



GCSE EXAMINERS' REPORTS

**PHYSICS
GCSE
SUMMER 2023**

Introduction

Our Principal Examiners' reports offer valuable feedback on the recent assessment series. They are written by our Principal Examiners and Principal Moderators after the completion of marking and moderation, and detail how candidates have performed.

This report offers an overall summary of candidates' performance, including the assessment objectives/skills/topics/themes being tested, and highlights the characteristics of successful performance and where performance could be improved. It goes on to look in detail at each question/section of each unit, pinpointing aspects that proved challenging to some candidates and suggesting some reasons as to why that might be.ⁱ

The information found in this report can provide invaluable insight for practitioners to support their teaching and learning activity. We would also encourage practitioners to share this document – in its entirety or in part – with their learners to help with exam preparation, to understand how to avoid pitfalls and to add to their revision toolbox.

Further support

| Document | Description | Link |
|-----------------------------|--|---|
| Professional Learning / CPD | WJEC offers an extensive annual programme of online and face-to-face Professional Learning events. Access interactive feedback, review example candidate responses, gain practical ideas for the classroom and put questions to our dedicated team by registering for one of our events here. | https://www.wjec.co.uk/home/professional-learning/ |
| Past papers | Access the bank of past papers for this qualification, including the most recent assessments. Please note that we do not make past papers available on the public website until 6 months after the examination. | www.wjecservices.co.uk or on the WJEC subject page |
| Grade boundary information | <p>Grade boundaries are the minimum number of marks needed to achieve each grade.</p> <p>For unitised specifications grade boundaries are expressed on a Uniform Mark Scale (UMS). UMS grade boundaries remain the same every year as the range of UMS mark percentages allocated to a particular grade does not change. UMS grade boundaries are published at overall subject and unit level.</p> <p>For linear specifications, a single grade is awarded for the overall subject, rather than for each unit that contributes towards the overall grade. Grade boundaries are published on results day.</p> | For unitised specifications click here: Results, Grade Boundaries and PRS (wjec.co.uk) |

| | | |
|---|--|---|
| Exam Results Analysis | WJEC provides information to examination centres via the WJEC secure website. This is restricted to centre staff only. Access is granted to centre staff by the Examinations Officer at the centre. | www.wjecservices.co.uk |
| Classroom Resources | Access our extensive range of FREE classroom resources, including blended learning materials, exam walk-throughs and knowledge organisers to support teaching and learning. | https://resources.wjec.co.uk/ |
| Bank of Professional Learning materials | Access our bank of Professional Learning materials from previous events from our secure website and additional pre-recorded materials available in the public domain. | www.wjecservices.co.uk or on the WJEC subject page. |
| Become an examiner with WJEC. | We are always looking to recruit new examiners or moderators. These opportunities can provide you with invaluable insight into the assessment process, enhance your skill set, increase your understanding of your subject and inform your teaching. | Become an Examiner WJEC |

| | Page |
|---|-------------|
| Executive summary | 4 |
| Unit 1: Electricity, energy and waves – Foundation tier | 5 |
| Unit 1: Electricity, energy and waves – Higher tier | 9 |
| Unit 2: Forces, space and radioactivity – Foundation tier | 13 |
| Unit 2: Forces, space and radioactivity – Higher tier | 16 |
| Unit 3: Practical assessment | 20 |
| Supporting you – useful contacts and links | 23 |

Subject Officer's Executive Summary

Advance information was provided for all theory units. The sub-topic areas were listed in rank order, it was mentioned that for some units this had aided revision.

A number of comments were made about candidates being entered for the incorrect tier.

Recall of knowledge was a problem for many – this has been an issue for a number of years. Certain topics every year candidates have issues with and the same pattern was seen this summer namely with heat transfer and domestic electricity devices.

Handwriting was noted as being an issue on a number of occasions. Answers requiring qualitative responses, candidates struggled with. Many examples of candidates not reading the question carefully, this was shown in contradictory answers. Lack of understanding of command words was often seen.

