PHYSICS

Paper 5054/11
Multiple Choice

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

General comments

There was the usual wide range of accomplishment from the candidates with some candidates obtaining nearly full credit whilst other selected a number of correct answers that suggested guesswork might well have been used extensively as an approach.

The methods for reaching the correct answer that the questions required also varied and whilst some questions required a few calculations, other simply required that a certain fact be known and recalled. Most of the questions that were well answered were questions that demanded factual recall in a very straightforward situation and in a manner similar to that referred to in the syllabus. **Question 15** was also very commonly answered correctly, however, even though it was a calculation. This might have been because the answer required was the subject of the equation when it is expressed in the most commonly quoted form.

Since there are several different approaches, some questions are more demanding in terms of time than others. A candidate should be advised that this is not a problem provided that it is compensated for by a similar number of questions that require rather less than the average time available per question. It is always

https://xtremepape.rs/
© 2017

better to work through a question to the end rather than to guess even when two answers have already been eliminated. If, however, a question is taking too long, it should be recalled that all the questions contribute equally to the final result and that it might be better to move on and to return to the question after all the other questions have been answered.

However, a successful result is only going to be obtained by those familiar with every part of the syllabus.

Comments on specific questions

Question 3

This question involved a certain amount of interpretation although the graphs given should all have been quickly recognised. Relating the graph in the question to the graph in the correct response was too abstract for some candidates and although the correct option was supplied more often than any other, there were many candidates who were attracted to each of the other suggestions. In particular, graph **C** was selected almost as often as the correct response.

Question 5

This question was only correctly answered by a minority of candidates and the incorrect option **C** was noticeably more popular than the correct option **D**. This might well be because some candidates are reluctant to select an option where the wording in both columns is the same. Alternatively, there are candidates for whom acceleration and velocity are not properly distinguished and this can cause confusion when these two vector quantities are in opposite directions.

Question 14

Although melting and boiling are comparable and in some ways very similar changes of state, they are very clearly not identical. When they are considered in terms of water at room temperature, they are frequently contrasted and this might well have led some candidates to see them as opposite processes. This could explain why the two most commonly offered answers were **B** and **C** where the energy changes for the two changes of state are wrongly given as opposites to each other. Option **D** was, in the main, only chosen by the candidates who scored more highly on the rest of the paper.

Question 20

Here the candidate was invited to consider two inequalities that relate to total internal reflection. Candidates very commonly but incorrectly assume that for total internal reflection to occur, the angle of incidence must be less than the critical angle and so option **B** was often selected. More commonly, the relative optical densities were reversed and this led to the choice of option **D**. The correct response was the most frequently chosen and only a few candidates made both errors.

Question 22

Here what needs to be understood when answering the question is the difference between the real image produced on a screen (such as that produced by a projector) and the virtual image produced by a magnifying glass. Options **B**, **C** and **D** apply only to the use of a magnifying glass whilst only option **D** applies in the case of a real image produced on a screen. The introduction to the question describes this latter situation and so only option **D** is correct.

Question 25

It is not unusual for candidates to have difficulty when rearranging formulas and the formula $v = f\lambda$ seems to be especially prone to this. This is not helped by candidates who use non-standard symbols; the symbol *w* is sometimes used to represent wavelength and is then easily confused with *v*. When answering this question, candidates needed to know that the frequency remains constant when a wave passes from one medium to another and then to apply the formula in its usual form. There is, therefore, plenty of scope for error and each of the four options was chosen by some candidates. The correct answer, however, was the most commonly selected.

Question 31

https://xtremepape.rs/
© 2017

The majority of candidates realised that the two labelled currents were equal although a few believed that the current decreased as it passed through the resistor. Of these candidates most realised that two cells in parallel produce an e.m.f. (electromotive force) that is equal to the e.m.f. of the individual cells.

Question 32

In addition to testing the effect of differently positioned switches in a circuit, the question also examined the method by which the price of electricity is calculated. The correct option was selected by more candidates than any other option but there was a significant number of candidates who chose each of the other responses. The second most popular answer was **B** which suggests that these candidates did not take into account the time of two hours for which the circuit was operating.

Question 33

The way in which the use of an earth wire acts as a safety measure is very commonly misunderstood and it is not surprising that each of the options attracted some support. The correct answer, however, was selected by the greatest number of candidates.

Question 37

To obtain the correct answer here, the candidate needed to be familiar with the Geiger-Marsden experiment. Although a significant deduction can be made from the alpha-particles that deflect in the direction **D**, this is not the direction in which the overwhelming majority of particles emerge from the gold sheet. This is direction **A**. Significantly more candidates selected **D** than selected the correct response **A** but at least **A** was more popular than **B** or **C**.

https://xtremepape.rs/
© 2017

PHYSICS

Paper 5054/12
Multiple Choice

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

General comments

Candidates showed a wide range of achievement on this paper. A few candidates obtained full credit whilst a few others performed less well than might be expected from random guesswork. Similarly, there were questions which were only correctly answered by candidates who scored highly on the rest of the paper and on other questions nearly every candidate supplied the correct response. **Question 20** was included in the latter category.

The questions asked require a range of different approaches. In some cases, the correct answer can be obtained very quickly by simply looking at the suggested diagrams or by reading a few short expressions. The answers to other questions might take noticeably longer and involve a couple of calculations or the application of a logical approach to the problem described. Inevitably, the second type of question is going to require more time even though the credit available is identical. Candidates need not be too concerned if determining the answer to some questions takes longer than for other questions. This is fine provided the extra time can be recouped from the time saved when answering more straightforward questions. It is never wise to get so far with a longer question and then to guess between, for example, the last two answers to be eliminated. The effect of doing so is only slightly more advantageous than guessing the answer initially. If,

© 2017
https://xtremepape.rs/

however, a question is taking too much time, then it might be better to make a note of the progress made and then to return to it when the rest of the paper has been completed.

The paper is likely to contain questions from nearly every section of the syllabus and so candidates need to ensure that there are no omitted topics when revising for the examination. Likewise, many different approaches are likely to be required and so candidates need to be able to extract information from text, graphs and diagrams and to use the information logically or to perform calculations accurately. Many candidates find difficulty in rearranging an equation such as $\rho = m / V$ so that m or V is the subject. An inaccurate rearrangement is likely to lead to one of the incorrect options supplied.

Comments on specific questions

Question 3

This question involved a certain amount of interpretation although the graphs given should all have been quickly recognised. Relating the graph in the question to the graph in the correct response was too abstract for some candidates and although the correct option was supplied more often than any other, there were many candidates who were attracted to each of the other suggestions. In particular, graph **C** was selected almost as often as the correct response.

Question 6

The answer most commonly offered here was answer **D**. This, of course, was obtained from simply adding together two densities. Whilst the masses and volumes of the two separate parts can be added, the overall density is not so simply obtained. This reveals that not all candidates are completely familiar with the way in which different properties behave and might well explain why some candidates have difficulty in distinguishing between density and mass.

Question 7

Although the calculation was fairly straightforward, the majority of candidates did not take into consideration the moment due to the weight of the springboard and gave option **C** as the answer. It is not clear why this was so as the question does specifically refer to the board and both its weight and the location of its centre of mass are supplied.

Question 8

Since the formula for kinetic energy was correctly used in all four options, the question was really testing the relationship between units and the need for values that are substituted into formulas to be given in base units if the correct answer is to be obtained. Each of the incorrect options involved at least one substitution that was incorrect in one way or another and each of these options was chosen by at least some of the candidates.

Question 12

This question was the most testing on the paper and rather more candidates selected the incorrect responses **B** and **C** than selected the correct response **A**. All four options, in isolation, are correct statements but three of them do not explain the different compressibilities of liquids and gases. Compression results in the molecules being forced together and so it is the repulsive forces between the molecules that oppose this and makes compressing liquids difficult. Only response **A** deals with these repulsive forces.

