome them. Only occasionally was work done, increased potential energy or latent heat mentioned. A few candidates supplied answers that were essentially a description of evaporation rather than boiling.

(c) Full credit was often awarded here and nearly all candidates placed the symbol for an ammeter in an appropriate position. A few voltmeters were shown connected into the series circuit or where connected in parallel with the ammeter.

(d) (i) Full credit was commonly awarded but occasionally candidates divided the potential difference (p.d.) by the current or supplying the joule (J) as the unit for power.

(ii) This part was also well answered although there were candidates who did not convert 1.0 minute to seconds and who calculated an answer that was sixty times too small.

(iii) This part was also well answered but there were candidates who calculated the reciprocal of the correct answer as a consequence of either rearranging a known equation incorrectly or because of a confusion between latent heat and specific latent heat. The latter confusion was often made when an equation was quoted in the form $L = ml$.

(e) The opinions of the candidates were fairly evenly divided as to whether the upward force on the piston changed as it moved upwards. Those who correctly stated that he force did not change very commonly gave a suitable explanation in terms of the constant speed of the piston.

Question 10

(a) This was well answered and full credit was very commonly awarded.

(b) (i) Although the effect of alpha-particle emission was well understood, some candidates determined the number of neutrons in a radon –222 nucleus.

(ii) The fact that the question asked about the original nucleus rather than the product challenged some candidates and whilst many answers were correct, there were many others that were incorrect.

(iii) This part was not well answered. A commonly given incorrect answer was that alpha-particles are radioactive.

(c) (i) This part was very well answered indeed. Even though the question was only concerned with interpreting a graph, the scale was expressed in standard form and this added some complication.

(ii) Full credit was often awarded here and many candidates had some idea about what was being asked. Whilst many candidates realised that this sort of question is likely to involve halving something a few times, there were candidates who halved the number 222 or even 7.6.

(d) Most candidates gained credit here and this part was well answered.

(e) Almost all candidates mentioned a particular, hazardous consequence of radiation on the lungs. A somewhat smaller number of candidates related this to the strong ionising effect of alpha-particles.

PHYSICS

Paper 5054/42
Alternative to Practical

Key messages

- Candidates should be reminded to include units when quoting the values of physical quantities. They should be encouraged to check that the unit they have provided is appropriate for the calculated or measured quantity.
- Candidates should be made aware that it is important to record measurements to the correct precision. In particular, measurements made with a rule should be given to the nearest millimetre. If a measured length is, for example, exactly 5 cm, the value should be quoted as 5.0 cm.
- Candidates should take care and pay attention to detail when drawing or annotating diagrams. The accuracy of straight lines on diagrams could be greatly improved by using a sharp pencil and a ruler.
- Candidates should be advised to avoid using vague phrases, such as, “to make it more accurate” or “to avoid parallax error”. These comments need to be linked to the practical situation being considered, and candidates should state why the accuracy has improved or how parallax error was avoided.

General comments

The level of competence shown by the candidates was good although some candidates approached 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 being short of time. Stronger candidates were able to follow instructions, record observations clearly and perform calculations accurately and correctly. Units were well known and usually included where needed. Writing was legible and ideas were expressed logically.

Comments on specific questions

Question 1

(a) (i) The majority of candidates measured the length of the spring and recorded answers that were within the tolerance allowed. Some candidates ignored the instruction that the loops at the end of the spring were not to be included in their measurement.

(ii) The position of the ruler was usually drawn close to the spring, but often it was not carefully drawn and very obviously not vertical. Occasionally the ruler drawn was much shorter than the spring itself.

(iii) Most candidates marked the position of the candidate’s eye correctly, level with the bottom of the spring.

(b) (i) Many candidates found this to be difficult and correct answers were not common. The load values in the table were deliberately recorded in a random sequence, so the obvious way to improve the table of results was to list the readings in order of increasing or decreasing load. The most common incorrect answer was that the readings should be repeated but this in itself would not improve the table of results.

(ii) The graph question was done well. The axes were usually labelled and sensible scales were chosen. There was some evidence this year of scales on the axes that were multiples of 3, 7 etc. The use of such scales makes it difficult for the candidates to plot their points accurately, and difficult for the accuracy of these plots to be seen.

The instruction that the scale of both axes started form the origin was frequently ignored and this caused problems in the next part of the question.