Performance on the QER is variable, it very much depends on the question type. However some recall QERs were answered very well compared to other recall QERs. Little evidence of candidates planning their answers to QERs.

Single stage calculations were managed much better than multi-stage calculations, converting units was noted as a problem. Rearranging equations is a weak area and ecf then becomes crucial for these candidates.

Unfamiliar practical contexts candidates struggle with far more than familiar contexts. In the practical assessment unit it was apparent that instructions in the method were sometimes not read. Identifying the resolution was problematic for a number of candidates. Candidates have a good understanding of practical terms e.g. reproducibility etc. Plans were variable with lack of clarity being an issue sometimes.

| Areas for improvement | Classroom resources | Brief description of resource |
|-----------------------------|--|---|
| Qualitative responses | <u>TEXT TOOLS</u> | A bank of tools that allow teachers to use their own piece of text to generate a range of activities. |
| Heat transfer | <u>HEAT TRANSFER</u> <u>HEAT TRANSFER</u> | Knowledge organiser Blended learning |
| Domestic electricity | <u>DOMESTIC ELECTRICITY</u> <u>DOMESTIC ELECTRICITY</u> | Knowledge organiser Blended learning |
| Refraction of wave diagrams | <u>FEATURES OF WAVES</u> <u>FEATURES OF WAVES</u> | Knowledge organiser Blended learning |

PHYSICS

GCSE

Summer 2023

Unit 1: Electricity, energy and waves – Foundation tier

Overview of the Unit

This paper was based on the unit 1 content, and included questions set in a practical context. Questions allowed candidates to demonstrate their knowledge, application of knowledge, and evaluation, and included graph plotting and analysis of graphical data. This paper also tested candidates' ability to substitute correctly into equations and calculate answers. The quality of extended response was tested in a question on the topic of domestic electricity, exploring safety features.

Most question parts had a good attempt rate, apart from the QER where frequent blanks were seen. Candidates' knowledge was extremely poor in this question and responses were often both badly written and contained many errors. Graph plotting was usually sound. Handwriting showed a slight improvement from last year although a substantial number of illegible responses were still evident.

Comments on individual questions/sections

Q.1 This question explored series and parallel circuits.

Part (a) required candidates to match circuit symbols and components and many correct responses were seen.

Part (b)(i) introduced a series circuit. Many candidates were unable to identify this as a series circuit and they did not always realise that current would be the same throughout.

The calculations in the next part were straightforward and most candidates were able to calculate the current and resistance correctly. Many were able to select the correct unit for resistance, with J being the most common incorrect response.

In part (c) candidates were shown a parallel circuit and told that the lamps were brighter. They were required to link this to a decreased resistance and hence an increased current. This was often poorly done with increased resistance being a very common incorrect response.

Q.2 There were many high scores on the question about seismic waves. In part (a) many candidates successfully identified the core as being liquid and most could identify one or two correct statements about P and S waves.

In (b)(i) candidates were given an equation and were required to substitute the numbers given. This question part had a high success rate. Where candidates did make errors, it was often a careless slip on the number of zeros recorded on the answer line. In the last part many candidates were able to identify the location of the epicentre.

Q.3 This question tested candidates' recall of total internal reflection. Part (a) required candidates to identify the critical angle and the process of total internal reflection by selecting the correct diagrams. This was not successfully answered by many candidates, and it was not common to award both marks. Similarly, in (b), selecting the correct condition required for total internal reflection was often not correct.

Part (c) was the first free response required of candidates. Few candidates could recall a use for total internal reflection with mirrors being a very common incorrect answer.

Q.4 (a) This question tested knowledge of Fleming's left-hand rule with a simple matching exercise requiring candidates to select words from the box to complete the diagram. Most candidates were able to attain one mark here for having one label correct.

In (b) many candidates were able to suggest at least one way the motor could be made to spin faster although few gained both marks here. A very common incorrect response was simply to make the force bigger.