Question 19

Of the incorrect options, only option **D** was offered by fewer candidates than the correct option **A**. It is clear that many candidates were uncertain as to what is meant by the vertical lines on a diagram such as this. Essentially, such lines are wavefronts and so by definition, the points on a given line move identically. Many candidates opted for other options, suggesting that this was not widely understood.

https://xtremepape.rs/
© 2017

Question 22

Here the candidate was invited to consider two inequalities that relate to total internal reflection. Candidates very commonly but incorrectly assume that for total internal reflection to occur, the angle of incidence must be less than the critical angle and so option **B** was often selected. More commonly, the relative optical densities were reversed and this led to the choice of option **D**. The correct response was the most frequently chosen and only a few candidates made both errors.

Question 30

This question involved getting two ratios the correct way around although for the correct answer to be obtained, one ratio was in fact equal to 1.0. Furthermore, there is the possibility of squaring the cross-sectional area ratio as would have been necessary had the diameter of the cross-section been given. There are then several ways in which an incorrect answer could be obtained. Although the correct option was chosen the most frequently, the other three options were all selected by a significant number of candidates.

Question 36

This question was a direct test of two facts that needed to be known. Many candidates made the wrong choice either for the thermistor or for the LDR or for both. All four options were chosen by at least some candidates.

Question 39

To obtain the correct answer here, the candidate needed to be familiar with the Geiger-Marsden experiment. Although a significant deduction can be made from the alpha-particles that deflect in the direction **D**, this is not the direction in which the overwhelming majority of particles emerge from the gold sheet. This is direction **A**. Significantly more candidates selected **D** than selected the correct response **A** but at least A was more popular than **B** or **C**.

https://xtremepape.rs/
© 2017

PHYSICS

Paper 5054/21
Theory

Key messages

- A small number of candidates write some answers in pencil before writing over the answer in ink. This often leads to the answer being less legible and, when combined with crossings out and uncertain expression, the answer can be extremely difficult to interpret.
- 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.
- A carefully drawn diagram can often show what the candidate intends to convey much more accurately than just words. Whenever a diagram is asked for or suggested, it is usually worth drawing it carefully and neatly and then labelling it, so that its intention is clear.
- The number of marks shown and the amount of space provided give a guide to the length of the answer required, and candidates who exceed the space provided may be wasting time giving unnecessary or irrelevant detail. It is helpful if candidates confine their answers to the space provided. 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 of the cover sheet.

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.

The standard of written English was high and there was no evidence of a language problem for candidates. The quality of expression 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 2(a)(ii)**, answers lacked structure and the explanation of why the decrease in pressure occurred was often lost amongst random irrelevant facts about the behaviour of gas molecules in general. The more able candidates expressed themselves eloquently and succinctly, confining their answers to the question asked, and were awarded full credit.

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

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

© 2017
https://xtremepape.rs/

Comments on specific questions

Section A

Question 1

(a) The majority of candidates were able to make some headway here. The calculation of the volume of the plank caused some difficulty and answers were frequently incorrect by a power of 10.

(b) (i) The calculation of the weight of the plank presented little problem to the majority of candidates. Marks were occasionally lost by the omission of the unit for weight.

(ii) Although most candidates knew how to calculate the moment of the plank about the support, many chose an incorrect distance in their calculation.

(c) Only the more able candidates realised that as the painter moved further along the plank to the right, his moment about the support would become greater than that of the weight of the plank and so the plank would rotate in a clockwise direction.

Question 2

(a) (i) Most candidates were able to define the term *pressure*. Sometimes the definition was given in symbols, without defining what the symbols represented.

(ii) Most candidates scored at least one of the three available marks. Answers lacked structure and often bore no relevance to the question asked. Many candidates realised that when the can of compressed air was used, there would be fewer molecules left inside it. Fewer candidates went on to state that there would therefore be less frequent collisions made with the walls of the can. Very few candidates stated that the consequence of this would be that less force would be exerted on the walls, and so the pressure inside the can would drop.

(b) Most candidates realised that Boyle's Law was needed to solve the problem. There was much confusion with the manipulation of this formula to make the original pressure inside the can the subject of the formula and the correct ratio of the two volumes was frequently inverted.

Question 3

(a) Most candidates were able to state at least one correct difference between the molecular structure of gold at temperatures below and above its melting point. A surprising number of candidates had the two states of gold in the wrong order – the melting point of gold was given as 1100 °C, and they incorrectly thought that gold at 1000 °C was a liquid.

(b) (i) Most candidates knew that thermal energy is needed to break bonds when gold melts, but far fewer stated that work needs to be done to overcome the molecular forces.

(ii) The calculation to calculate the thermal energy needed to melt the gold was usually performed correctly, but many candidates missed the fact that the specific latent heat quoted, had units of kJ/kg, and gave answers which were out by a factor of 1000.

Question 4

(a) The first two marks available were scored by most candidates who realised that the thermometer needed to be immersed in boiling water to check if the 100 °C mark was correctly calibrated on the thermometer stem. Fewer candidates made the last, obvious step that if the 100 °C mark was in the correct position, the position of the mercury in the capillary tube would correspond to this.

(b) Fully correct answers to this more demanding part were rare. Nearly all candidates thought that since ethanol had a greater thermal expansion than mercury, the maximum range of an ethanol thermometer would be greater. In fact because ethanol expands more than mercury, the ethanol thread would reach the end of the thermometer at a lower temperature and the range of the thermometer would be consequently reduced.

https://xtremepape.rs/
© 2017

Question 5

(a) Most candidates stated that ultrasound had a frequency greater than 20 kHz, and obtained one of the two available marks. Far fewer candidates stated what was meant by ultrasound, by giving some further detail. Few candidates stated the ultrasound was a longitudinal wave/had compressions and rarefactions/was a sound wave which is inaudible to humans.

(b) The use of ultrasound in pre-natal scanning was not well known. Many candidates knew that an image/picture is produced on a screen, but had no idea of how the image was produced. Many candidates confused this process with the use of X-rays. The minority of candidates who knew that the ultrasound is transmitted into the body and is reflected off the fetus to produce an image at the receiver, scored full marks effortlessly.

Question 6

EITHER

(a) Although most candidates who attempted this option knew that a positive potential is needed to produce a continuous flow of electrons in the tube, far fewer gave a second valid requirement. The important fact that the filament needs to be heated continuously, was nearly always absent from candidates' answers.

(b) Again, only a small minority of candidates had any idea of how the given output trace could be used to determine the time between the two pulses. The use of an oscilloscope to measure a small interval of time was not known to the majority of candidates.

OR

(a) About half of the candidates who attempted this optional part were able to draw the correct symbol for a NAND gate.

(b) (i) Only a handful of candidates had any idea where the energy supplied by the NAND gate came from. Only a small minority of candidates realised that to function, a NAND gate needs a power supply connected to it.

(ii) The truth table for a NAND gate was completed correctly by about three-quarters of the candidates.

Question 7

(a) A majority of candidates ignored the instruction to mark one tick in each column, and proceeded to place one tick in every one of the seven rows in the table. This indicates that the force experienced by a current carrying conductor when placed in a magnetic field is very poorly understood.

(b) The effect of reversing the battery in the circuit was better understood, but only a small number of candidates scored both marks because they omitted to state that reversing the battery would reverse the current in the circuit.

(c) Only the more able candidates stated that decreasing the current in the circuit by adjusting the variable resistor would reduce the size of the magnetic force.

Question 8

(a) (i) Less than one-third of candidates could describe correctly the structure of an alpha-particle. Most answers referred to a helium atom and not nucleus. Where the correct composition of two protons and two neutrons was given, the answer was invariably spoiled by adding two electrons to the list.

(ii) The process of ionisation was not well known. Only a very small number of candidates described the ionisation of air by alpha-particles correctly. Many candidates thought that the alpha-particle donated electrons to the air molecules during collisions, whereas the reverse is true. It was rare so see a candidate state that an alpha-particle was a (positively) charged particle.

(iii) Again, this part was poorly answered, with guesswork playing a large part.

https://xtremepape.rs/
© 2017

(b) (i) The problem on radioactive decay was solved correctly by about half the candidates. Many candidates deduced that five half-lives had elapsed during the decay process and scored two of the available marks. The third mark proved to be more elusive.