Most candidates plotted the points accurately and drew a good line of best fit, as requested. Candidates should be reminded that they need to plot to the nearest half square, so plotting all the points on grid intersections will sometimes mean an error in the plot.

Some candidates did not gain credit for best-fit line because they forced their line through the origin, when clearly the trend of the plotted points made it obvious that there should be an intercept on the l–axis.

(iii) This was only answered well by stronger candidates. The concept of direct proportion was not well understood. Most candidates stated that l and L were directly proportional because the graph was a straight line, and as one quantity increased, so did the other. Only the strongest candidates realised that the quantities were not proportional to each other because although the graph was a straight line, it did not pass though the origin.

(iv) Most candidates extrapolated their graph and obtained a sensible value for the length of the unstretched string. Credit was available here for the accuracy of point plotting and the positioning of the line of best fit. This was only awarded for answers within the range 34 ± 2 (mm)

(c) (i) Most candidates only gained partial credit for this calculation. The graph was usually read correctly to determine the spring length for a load of 3.6 N, and most candidates gave this as the answer. The question asked candidates to determine the extension of the spring for this load, and only stronger candidates realised that the unstretched length of the spring needed to be subtracted from their graph reading.

(ii) The graph of *L* against *e* was well known, and most candidates drew a straight line passing through the origin.

(d) This more difficult final part was done well. A majority of candidates deduced that a spring of the same length but with a greater force constant, would have the same initial value of l but would have a greater gradient. The sketch graphs they drew reflected this.

Despite the instruction to draw their lines on **Fig. 1.2** on the axes provided, a large number of candidates drew their sketch graphs on **Fig. 1.3**.

Question 2

(a) The majority of candidates correctly recorded the reading on the top-pan balance to three significant figures. Common errors were the incorrect rounding of the truncated value and using a colon instead of a decimal point.

(b) (i) The reading of the new water level in the measuring cylinder caused many candidates problems, perhaps because the water level was between two consecutive scale graduations. Common incorrect answers were 81 and 69.5.

(ii) The increase in the volume reading on lowering the test-tube into the water was nearly always found correctly.

(iii) Many candidates misread the question and explained how to read the scale of the measuring cylinder accurately. However, the question was different to this, and asked for a source of experimental inaccuracy, so answers needed to give examples of how not to read the scale of the measuring cylinder accurately.

(c) Most candidates divided their values of mass and volume correctly to determine the density of water. Where errors occurred, it was usually in the incorrect rounding of a truncated value. Some candidates did not know the unit of density or omitted this.

Question 3

(a) (i) The scale reading of the voltmeter was usually correct. Occasionally it was recorded as 0.22 (V).

(ii) Most candidates substituted correctly into the given equation and obtained the correct answer for the resistance of a 10.0 cm length of the wire.

(b) Although most candidates gained partial credit here, the reasoning behind their answers was usually incorrect. Candidates were expected to deduce that the length of the wire and its resistance were directly proportional to each other. Although many candidates stated this, they went on to say that they were directly proportional because as one increased, so did the other. This was an insufficient explanation and did not, in isolation, necessarily mean that the quantities were directly proportional. Stronger candidates showed that the ratio of resistance to length was constant for the values in the table, or that doubling one quantity, doubled the other etc.

(c) Most candidates described a sensible precaution to prevent the overheating of the resistance wire in an investigation of this type. The most common correct answers referred to using smaller currents/voltages or switching off the circuit between readings. The use of a fan to cool the wire was also accepted but immersing the apparatus in water gained no credit.

Question 4

(a) (i) Most candidates drew a normal to the prism at point Z. The normal was expected to extend on both sides of the air-glass interface.

(ii) Although there was a clue given in the diagram because of the positioning of the pins P_3 and P_4, many candidates had difficulty in drawing the path of the ray of light until after it emerged from the prism. Many candidates refracted the ray back out into the air at point Z or had the ray from Z missing side XY altogether and reflecting downwards to emerge from WY. What was expected, was two total internal reflections of the ray from WX and then from XY with the ray then emerging normally through WY and passing through pins P_3 and P_4.

(b) Only the strongest candidates answered this question correctly. Candidates were asked to describe the overall effect of the prism on the ray of light. Most candidates were preoccupied with the ray being totally internally reflected, when all that was required was to state that the direction of the ray had been reversed, or that the ray had been turned through 180°.