Q.5 This question investigated the cost of electricity. In the first part a simple calculation was needed that required candidates to select information from a diagram of a smart meter to determine a mean power. This was almost always done correctly.

In (a)(ii) I candidates needed to convert £0.75 into pence and it was designed to help them in the next question part. Although many correct responses were seen it was not uncommon for candidates to simply give the value as 0.75 p without any conversion. In II full marks was often awarded with error carried forward and lots of candidates obtained both marks which was pleasing to see as some of the numerical information required here was much earlier in the question. One common error was to use the unit value in pounds and not pence.

In part (b) the best answers addressed issues surrounding CO₂ emissions, but these were not common. The most common correct response was that reducing electricity use has a positive impact on the environment. Some candidates did not read the clear and emboldened instruction to give a reason other than saving money and gave answers along those lines.

The QER question required candidates to demonstrate their recall of the function of earth wires, fuses, and residual current circuit breakers. It was most common to see bottom band responses in which candidates had very poor understanding of what these safety features do and the faults that cause them to work with much scientific inaccuracy evident. The role of the earth wire in preventing electrocution was known best. Much of the writing was lacking in punctuation and littered with spelling mistakes.

Q.6 This question explored heat transfer, an area which has previously been identified as one that candidates often do poorly on. This question proved no exception.

In (a)(i) and (ii) candidates were required to examine data from two experiments to identify which surface was the best absorber and which the best emitter. Many confused and poorly explained responses were seen. It was rare to award more than two marks out of the four available. Many candidates could not identify which experiment investigated the emission and which investigated the absorption of infra-red radiation. Many incorrect responses selected silver as the best emitter or absorber and could gain no further credit in that part.

Marks were most frequently awarded where candidates identified that the black surface was hotter, and this was given even if the incorrect experiment was identified as the data had been used.

Part (b) was very poorly answered with only a small percentage of candidates attaining a mark. It was rare for candidates to refer to silver being poor emitters of infra-red. A small number were credited for sensible responses in terms of infra-red radiation being reflected back into the house.

In (c)(i) the payback calculation was done correctly by most candidates.

The last part required candidates to evaluate a claim using the data presented. There were lots of good responses to this question where candidates either compared payback times or they discussed the cost and relative savings for the two methods.

Q.7 This question was set in an unfamiliar practical context, investigating the link between pressure and temperature for a gas. In part (a) candidates had to read the information given to determine what the independent variable was. This was done poorly, despite the presented results table just underneath the question. Incorrect responses included volume of air and the metal bulb.

Graph plotting in (b)(i) was usually sound, despite the small grid and a scale which was not straightforward. In (ii) describing the relationship between temperature and pressure shown by the graph was usually done reasonably well, with most candidates gaining the first mark. Identifying that that the increase in pressure was at a constant rate was missed by many but a pleasing number of candidates did attain two marks.

Part (iii) required candidates to use the data given to determine the pressure of the gas at -10°C . In the most successful responses, candidates handled the data well attaining all the marks available.

Few candidates could recall the value of absolute zero in degrees in part (iv) and it was common to see 0 or 100 or $+273$.

The calculation in the last part was done well by many.

Q.8 This was the first of the two common questions.

In (a)(i) candidates were required to identify that the power station had the highest rank for all categories. Many good responses were seen although a common error was to ignore the efficiency or to state that the cost was low rather than the lowest, which is important in these comparison questions.

In (ii) candidates were asked to discern the type of power station from the information given. Foundation tier candidates found this challenging, and it was rare to award all marks here.

Part (b) was a relatively straightforward efficiency calculation. Candidates had to select which was the useful energy. Many candidates added the electrical and heat energy and then calculated an efficiency of 100% which is clearly incorrect. Similarly, some incorrect calculations led to values of more than 100%.