(ii) Correct answers were obtained only by the more able candidates. Most candidates did not appreciate that radioactive decay is a random process and answers obtained using theory may differ slightly from those obtained by experiment.

Section B

Question 9

(a) (i) Most candidates used the correct formula and were able to calculate the work done per second by the resistive forces. A mark was occasionally lost because the unit was omitted or an incorrect unit given.

(ii) Totally correct answers to this straightforward question on energy transfer were rare. An extra incorrect energy conversion (usually to kinetic energy) was usually included in the list given by candidates. The idea that since the ship travelled at constant speed, all the chemical potential energy of the fuel is converted to thermal energy was beyond the scope of most candidates.

(b) (i) About half of the candidates were able to calculate the acceleration of the ship correctly. Common errors were power of ten mistakes and the inclusion of an incorrect unit.

(ii)1 Few candidates were able to deduce from the information given, that the deceleration would decrease because the resistive force on the ship would decrease as the ship slowed down.

(ii)2 Most candidates sketched a speed-time graph with the curve/line they had drawn, correctly decreasing to zero. Far fewer candidates realised that the gradient of the graph they had drawn would decrease as the deceleration decreased.

(ii)3 Most candidates knew that the distance travelled by the ship could be determined by calculating the area under the curve/line that they had drawn.

(c) (i) Approximately half the candidates were able to state an acceptable relationship that defines efficiency. Vague answers such as output divided by input were not accepted. Answers needed to be expressed in terms of energy, work or power.

(ii) Candidates did not read the question carefully and only completed half the calculation. Most candidates were able to calculate the rate of useful energy output of the engines but did not perform the final, simple subtraction to calculate the rate of energy wastage.

Question 10

(a) This question was well done, with most candidates correctly naming the missing components of the electromagnetic spectrum.

(b) Most candidates correctly identified the components of the spectrum that had frequencies greater than that of visible light.

(c) (i) The calculation of the frequency of the infra-red radiation was done well. The values given in the question gave some candidates problems with dealing with the powers of 10.

(ii) Full marks for the required explanation required were rare. Most candidates knew that the television remote controller emitted infra-red waves. Far fewer candidates knew what happened to these waves when they were received by the television set. It was rare to see the answer that the radiation was then encoded/decoded. A sizeable minority of candidates thought that the remote controller sent infra-red rays to the satellite and then the satellite returned these waves to the television set.

(d) (i) About half the candidates completed the diagram correctly. The normal for the ray was often incorrectly drawn as a vertical line, instead of a line at right angles to the first face of the prism. The location of the angle of incidence was not well known.

https://xtremepape.rs/
© 2017

(ii) Most candidates scored one of the two available marks for using the correct equation to calculate the angle of refraction. Mistakes in the transposition of this formula were frequent and many candidates calculated an angle of refraction that was larger than the angle of incidence.

(iii) About half the candidates were able to state correctly what happens to the frequency, speed and wavelength of the light as it passed from air into glass. There was much evidence of guesswork here.

(iv) The path taken by the light on passing through the glass and back into the air was well known and most candidates produced correct sketches.

Question 11

(a) (i) Approximately half of the candidates were able to name a suitable material for the insulating stand.

(ii) The distribution of the charges on the sphere was usually drawn correctly. Where a mark was lost, it was because candidates' diagrams showed that there was more positive charge on the left hand side of the sphere than negative charge on the right hand side of the sphere.

(iii)1 Few candidates could explain what happens to the charge on the sphere when the sphere is earthed. Many answers incorrectly involved the movement of positive charge to or from the earth. Where electron movement was described, the direction of this flow was often incorrect.

(iii)2 Correct answers to this more demanding final part were rare. Very few candidates realised that electrons would flow back to the sphere from the earth.

(b) (i) The determination of the total resistance of the circuit was usually performed correctly. The most common error made was to add the two parallel resistors to calculate their effective resistance.

(ii) The current flowing in the power supply was usually calculated correctly.

(iii) It was surprising to note that very few candidates had any idea of the relative magnitudes of the currents in the different resistors in the circuit. Few candidates realised that the current would be greatest in the 18 Ω resistor.

(iv) Most candidates realised the five cells were needed to produce a 7.5 V power supply. Occasionally the cells drawn were not always facing in the same direction.

(v) Only the more able candidates realised that if the 18 Ω resistor were made of metal then its resistance would increase as the temperature increased. Only a minority of these candidates went on to state that the consequence of this would be that the current in the circuit would therefore decrease.

© 2017
https://xtremepape.rs/

PHYSICS

Paper 5054/22
Theory

Key messages

The O-level Physics syllabus is, of course, examined by three separate components and as a result, the overwhelming majority of the syllabus is tested each time. Even though Section B of this paper allows for the omission of one question, the subject material for the three questions in Section B varies randomly and over many years is likely to include all the topics in the course. The only approach, therefore, that can guarantee a successful outcome, is for a candidate to be thoroughly conversant with all the topics included in the syllabus. From time to time, a candidate chooses to answer part or indeed all of a third optional question; this very rarely results in an improved performance and candidates should be advised to choose the two questions for which they are likely to produce the most satisfactory responses and then to spend the time available ensuring that these are answered well. Time spent answering a question that does not contribute credit to the candidate's overall performance is time wasted.

Candidates should also notice the precise wording of a question and also the maximum credit that may be awarded for a given part of a question. They should then tailor their answer accordingly. The syllabus lists descriptions of many of the command words used in this examination paper and although candidates need not memorise exactly what they mean, it is important that it is realised that a question using the command word *State* is going to require a rather different type of approach from a question that uses *Explain*. The credit available for a particular part is printed on the paper in square brackets and no matter how detailed an answer is, this credit remains the maximum available. It would be unwise to spend too much time answering one part and not to leave enough time to deal with other parts. The amount of answer space supplied needs to cope with those few candidates whose handwriting is noticeably larger than the average and so it follows that many candidates will find the answer space to be quite generous. Once the question has been fully answered candidates should not feel obliged to fill up the remaining space. When this is done, a point that has already been credited, can easily be contradicted and this can result in reduced credit.

It is worth repeating the advice that has been offered previously concerning the replacement of answers. Candidates are very often tempted to cross out one answer and to replace it by writing between the lines already written on or even on top of what has been crossed out. There is almost always some blank space on a question paper and candidates should write replacement answers in such a space and make a reference to the location of the replacement answer in the original answer space. The front page of the paper, however, is not seen by the Examiner and so this must not be used for replacement answers.

General comments

Almost all numerical answers require an appropriate unit and full credit is not awarded where an incorrect unit is supplied or where a unit is omitted altogether. For full credit, the Examiner should see the correct numerical answer with the correct unit (or its symbol). The numbers given in the question are usually expressed to two significant figures and hence candidates should express their answers to at least two significant figures. Numerical values should also be correctly rounded. Thus, in **Question 3(a)**, where a calculator is likely to produce the number 2.597402597×10^3 the answer 2.5×10^3 would not gain full credit.

https://xtremepape.rs/
© 2017

Comments on specific questions

Question 1

(a) There were many good answers where candidates were able to draw appropriate parallelograms to scale. Common errors were right-angled triangles or the use of inaccurately drawn angles. Those who were able to select an appropriate scale often went on to find an accurate resultant though a common error was measuring the resultant and then quoting a value of about half the size required. Good responses often showed the working out for scaling up the measured resultant.

(b) Very few candidates linked the backwards force to water friction or drag and many of those who did realise there was a resistive force mentioned air resistance rather than thinking about the context of the question. A significant number of candidates suggested that the ship moved at a constant speed because equal forces were applied by the tugs at equal angles. In a specific context such as this one, candidates commonly abandon the second law and assume that a constant resultant force is needed to produce a constant speed.

Question 2

(a) The question states that a force can change the velocity of an object and asked for other properties that a force might change. It was unfortunate that one of the properties which many candidates suggested was *velocity* and this prevented full credit from being awarded. Almost all candidates, however, gained some credit for this part by referring to shape or size.

(b) (i) Many candidates gave the correct answer here although a few converted the mass into grams and produced an answer that only had the correct significant figures.

(ii) This was only occasionally correct as many candidates referred either to the spring's exceeding its elastic limit or to the two springs sharing the load.

(iii) The majority of candidates gave answers in terms of the elastic limit (which is not a syllabus topic) rather than the limit of proportionality. Many answers suggested that this was the point where the deformation became permanent. It was unfortunate that there were candidates who probably knew what was required but who gave answers such as *The extension is not directly proportional to the load*. This phrasing does not define a point and falls short of what was expected.

(c) (i) The word *elastic* was only used occasionally and *potential energy* (on its own) was not a sufficiently detailed response.

(ii) That a resistive force was acting to prevent the continuing motion of the load was only referred to very rarely.

Question 3

(a) Although a large number of candidates were able to quote the equation that defines pressure, a much smaller number of candidates substituted the correct value for the area. A very common error was to use the volume of the block instead.

(b) More candidates attempted an explanation in terms of a change of area in contact with the ground or in terms of the quoted values being wrongly determined than realised that the total pressure also included the pressure of the atmosphere.

(c) (i) Although either 0.13 m or 0.065 m were commonly given (only the second is correct, of course), there were many answers that far exceeded these values. Candidates should be advised to consider the context of the question and whether the answer they give is likely or indeed possible.

(ii) Many candidates were awarded some credit but only a few gained full credit.

© 2017
https://xtremepape.rs/

Question 4

(a) (i) This was generally well answered. Now and again, a candidate omitted to convert the time in hours to seconds or only converted it to minutes. The unit given for the answer did not always correspond to the calculation that was conducted.

(ii) Although more straightforward than the previous part, this part was less well answered. Common errors included answers that were one hundred times too large and answers that were derived by dividing the answer to **(a)(i)** by the efficiency.

(b) (i) This was generally well understood but credit was not awarded where no explanation was offered. Where a double command is used (in this part *State and explain*) candidates must ensure that both instructions are followed.

(ii) Most candidates were able to produce a discussion that dealt with this issue; the most common approach was to consider the effect of the production of CO_2 or other greenhouse gases. The destruction of the ozone layer is not related to the use of oil as a source of energy but many candidates suggested this as an answer here.

Question 5

(a) Although many answers were correct, only a minority of answers discussed the process of nuclear fusion in sufficient detail. A noticeable minority described nuclear fission. The fact that it is nuclei that combine in the Sun was required in this part; many candidates referred only to the fusion of atoms, particles or molecules and were not awarded full credit.

(b) The term *radiation* on its own was commonly used to describe how energy from the Sun travels to Earth; more precision was required, however, and many candidates were not awarded full credit.

Question 6

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

(b) (i) This part was also well answered.

(ii) This was less well answered than the previous parts although most candidates were awarded the credit. Perhaps frequency is a less accessible concept than amplitude and less easy therefore to relate to an observable feature of the sound.

(c) There are very commonly candidates who struggle to rearrange an equation such as $v = f\lambda$ and this is especially the case with this particular equation. Although the majority of candidates obtained the correct answer, there were those whose rearranged equation was the erroneous $\lambda = f / v$. This did not produce the correct answer when the numbers were substituted. Candidates who use the symbol w in this equation are prone to forget what it represents. When it is used as the wavelength, it is not clear what the symbol λ means when that also appears. The use of standard symbols should be encouraged.

Question 7

(a) (i) The correct answer was very commonly obtained and full credit was awarded when this was done. From time to time, a candidate either quoted an equation suggesting that the resistance of the parallel pair was actually equal to the sum of the reciprocals of the two individual resistances or more commonly quoted the correct equation but then omitted to calculate the final reciprocal before stating the answer. Some candidates obtained the incorrect answer 10 800 Ω by simply using the equation for resistors in series. There were others, however, who quoted the correct equation and who then substituted correctly but did not see that $1 / R = 1 / R_1 + 1 / R_2$ is not mathematically the same as $R = R_1 + R_2$.

(ii) This part was also correctly answered very frequently; only the occasional candidate used $I = VR$ or some other incorrect rearrangement.

https://xtremepape.rs/
© 2017

(b) (i) In this part, many candidates stated the correct answer but did not explain why it was correct.

(ii) A significant number of candidates gave the opposite answer to the one given in **(b)(i)** and only a minority gave the correct response. Of those who did, it was unfortunate that only very few explanations were offered. Candidates seem reluctant to accept that paired questions such as **(b)(i)** and **(b)(ii)** do not always generate opposite answers or that *nothing happens* can also be a correct response.

Question 8

(a) This was very commonly correct but not invariably so. Attempts to rearrange the equation were not always successful and the original equation was itself sometimes misremembered. The unit for charge was not always correct with both *joule* and *volt* being suggested on several occasions.

(b) Answers that made no reference to the role of magnetism in the operation of the relay were common but were awarded no credit. There were some very good diagrams (even though none was asked for) but overall, many candidates struggled with this part.

Question 9

(a) (i) Very many candidates knew the correct equation and as it did not need to be rearranged if memorised in the usual form, full credit was commonly awarded.

(ii) There were many good answers here and full credit was awarded quite frequently. A minority of candidates attempted to use the equation that defines speed and this was commonly accompanied by substituting the acceleration value given into the equation as the speed value.

(b) (i) Although there were many correct speed-time graphs, there were also a few fairly common misunderstandings. Some candidates began the graph with a horizontal straight line and continued with a straight line of negative gradient. Most candidates sketched a graph that underwent an abrupt change at approximately 1.2 s.

(ii) This was quite commonly correct although a few candidates did not make any reference to the graph or suggested that its gradient could be used to determine the distance travelled.

(c) (i)1 A correct arrow was often supplied but some candidates drew arrowheads on the orbit or an arrow that was directed either up or down the page.

(i)2 Although there were some good answers, a significant proportion of answers suggested that the centripetal acceleration was the cause of the force rather than suggesting the actual cause of the force acting on the space station.

(ii) Many candidates revealed a basic understanding of the meaning of the term but a much smaller number were awarded full credit. Many answers omitted one key point or another.

(iii)1 A comparatively small proportion of the candidates made both points here and answers such as *the velocity increases* do not accurately indicate the change that is taking place.

(iii)2 There were few correct answers here and even fewer who explained why the kinetic energy remained constant. Candidates need to look out for questions which have a double command and ensure that both instructions are dealt with in the answer.

Question 10

(a) (i) Many candidates quoted the correct equation and went on to obtain a correct answer with the correct unit. There were a few power-of-ten errors and a small number of candidates calculated the operating resistance of the heater although the unit given was still usually the ampere.

(ii) Only a few candidates were able to suggest an appropriate fuse rating with the majority of candidates suggesting a value equal to or greater than 20 A even when the answer to **(a)(i)** was correct.

https://xtremepape.rs/
© 2017

(b) (i) Although the temperature increase needed to be determined first and there were three terms in the expression for internal energy, full credit was awarded very commonly, and many other candidates gained at least some credit even if the final answer was not correct.

(ii) This part was only very rarely awarded credit. Thermal energy is lost to the surroundings at all temperatures above the room temperature and so the explanation required demanded a reference to the fact that thermal energy was being lost at a greater rate between 49 °C and 75 °C.

(c) (i) Many candidates produced thorough and complete answers and clearly understood the cause of a convection current. Candidates who made no reference to how the thermal energy was transferred throughout the water had not completely answered the question.

(ii) Many candidates understood the essential features of thermal transfer in steel and many candidates were awarded some credit. Rather fewer candidates referred to the collision of the particles and full credit was only awarded occasionally. Some candidates attempt to explain the transfer of energy by electron diffusion by suggesting that electrons collide with neighbouring electrons and in this way pass energy thorough the material. This is essentially the mechanism by which molecules transfer energy in a solid. The electron diffusion mechanism is subtly different.

(iii) This part was rather poorly answered. Only a minority of candidates related the expansion of the steel to its density or to the behaviour of its molecules.