Q.9 Unsurprisingly this last question on the paper proved challenging for foundation tier candidates. In (a) despite the wave direction being given, many candidates were unable to complete the diagram to show the water waves in the shallow water. Many candidates did not attempt this question and amongst those that did the quality of the diagrams was poor. In the best responses candidates used a ruler to produce accurate diagrams, but in the weakest the wavelength was not consistently lower, and the waves were not shown as perpendicular.

In part (b)(i) it was rare to award both marks. A common error in the first part was to state that there were two waves present. Few candidates realised how to determine the wavelength from the information given.

The next part proved very challenging for foundation tier candidates with most agreeing that the waves would speed up. Many attained one mark for recognising that there were more waves in B but did not link this to a reduction in speed.

Most candidates attained a mark in part (c)(i) for recognising the pattern in the table. In part (ii) the most successful candidates were able to extract the correct information from the table, but a common error was to simply use the numbers from the question stem so substituted a depth rather than a wave speed or they selected the incorrect wave speed.

The last part was quite a challenging evaluation question, and it was pleasing to see some good foundation tier responses with candidates engaging with the data. Less successful attempts did not consider the one quarter factor referred to in the question.

PHYSICS

GCSE

Summer 2023

Unit 1: Electricity, energy and waves – Higher tier

Overview of the Unit

This paper was based on the unit 1 content. Many candidates seemed well-prepared for the paper, and it was pleasing to see most questions attempted.

Questions allowed candidates to:

- demonstrate and apply their knowledge and understanding of scientific ideas, processes, techniques and procedures;
- analyse, interpret and evaluate scientific information and evidence, including making judgements and reaching conclusions;
- demonstrate their proficiency in substituting numerical values into equations and solving them, rearranging equations, graph plotting and analysis of data in graphical, tabular and diagrammatical forms.

The quality of extended response was assessed in a question about heat transfer by conduction and convection. Three questions were set in a practical context. These were investigating the speed of water waves using a ripple tank, how temperature affects the resistance of a thermistor and how the number of turns on a secondary coil affects the output voltage of a transformer.

Questions based on application of knowledge tend to be better answered e.g. Q1 and Q4(a).

Recall questions tend to have lower mean marks than other types e.g. Q3, 5 and 8(a).

Candidates must read questions carefully and follow instructions e.g. Q1(a)(ii) and 2(c)(ii). Rearranging equations was one area of the paper that was sometimes weak and, in cases, candidates lost marks for failure to show their workings e.g. Q6(c) and 8(d).

Candidates also answer questions based on analysis and evaluation quite well but sometimes fail to state a conclusion or include data in their response e.g. Q6(b)(i).

Comments on individual questions/sections

Q.1 Very little recall was required for this question. As a result, performance was generally good.

In the first part To gain both marks candidates were required to interact with the information in the table and refer to the three features in precise terms. Most candidates achieved this. Some candidates lost a mark because they did not refer to efficiency, probably because the box was blacked out, however it was still ranked number 1. A small minority of candidates gave answers such as low running cost or low emissions which were not accepted since they were not precise enough. A conclusion was not required on this occasion to earn full marks.

In (a)(ii) most candidates earned 2 or 3 marks for matching the energy sources with the power stations. A common error seen in 0 and 1 mark answers, was the use of energy sources other than the ones given in bold in the question.

Most candidates calculated the correct answer in (b). Those that failed to earn a mark either used the heat energy value as the useful output or added the heat and electrical energy values together and arrived at an efficiency of 100%.

Q.2 This type of question has caused problems for candidates in the past so it was eased by giving the wave direction in shallow water. Candidates should know that wavefronts are drawn at right angles to the wave direction and join the wavefronts in deep water at the boundary. This was only achieved in the minority of instances.

Common errors were:

- continuing the wavefronts in the same direction as those in deep water
- wavefronts heading to the top right of the diagram
- wavefronts being reflected
- no joining of wavefronts at the boundary
- wavefronts not perpendicular to the wave direction
- a varying wavelength in shallow water.