Question 11

(a) The answers to **(a)(i)** and **(a)(iii)** were commonly restricted to the two magnetic materials in the list but they were not always given the correct way around. It was only occasionally realised, however, that the answer to **(a)(ii)** also need to be a magnetic material and the five listed materials were suggested as answers with very similar frequencies.

(b) (i) Many candidates were able to state that a transformer can be used to change a voltage or a current but only a small minority of these gave any relevant suggestion. This is an example where the maximum possible credit ([2] in this case) should suggest that the answer needs to be more detailed than a simple statement.

(ii)1 Most candidates drew an appropriate set of axes but very few sketch graphs even suggested a sinusoidal variation. Horizontal straight lines and lines with positive and negative gradients were all more commonly offered than what was required.

(ii)2 Many candidates recalled, rearranged and used the correct equation and then obtained the correct answer. There were errors, however, and common sources of inaccuracy included increasing the voltage by a factor equal to the turns ratio and obtaining a voltage of 4400 V. Some candidates obtained an answer by adding number of turns on the primary coil to the number on the secondary coil. The use of the symbol *V* for voltage, in the usual equation, encouraged some candidates to try to use the Boyle law.

(c) (i)1 Many candidates struggle to understand electromagnetic induction and so although full credit was awarded fairly commonly, there were other answers that did not include any reference to the changing magnetic field and did not offer any explanation for what was happening These answers were awarded very little credit.

(i)2 This part, in the main, was very poorly answered with many answers repeating what had been said in the previous part and making no reference to the Lenz law.

(ii) There were many answers that made no mention of the reading on the ammeter and which suggested other ways in which the current could be changed. Although the expected answers were relatively straightforward, few actual answers gained full credit.

https://xtremepape.rs/
© 2017

PHYSICS

Paper 5054/31
Practical Test

Key messages.

This was an examination of practical skills, using equipment to obtain a set of raw data and to process the raw data to produce a set of results. Responses to questions did not require repetition of theories. Good responses required good practical skills particularly in following instructions, making observations, making measurements (with repeats and averages where appropriate), recording and processing them according to the instructions given. Weaker responses often recited parts of work candidates had revised and this was not often a relevant response. Good answers show all repeated measurements (even if they are the same), all working for calculations, state units for all quantities and give answers correctly rounded to an appropriate precision (usually 2 or 3 significant figures). Measurements from an instrument (e.g. ammeter or voltmeter) should be recorded to the precision of the instrument. All measurements and answers should include the correct unit, if there is a unit. In some questions a unit may be specified and it should be ensured that quantities are converted to these units so that the final answer is given in the correct unit.

General comments

Good answers demonstrated that candidates were able to:

read the question and perform the tasks as requested; take measurements to an appropriate degree of precision, with repeat measurements wherever appropriate and practicable; process those results; take averages of repeat measurements; perform calculations by substitution into equations; construct tables of results (often a grid is provided) and use their data to plot graphs (i.e. line graphs) and then draw conclusions; make comments or perform further calculations based on those results or graphs according to the guidance given by the instructions given in each part; give answers with units and to appropriate precision usually 2 or 3 significant figures, depending on the quantity measured; present tables of results.

In some questions candidates were asked to describe how they used, checked or set up a particular piece of equipment. Good responses were characterised by a concise description giving the specific information in just one or two sentences and in some cases accompanied by a good labelled diagram.

It is in the interests of the candidates that supervisors provide a complete set of results for each set of apparatus used by candidates, especially for electrical circuits and optics questions.

Comments on specific questions

Question 1

(a) A mass was attached to a set of two springs in a series arrangement with a rod to act as a marker and the system was set oscillating by pulling the mass down a little and releasing it.

(b) (i) Candidates were asked to describe (with or without the assistance of a diagram) how they used the rod to help count the oscillations. The best responses described the most accurate method: setting the rod level with the mass in its resting position; one oscillation then occurred in the time from the mass travelling upwards past the rod to the next time it was passing upwards past the rod. The mark was also gained for descriptions of setting the rod at the lowest point of the oscillation and counting one oscillation as occurring in the time between the mass reaching the lowest point of its movement and the next time it reached that point, although this was a less accurate method.

© 2017
https://xtremepape.rs/

(ii) Candidates were asked to take measurements to determine an accurate value for the time, t_1, for 10 oscillations. At least two times for a set of ten oscillations (the total time for ten oscillations without stopping or re-setting the stopwatch) should have been measured and written down with the unit. The average value should then have been calculated and working shown and the final answer given with the unit s or seconds (not minutes). This time should have been in the range 9.0–16.0 s if the prescribed apparatus had been used.

Some responses often calculated ten single oscillations which led to inaccurate results. Times should be given as single decimal numbers with single decimal points and not with colons and not as representations of stopwatch displays with superscripts.

(iii) Candidates were required to use the value calculated in **(b)(ii)** and divide it by ten to obtain T_1 and give their answer to not more than 3 significant figures. Some responses often used a different value of t or calculated $10/t$ instead of $t/10$.

(c) Candidates were asked to replace the two-spring system by just one spring and then measure the new values of t and T (i.e. t_2 and T_2). Good responses listed repeat measurements which were averaged to get t_2 and the T_2=t_2/10. The value of t_2 and T_2 should have been less than t_1 and T_1.

(d) Candidates were asked to calculate the ratio of T_2/T_1. Good responses obtained values in the range 0.67 to 0.75, expressed as a decimal number and not as a fraction, and there should have been no unit to the ratio.

Question 2

Candidates were provided with a circuit with an LDR attached to the outside of the back of a beaker of water, resistor and a voltmeter placed parallel to the resistor. A light source was placed in front of the beaker of water.

(a) Candidates were asked to switch on the circuit and record the voltmeter reading, V_1. Values in the range 3.0 V to 4.5 V should have been recorded and given to at least 1 decimal place and the unit given.

(b) Candidates were asked to add a measured amount of blue liquid to the beaker and after mixing, record the new voltmeter reading, V_2, and then to do this again to get a third voltage, V_3. Each addition of blue liquid should have reduced the measured voltage and each voltage should have been written to the same precision and the correct unit (V or Volts) given each time.

(c) (i) Candidates were asked to plot a graph of the voltmeter reading against the volume of blue liquid added. A line graph was required and a smooth line attempted, utilising the three points plotted. Most candidates obtained a very shallow decreasing curve or straight line.

(ii) Many candidates correctly described the trend of their results, the voltage decreased as the volume of blue liquid added increased, whilst the best responses described the trend in terms of the concentration of the blue dye. There were insufficient results to show whether the relationship was of inverse proportionality but this comment was awarded the mark, but the term ‘indirectly proportional’ was not.

Question 3

A ramp was set up with a metre rule clamped vertically behind it.

(a) Candidates were asked to explain how they checked that the rule was vertical. Good responses described checking that the rule was parallel to an accepted vertical reference line e.g. a door or window frame or by placing a set square against the bench and the rule (in two directions) . Using the clamp stand as a reference was not awarded the mark as in many school laboratories they are rarely vertical. A good labelled diagram could achieve the mark.

(b) A table tennis ball was dropped from a height, h, of 30 cm onto the ramp at a marked point, P, and the horizontal distance travelled by the ball was measured. A value in the range 15 cm to 35 cm should have been obtained and given to the nearest mm.

https://xtremepape.rs/
© 2017

(ii) Candidates were asked to add to a diagram to show the ball at its initial position (its point of release) and to mark the height, *h*, on the diagram, There were very few correct diagrams, many were too vague and did not mark corresponding points with sufficient accuracy for the mark to be awarded. The best responses showed a circle (representing the ball at the point of release) vertically above the printed circle representing the ball and a horizontal line at the base of each circle (or the top, or the centre of gravity if it was indicated) with a vertical line between the two horizontal lines labelled '*h'*.

(iii) Candidates were asked how they removed the ball from the tray without disturbing the sand. The best responses stated that the ball would be lifted vertically and carefully. Good responses stated the ball was lifted upwards. Some responses were too vague or incorrectly described pushing the ball into the sand to make the indentation more pronounced.