In (b)(i) most candidates earned one mark because their answer for the number of waves was wrong, but the wavelength was correct after applying an ecf. Part (ii) was not answered very well. A common error was stating the frequency was greater in region B. A minority of candidates earned both marks which required a conclusion.

In (c)(ii) the majority of candidates completed the calculation correctly. However, some may have misread the question since they used the wave speed for a glass block of thickness other than 6 cm. About half of candidates earned full marks in the last part. They compared wave speeds at 8 and 6 cm and again at 6 with 4 cm. They found the difference in speed and showed whether the increase was a quarter. Other candidates compared 8 and 4 cm which is not a difference of 2 cm.

Q.3 This QER question depended on recall of conduction and convection which traditionally is not well answered. The standard of response varied in quality by a large margin covering the complete range of available marks. At the top end there were some coherent and well-structured responses demonstrating excellent knowledge and understanding of conduction and convection. However, these were in a small minority of cases. It was more common to see answers that partially covered conduction and / or convection. Frequently conduction was described without the contribution of free electrons, while convection was not described in terms of particles. In the lower band, candidates' answers were full of misconceptions combined with an element of correctness. Some candidates answered their own question. Common errors were:

- particles start to vibrate when heated;
- particles move about in metals;
- heated particles expand;
- hot particles become less dense.

Q.4 This question did not depend on recall of content and as a result candidates generally answered the various parts well except part (c).

In (a) and (b) most candidates handled the data well to solve three or four of the calculations correctly. About half scored full marks. Even if errors were made in parts (a) or (b)(i) then marks could still be gained in (b)(ii) and (iii) because ecf was allowed. The most common errors were leaving out one of the multiples in part (a) and failing to find the extra cost and using this value when calculating payback time in (b)(ii)II.

The wording of part (c) was deliberate to exclude any reference to manufacture, however responses to this effect were seen. It was surprising how few candidates mentioned that electric cars need to be charged up. The majority of answers stated that electric cars don't produce greenhouse gases because they don't use petrol. Candidates could argue in agreement or disagreement depending which energy source they stated was used for charging e.g. fossil fuel power plants or renewable energy sources. A conclusion was required for full marks.

Q.5 This question required recall of facts and as a result this depressed the mean mark.

A minority of candidates were able to fully describe the difference in (a) to earn both marks. Another group were almost successful but omitted to mention the term vibrations. The majority earned zero by describing the difference in terms of crests and troughs, ability to travel through solids or liquids, comparing by speed and by using terms such as side to side and back and fore.

A common error in (b)(i) was total internal refraction. In (ii) a small minority of answers included both conditions required for total internal reflection to occur. The fact that the angle of incidence needs to be larger than the critical angle was better known than the requirement of light travelling towards a less dense medium.

In (c) candidates were expected to state that S waves travel through solids but not liquids so the mantle must be solid and the core a liquid. This was achieved by a minority of candidates. Some candidates lost a mark by only referring to liquids. Other candidates stated S waves travel through liquids and not solids and reversed the states of the mantle and core.

Q.6 In (c) about half of instances, fully detailed explanations, earning all marks, were seen. Most other candidates earned at least one mark for mentioning the particles get closer together as volume decreases. This was clearly shown in the diagram anyway, but it was included as an aid to candidates when answering the question.

No recall was required to answer (b)(i) and mostly correct answers were seen. The main reason why candidates lost a mark was because they did not provide a concluding statement. The following answer was seen on a few occasions – 'This is only true if the temperatures are in Kelvin'. This earned both marks. Recall was required in (ii) and few correct answers were seen. Candidates stated that the value of absolute zero is -273°C but could not explain how a graph could be extrapolated to determine this value.

No recall was required for the calculation in (c) and just under half of candidates scored full marks. They handled the conversion and manipulation or ratio method very well. Some candidates failed to manipulate correctly but gained a mark for converting the temperature. The remainder failed in all aspects of the method.

Q.7 Both meters were correctly added to the diagram in (a) in over half of instances. Voltmeters are still being connected in series.

In (b) full marks was often awarded for plotting the data and drawing a smooth curve. Sometimes plotting errors and / or a failure to draw a smooth curve resulted in loss of mark(s).

In (c)(i) only a small percentage of candidates produced a correct calculation to earn full marks. Most candidates failed to recognise the thermistor is in series with the resistor and did not either find the total resistance or treat the circuit as a potential divider. In (ii) candidates did not refer to the thermistor resistance decreasing as the temperature increases and did not refer to a decrease in total circuit resistance.

About half of candidates calculated the resistance correctly in (d)(i). Errors made by the others include: mistakes in substitution, incorrect divisions, attempting a parallel resistance calculation and calculating the current and ending their answer at that stage. The last part was poorly responded to with most candidates failing to achieve a mark. Candidates did not recall that when components are added in parallel the resistance decreases.

Q.8 Parts (a) and (b) required recall and so were not answered very well. In (a) candidates described the set-up shown in the diagram and attempted to explain how transformers work. Very few addressed in full what the question asked.

In (b) few candidates made creditworthy statements. Most said something vague about a.c. voltages or described the difference between a.c. and d.c.

Part (c) also depended on recall but was much better answered than parts (a) and (b). Marks were lost for statements such as step-up transformers increase current or stop heat loss.

The last part could be answered without recall of any information. As a result, performance was much better. Full marks were gained in many cases. Where this was not the case errors with substitution or manipulation were made.

PHYSICS

GCSE

Summer 2023

Unit 2: Forces, space and radioactivity – Foundation tier

Overview of the Unit

The paper gave candidates the opportunity to demonstrate their skills and understanding of the subject in all three of the assessment objectives. There were many examples of candidates demonstrating good subject knowledge, coupled with sound mathematical skills which contrasted with much of the evidence of poor expression in responses that required a sentence or two to be written. Evidence of candidates' abilities in solving given equations was generally pleasing but there continues to be much evidence of not showing workings leading up to a given answer. One mistake made in this means that no credit can be given. The quality of writing in a significant number of cases was poor, causing examiners to spend some considerable time in deciphering the wording.

The advance information released this year allowed teachers and candidates to concentrate their revision on Newton's laws and work done principles down to the topic of half-life being least represented on the paper. Understanding of the latter topic is generally weak at this level and so it benefitted candidates that it should be the least represented in the paper.

Comments on individual questions/sections

Q.1 Part (a) of the question tested candidates' knowledge and / or understanding of the Newton's three laws of motion by placing ticks in boxes alongside three statements. The question was generally well answered.

Part (b) gave the first opportunity for candidates to show their mathematical skills, this time with the symbols used in the equation being defined alongside the quantities that needed to be substituted into it. This way of presenting the numerical values enabled lower ability candidates to access the question better than has been the case in past years.

Q.2 Knowledge of how isotopes are represented with their atomic and mass numbers was investigated in part (a) of this question, with three options being presented in a multiple-choice manner. There was little confidence that the candidates were exercising their knowledge in choosing any answer.

In (b) there was considerable variation in the choices of answers.

The second part of (c) required candidates to have to explain whether a suggestion was valid. Whilst answers to the first part were often correct, the two marks on offer were rarely both awarded.

Q.3 Part (a) was usually correctly answered as it involved substitution into a word-written equation. This required candidates to access one of the values, which was to be used in the equation, from a graph that was presented to them. It was generally well answered but a significant minority of candidates entered the numbers into the numerator and denominator the wrong way around.

In part (b)(i), no less than five small graphs were presented which each showed how the lengths of springs varied with the force applied. The four parts to the question then quizzed the candidates on the information contained in those graphs. Again, the correctness of answers given was very varied.

The last part to the question required that one of the force-length graphs be converted to a force-extension graph. The outcome should have been a straight line from the origin but of the same gradient as the one given. Very few answers earned both of the marks that were on offer.