(iv) Candidates were asked to take measurements to determine an average value for *x*, the distance travelled by the ball. At least two values, preferably three, should have been recorded and averaged correctly and given to 2 or 3 significant figures with an appropriate unit (m, cm, mm).

Question 4

(a) Candidates were asked to measure the length, x_0, of a cylinder of modelling clay. The measurement should have been in the range 15.0 to 25.0 cm and given to the nearest mm and the unit given.

(b) Candidates were asked to set up a system of two springs in series with the modelling clay hanging from the lower end and fully submerged inside a measuring cylinder of water but not making contact with the sides of the vessel.

(c) Candidates were asked to explain how they checked that the cylinder of modelling clay was not touching the sides of the measuring cylinder. There were very few adequate explanations. Good responses described looking down from vertically above the central axis of the clay cylinder and ensuring there was liquid all the way around the clay. An alternative method was to displace the clay vertically (push it down a little or pull it up a little) and ensure that it oscillated smoothly within the measuring cylinder and did not rub against the sides as it moved.

(d) Candidates were asked to measure the length of the spring system, *s*, which should have been in the range 6.0 cm to 10.0 cm and given to the nearest mm and with the unit.

(e) Candidates were asked to lift the boss so that the top of the clay cylinder was about 2 cm above the surface of the water and then measure the new value for *s*, (which should have been larger than the original value) and the length of the clay cylinder that remained submerged, *x*. the value for *x* should have been about 2 cm smaller that the original length of the clay cylinder. These two lengths should both have been measured to the nearest mm and the unit given.

(f) Candidates were asked to use the grid provided to construct a table of results with headings and with units and to put in their first two sets of results and then to obtain further sets of data. Good responses provided at least 5 complete sets of data with *x* values ranging from 1–4 cm to the full length of the cylinder and a smooth linear increase in *s* as *x* decreased linearly.

(g) Candidates were asked to plot a graph of *s*/cm(*y*-axis) against *x*/cm(*x*-axis) and to draw the line of best fit. A line graph was required and good graphs had plots occupying half the page or more, using scales based on 2, 4, 5 or 10 (and making use of the grid's bold lines for 'key' numbers). Good graphs were plotted neatly, in pencil, with fine plots (points or crosses) accurate to within 0.5 small squares of the correct position and a fine neat line of best fit. A line drawn from first plot to last was very rarely the line of best fit and would not normally be awarded the mark. Dot-to-dot lines would not qualify for the line mark.

(h) Candidates were required to find the gradient of their line and to give the answer to an appropriate precision. Calculation by the triangle gradient method was required. The best responses drew a large gradient triangle to their line (or tangent to their line if they had drawn a curve as the best fit in part **(g)**. The same triangle was then used to obtain two pairs of coordinates from the line, calculate the gradient and give the answer to 2 or 3 significant figures. In some weaker responses large triangles were drawn but coordinates taken from a smaller triangle, or points off the line (but in the table) used and therefore marks could not be awarded because the method was incorrect.

https://xtremepape.rs/
© 2017

PHYSICS

Paper 5054/32
Practical Test

Key messages

This was an examination of practical skills, using equipment to obtain a set of raw data and to process the raw data to produce a set of results. Responses to questions did not require repetition of theories. Good responses required good practical skills particularly in following instructions, making observations, making measurements (with repeats and averages where appropriate), recording and processing them according to the instructions given. Weaker responses often recited parts of the question wording or parts of work candidates had revised and this was not often a relevant response. Good answers show all repeated measurements (even if they are the same), all working for calculations, state correct units for all quantities and give answers correctly rounded to an appropriate precision (usually 2 or 3 significant figures). Measurements from an instrument (e.g. ammeter or voltmeter) should be recorded to the precision of the instrument. In some questions a unit may be specified and it should be ensured that quantities are converted to these units so that the final answer is given in the correct unit. Candidates were also asked to make straightforward predictions or comparisons, bearing in mind the concept of limits of experimental error.

General comments

Good answers demonstrated that candidates were able to:
read the question and perform the tasks as requested; take measurements to an appropriate degree of precision, with repeat measurements wherever appropriate and practicable; process those results, e.g. take averages of repeat measurements, perform calculations by substitution into equations, construct tables of results (often a grid is provided where tables are required) and use their data to plot graphs (i.e. line graphs) and then draw conclusions; make comments/predictions or perform further calculations based on those results according to the guidance given by the instructions given in each part; give answers with units and to appropriate precision usually 2 or 3 sig figs, depending on the quantity measured.

In some questions candidates were asked to describe how they used, checked or set up a particular piece of equipment. Good responses were characterised by a concise description giving the specific information in just one or two sentences describing the method used and what result would be expected to demonstrate the check showed the apparatus was correctly set up. In some cases a good labelled diagram could show all the required information.

It is in the interests of the candidates that supervisors provide a complete set of results for each set of apparatus used by candidates, especially for electrical circuits and optics questions.

Comments on specific questions

Question 1

Candidates were provided with a mass attached to a set of two springs in parallel and a rod to act as a fiducial marker.

(a) (i) Candidates were asked to determine an accurate time, t_1, for 10 oscillations. At least two times, preferably three or four, for a set of ten oscillations (the total time for ten oscillations without stopping or re-setting the stopwatch) should have been measured and written down with the unit. The average value should then have been calculated and working shown and the final answer given with the unit s or seconds (not minutes). This time should have been in the range 6.0–10.0 s if the prescribed apparatus had been used.

https://xtremepape.rs/

© 2017

Some responses often calculated ten single oscillations which led to inaccurate results. Times should have been given as single decimal numbers with single decimal points and not with colons and not as representations of stopwatch displays with superscripts.

(ii) The time t_1 calculated in **1(a)(i)** was then to be used and divided by 10 to calculate the time, T_1, for one oscillation. Weaker responses either produced a different set of times or erroneously divided 10 by the time. Final answers should have been given with the unit (s or seconds) and to 2 or 3 significant figures.

(b) New times, t_2 and T_2 were to be obtained by the same method, but using just one of the springs. Units and a precision of 2 or 3 sig fig were shown by good responses. The values of t and T obtained should have been larger than the respective values obtained in part **(a)**.

(c) The ratio, R, of T_2/T_1 was calculated and good responses wrote their final answer as a decimal number (and not left as a fraction) in the range 1.34 to 1.48 and as this was a ratio of two times there was no unit for R.

(d) Candidates were given a formula to use with their value of R to calculate the percentage difference between R and the theoretical value of R (1.41) and then to explain whether their results agreed with the theory. Weaker candidates were distracted when a negative value for the percentage was obtained because their R was smaller than the theoretical value. Agreement with the theory was accepted if the percentage difference was small ($\pm$5%) or disagreement if the percentage difference was greater than $\pm$10%.For values between 5% and 10% either argument was acceptable with an adequate comment. There were few good responses which showed a good understanding of the concept of limits of experimental error.

Question 2

Candidates were provided with a circuit with a component X and a resistor in series with a power supply and a voltmeter parallel to the resistor. Voltmeter readings were taken at two different temperatures.

(a) (i) The voltmeter reading, was taken when the X was in water at room temperature and a value in the range 3.0 to 4.5 Volts should have been recorded to a precision of 0.1 V or better.

(ii) The voltmeter reading was taken when the X was in a water/ice mixture and a value lower than the first voltage should have been recorded to a precision of 0.1 V or better.

(b) Candidates were given a formula to use in order to calculate the resistance of component X at the two temperatures and they were given the unit of kΩ for their answers. The resistance for X in the cooler liquid should have been 1.5 to 4 times larger than the value at room temperature. There were many good responses. A few responses showed calculations incorrect by 1000, indicating that the candidates had not noticed the symbol for the unit or had misunderstood the meaning of the symbol.

(c) Good responses indicated that as the temperature of the component X increased its resistance increased, or as the temperature of X decreased the resistance decreased.

Question 3

(a) Candidates investigated the distance travelled by a glass sphere as it rolled down a ramp and dropped onto a sand tray.

(b) The sphere when was released from a distance, y, of 10 cm up the ramp.

(b) (i) Candidates were asked to measure the horizontal distance, x, from the end of the tray to the centre of the indentation made by the sphere when it landed in the tray. There were some comments from supervisor reports that there was no indication of which end of the sand tray the measurement should have been taken, but candidates had been told at the beginning of the question that they were investigating the distance travelled by the sphere and so the measurement should have been made from the end of the tray that was nearest to the ramp to the indentation as the sphere had travelled over that part of the tray.

https://xtremepape.rs/
© 2017

Good responses listed a value for *x* to the nearest mm and with a unit (mm, cm or m).

(ii) Good responses explained that the sphere had to be lifted vertically or in an upwards direction only and indicated that there was no contact with the sand. Some weaker responses did not gain the mark because they described pressing the sphere into the sand in order to make the indentation more visible, but candidates were specifically asked how they removed the ball without disturbing the sand.

(iii) Candidates were then asked to take measurements to determine an average value for *x*. Good responses listed at least two (preferably 3 or 4) measurements which were correctly averaged, with the working shown and their final answer given to the nearest mm with the unit.

(c) (i) Candidates were asked to predict a new value for *x* if *x* and *y* were directly proportional and *y* was increased by a factor of 5 (so that $y = 50$ cm). Good responses gave a new value for *x* obtained by multiplying their value of *x* obtained in **(b)(iii)** by 5. Many weaker responses multiplied by 10 or 2. There were few good responses.

(ii) Candidates were asked to repeat the experiment using the new *y* value of 50 cm. Good responses obtained a value larger than their previous values but not as large as the correct prediction.

(iii) Good responses indicated that the results had been compared and a valid conclusion drawn, for example, that whilst *x* increased as *y* increased, the two were not directly proportional because a 5 fold increase in *y* produced a much smaller increase in *x* and the difference was outside the limits of experimental error. There were very few good responses.

Question 4

Candidates were asked to investigate the equilibrium of a metre rule held by a rotatable clamp and a system of two springs in parallel.

(a) (i) Good responses explained how the height of the metre rule above the bench was measured and found to be the same in at least two places, preferably measuring at each end of the rule. A complete annotated diagram indicating equal heights for at least two well separated points was also awarded the mark. The mark was also awarded if candidates explained that they compared the top or lower edge of the rule with a known horizontal reference in the room e.g. a window sill or top of a door frame.

(ii) Good responses explained that the rule could rotate freely if it was displaced from its resting place either upwards or downwards and released and each time it returned to the same original resting place. There were very few good responses.

(iii) the length of the spring was measured and written as the value of *L*. Good responses were in the range 4.0 to 8.0 cm measured to the nearest mm and with a unit (mm, cm, m).

(b) The new length of the spring was measured after a total mass, *M*, of 20 g was added. The new value for *L* should have been larger than the value measured in **4(a)(iii)**.

(c) A grid was provided for a table to be constructed with the headings *L* / cm, *M* / g and the first two sets of results listed should have been the values for *L* and the corresponding masses (for **4(a)(iii)** the value of *M* was 0 g as no mass was attached). Candidates were asked to produce further sets of readings and write them in the table. Good responses used masses increasing evenly by 10–20 g to a maximum of 90–100 g with *L* values to the nearest mm increasing linearly as *M* was increased linearly.

(d) Candidates were asked to plot a graph of *L* / cm(x-axis) against *M* / g(y-axis) on the grid and to draw the straight line of best fit. A line graph was required and good graphs had plots occupying half the page or more, using scales based on 2, 4, 5 or 10 (and making use of the grid's bold lines for 'key' numbers). There were a number of weaker responses using very awkward scales e.g.11.5 to 5 mm which seemed to have been chosen in order to use the largest possible area of the grid but they were impractical to use. A few weak candidates placed the origin in the lower right corner of the grid and put the scale increasing towards the left. Candidates should note that the convention is to place the origin in the lower left (if it is included) and scale markings for increasing upwards and to the right. Good graphs were plotted neatly, in pencil, with fine plots (points or crosses) accurate to within 0.5 small squares of the correct position and a fine neat line of best fit. A line drawn from first plot to last was very rarely the line of best fit and would not normally be awarded the mark. Dot-to-dot lines would not qualify for the line mark.

(e) Candidates were required to find the gradient of their line and to give the answer to an appropriate precision. Calculation by the triangle gradient method was required. The best responses drew a large gradient triangle to their line (or tangent to their line if they had drawn a curve as the best fit in part **4(d)**). The same triangle was then used to obtain two pairs of coordinates from the line, calculate the gradient and give the answer to 2 or 3 significant figures. In some weaker responses large triangles were drawn but coordinates were taken from a smaller triangle, or points off the line (but in the table) were used and therefore marks could not be awarded because the method was incorrect.

https://xtremepape.rs/
© 2017

PHYSICS

Paper 5054/41
Alternative to Practical

General comments

The aim of the examination is to enable candidates to display their knowledge and understanding of practical physics techniques. These include:

- graph plotting
- tabulation of readings
- manipulation of data to obtain results
- drawing conclusions
- dealing with possible sources of error
- control of variables.

The level of competence shown by the candidates was sound, although, as in previous years, some candidates continue to approach this paper, as they would a theory paper, and not from a practical perspective. Candidates need to think about what they would do in a practical situation rather than try to answer the question from the point of view of a theory paper. Some candidates appear to come to the examination without pencils, rulers and protractors and so could not take accurate measurements. 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. The better candidates were able to follow instructions, record observations clearly and perform calculations accurately and correctly although a few were unable to give an answer to the correct number of significant figures. Units were generally well known and usually included where needed.

https://xtremepape.rs/
© 2017

Question 1

(a) Most candidates could identify that the ball would be likely to move around and that this would make measurement difficult. Others noticed correctly that the top pan balance only measured to the nearest gram and so the exact mass of the ball would be an approximation.

(b) **T**his was answered well and many candidates knew the best way of finding the mass of the balls using the beaker. Some candidates were adding water to the beaker which usually ensured zero marks for the question. Others simply took the mass of 10 balls (in the beaker) and divided by ten thus including a tenth of the beaker mass in their measurement. The idea of zeroing the balance (using the tare facility) was rarely mentioned and it would seem that candidates are not familiar with using the balance in this way.

Question 2

(a) Similar questions have been included in recent papers but many candidates still do not realise that they must ensure the bottom of the ball is level with the start reading on the metre rule.

(b) This is a practical experiment and the candidate would have needed to have his eye in the approximately correct position before dropping the ball in order to be able to get an accurate reading of a fast moving event. The trial run was intended for them to get a rough idea of the bounce height before carrying out the experiment. Very few candidates realised this – they should try to put themselves in the position of carrying out the practical procedure.

(c) (i) The bounce would be fast moving and it would be very difficult to get an accuracy of more than the nearest centimetre in the reading. Few candidates gained credit.

(c) (ii) This was answered well. Most candidates calculated the correct average and gave the answer to two significant figures.

(d) (ii) Candidates were now asked to consider how they could extend the experiment to heights of up to 3 metres. The question was poorly answered by the majority. The first thing needed was a change in the measuring instrument – the most common incorrect response was to use a longer metre rule. Very few seemed to realise the incongruity of this – a metre rule is one metre long and cannot be longer. A few correctly suggested using a tape measure or joining several metre rules together to take the measurement. The second problem was that the height of 3 metres meant the candidate would need to climb high to drop the ball but be down much lower a few seconds later to take the measurement. Very few candidates gave this any consideration and only the more able suggested the use of another student to help in the procedure. Candidates need to consider the practicalities of doing an experiment.

(d) (iii) The graphs were drawn well by most candidates and the majority secured at least three marks out of four. The scales were mostly sensible and labelled, the points were plotted correctly. The drawing of the curve was less well done – the question did say 'curve' so a straight line was unlikely to be acceptable. One point was clearly not on the line of best fit but many candidates tried to include it on their curve and lost this mark.

(e) (i) This was not well answered. The fact that the bounce height would be very low making it difficult for a student to get his eye down to that level was not noted very often.

(e) (ii) This was answered well with most students taking a correct measurement from their graph.

https://xtremepape.rs/
© 2017

Question 3

(a) Less than a third of candidates knew the correct symbol for a thermistor.

(b) (i) The majority of candidates took the reading from the voltmeter correctly. A small number then lost the mark by not including the unit in their answer.

(b) (ii) The candidate was asked how they could take a reading at 0 °C. Surprisingly, very few knew the correct answer of using a beaker of melting ice. Many suggested turning the air conditioning down – it is doubtful if air conditioning systems go as low as freezing point. Other responses were similarly impractical. Using melting ice to achieve 0 °C should be well understood but clearly was not.

(b) (iii) This question required substitution into an equation and it was done well by the more able half of the cohort. Others calculated a correct answer but could not give their values correct to 2sf, frequently losing both marks as they had not recorded the intermediate values before rounding. It is always a good idea to record the full answer before rounding to 2sf as required.

(b)(iv) The majority of candidates could give the correct trend for their results.

Question 4

(a) This was mostly answered correctly with the majority of candidates knowing which length was the focal length.

(b) (i) The candidates were simply asked to follow an instruction here and it was done well by almost all.

(b) (ii) Rather fewer candidates could explain how they ensured that their line was parallel to ST. Some correctly explained the use of a set square and ruler but marks were not given for just stating these items – an explanation of their use was required. The other way to get the mark involved measuring the distance of their line from ST at more than one point and stating that they were equal.

(**c)** Again, they simply had to follow the instruction and most did this well although some lost the mark for not labelling the point R as requested.

(d) The candidates were required to measure the angle on their diagram and this was an accuracy mark. It was clear that some candidates did not have a protractor and were guessing the answer.

(e) The candidates were required to substitute their value into a given equation and the majority of candidates could do this without difficulty.

(f) The final part required them to measure a length and compare it to their result in **(e)**. Some candidates changed their angle in **(e)** to get the same answer, losing marks. Some candidates lost the mark for not recording the length of CF from their diagrams. Others did not make a comparison or did not answer with a yes/no. We accept that mistakes are made and all the candidates were expected to say was ‘yes the results support my value because they are close/within 10%/within experimental error’ or ‘no, they do not support my value because the values are too far apart/more than 10% apart/not within experimental error’. Very few candidates understood to respond in this way.

https://xtremepape.rs/
© 2017

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, say, exactly 5 cm, the value should be quoted as 5.0 cm.

Candidates often lose credit for lack of care and 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 rote 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.

Candidates should be reminded that, when plotting a graph using data obtained from practical work, there will almost always be some scatter about the line of best fit. Forcing the line through all points will often produce a curve that is not smooth, and candidates should be discouraged from doing this.

General comments

The level of competence shown by the candidates was sound, although, as in previous years, some candidates continue to 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.

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 **Questions 1(e) 2(b)(iii) 2(c)(ii)** and **4(c)** produced only small numbers of correct responses.

Comments on specific questions

Question 1

(a) (i) The distance *D* on the diagram was usually measured correctly to the nearest millimetre.

(ii) Most candidates used the scaling factor given, to deduce the actual height *H* of the point of support of the pendulum above the bench correctly. A sizeable minority of candidates divided their answer in **(a)(i)** by 10 instead of multiplying it by 10.

(b) (i) The period of the pendulum *T* and the value of T^2 were usually calculated correctly. The value of T^2 was often rounded incorrectly and was subsequently penalised.

https://xtremepape.rs/
© 2017

(ii) Answers to this part were disappointing, as similar questions about the timing of oscillations have been set before. Many candidates merely repeated what was given in the stem of the question and stated that the reason for timing 20 oscillations rather than 1 oscillation was that the result would be more accurate. What candidates need to realise here is that any reaction time errors in starting or stopping the stopwatch will have less effect on the larger time and as a consequence, the percentage error in the timing is reduced.

(c) (i) The graph question was done well, with most candidates scoring 3 or 4 marks. The axes were usually labelled and sensible scales were chosen. There was less 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. Most candidates plotted the points accurately and drew a best-fit straight line, 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.

(ii) Most candidates followed the instruction given and produced a correct extrapolation of their line and read off the value of the *y*-intercept correctly.

(iii) When determining the gradient of a straight-line graph, candidates are expected to draw a large gradient triangle, which covers more than half the plotted line. Despite the instruction in the rubric for candidates to show clearly on the graph how they determined the gradient, in many cases there was no evidence given, and consequently credit was lost.

(d) Most candidates substituted their values for the gradient of their graph and the *y*-axis intercept into the given equation to calculate a correct value for *H*.

(e) Candidates found this more demanding final part to the question difficult and only a small number of correct responses were seen. Most did not realise that the two values of *H* that they had calculated, did agree with each other and that the small difference between them could be attributed to experimental error.

Question 2

(a) (i) The majority of candidates read the thermometer correctly and recorded the temperature value in the appropriate space. Where occasional mistakes were made, the common incorrect answers were 80.8 °C and 92 °C.

(ii) Most candidates could not give a convincing reason as to why the student waited a short time before recording the temperature of the water at the start of the experiment. Most seemed unaware that it took time for the reading to stop rising when the thermometer is placed in the hot water, so that the maximum temperature reached could be recorded immediately.

(b) (i),**(ii)** The column headings were usually completed correctly. Where errors did occur, it was usually because the unit of time given was minutes instead of seconds.

(iii) Only a handful of candidates were able to make a sensible comment about the effect of insulation on the cooling of the water in the beaker. Because the final temperatures of the water in the uninsulated beaker and the insulated beaker were both the same, most candidates concluded that the insulation made no difference to the rate of cooling. What these candidates neglected to take into account was that the water in the insulated beaker had started cooling from a lower temperature and so the temperature <u>change</u> of the water in the insulated beaker <u>in the same time</u> was less.

(c) (i) The majority of candidates realised that putting a lid on the beaker would reduce the loss of thermal energy from the beaker by evaporation.

(ii) Only the more able candidates were able to suggest a modification to the apparatus that would further reduce the loss of heat. Few candidates suggested the obvious modifications – lagging the bottom of the beaker or increasing the thickness of the existing lagging.

(d) Approximately half the candidates were able to suggest a sensible quantity that should be kept constant when comparing the rates of cooling of the two beakers.

https://xtremepape.rs/
© 2017

Question 3

(a) (i) The majority of candidates followed the instructions given, and drew a normal at the correct point and also labelled the point where the extended normal crossed the line CD.

(ii) The angle of incidence was measured correctly by just over half the candidature. The remainder of candidates measured the angle that the incident ray made with the top face of the glass block and not with the normal. The degree symbol for the unit of the angle was also frequently missing.

(b) (i),**(ii)** Candidates who followed the instructions and drew the required lines correctly, nearly always had values for the lengths *x* and *y* which were within an acceptable tolerance.

(c) The value for the refractive index of the glass was usually calculated correctly, although some answers were spoiled by the inclusion of a unit.

Question 4

(a) The circuit diagram needed to show how to determine the resistance of a wire using the given components was usually drawn correctly, if untidily. Credit was often lost because it was impossible to decide if candidates had included the metal wire in the circuit. Better candidates labelled the wire so that it could be distinguished from the connecting leads used to build the circuit. Occasionally candidates confused the correct positions of the ammeter and voltmeter.

(b) Approximately half of the candidates obtained full marks for explaining how they would carry out the investigation. The determination of the resistance was well known, but many candidates did not continue and explain that they would repeat the experiment with different lengths of the wire so that the variation of resistance with length could be investigated.

(c) Few candidates were able to explain how the results that had been taken in part **(b)** could be used to reach a conclusion. All that was required was that the resistance values obtained as the length changed be compared and a conclusion drawn. More able candidates suggested correctly that a graph of resistance against length could be plotted.

https://xtremepape.rs/
© 2017