- Q.4** For part (a), the graph forms a smooth curve of decreasing gradient as the distance increases and candidates were asked to describe how one quantity varies with the other. The two aspects of the fact that the speed decreases at a decreasing rate as the distance from the Sun increases was very rarely identified.

In part (b) the graphical information given at the start of the question had to be converted to a tabular format with the majority of the data already completed. The values fed into the two remaining cells in the table were generally correctly read from the graph.

In part (c), the distance of Saturn from the Sun, given in the table and graph as 9.5 AU (Astronomical Units) needed to be doubled and identified as roughly the distance that Uranus is from the Sun. This was also usually well answered for just one mark.

Very few answers were awarded a mark in part (d) in explaining what an AU represents. The fact that the table shows that Earth is at a distance of 1 AU from the Sun rather gave the answer but it was not spotted by many candidates.

The last part of this question invited an explanation of which (either or both) of two people's statements about data in the table is/are true. One was true and the other wasn't, but answers were so poorly expressed, indistinct and convoluted that all three marks were rarely awarded.

- Q.5** The first part of this question was multiple choice. A diagrammatic presentation of the process was shown in the question and THREE marks were offered for ticking boxes. It is remarkable that some candidates think that they could earn three marks by ticking only one or two of the boxes. The exercise was not done terribly well.

In part (b), ten words were given to be chosen from in completing the statements that followed. Some good answers were seen from a good number of candidates.

- Q.6** Parts (a)(i) to (iii) sought answers from information that could be extracted from the chart and most candidates gained a lot of success in this part. Part(a)(iv) required some thought about doubling the thinking distance (only), from data in the chart for a tired driver and then calculating the total stopping distance, knowing that tiredness does not affect the braking distance. Answers were very poorly expressed and it was most usual to see that the total stopping distance, given in the chart as 45 m, was simply doubled – as was stated in the suggestion in the question.

The final parts of the question were very straightforward and served to increase the facility factor for the question as a whole.

Q.7 Not unusually, the QER was very poorly answered by the vast majority of candidates. Many failed to mention in any way that balance was to be achieved to investigate the principle of moments and many failed to mention anything about calculating a moment anywhere in their answer. Most responses concentrated on the set up of the apparatus, taking their cue from the diagram that was presented along with a list of the apparatus provided for the experiment. Many had no clue as to the reason for being provided with plasticine and giving the method for undertaking the experiment was frequently overlooked although it should have been a major part of the answer to the question. Any mention of data obtained from carrying out the experiment was not accompanied by an explanation of how the data should be managed. There were suggestions that a graph should be drawn without making any mention of what the axes should represent.

Q.8 In the first of the two questions that were common with the higher tier paper, part (a) asked for a risk and control measure associated with a teacher undertaking a demonstration of the absorption of nuclear radiations by a variety of absorbers. There were some answers that were extreme such as suggesting that the teacher should wear a hazmat suit or use breathing apparatus.

In answers to parts (b)(i) and (ii), the presence of evidence for there being no alpha radiation emitted by the source and then the evidence for the presence of beta and gamma radiation were not well explained. Candidates often gave text-book answers that alpha cannot pass through paper, beta cannot pass through aluminium and the intensity of gamma radiation passing through lead without any reference to count rate data in the table that was given in the question.

Fortunately, in part(b)(iii), there were good answers to the causes of background radiation and how data in the table should be corrected for it.

Q.9 There were generally good answers to the numerical parts of this question but the descriptive parts were often confused resulting in a loss of marks.

In (b)(i), there was a significant number of answers in which the two opposing forces were multiplied by each other, instead of their values having been subtracted to give the resultant force. There were however many, many correct answers. In (ii) the unit of acceleration was often written as m/s or N/kg, the latter of which, it was decided, should not be accepted.

In part (b)(iii), the request for an **explanation** to get the two marks was not heeded by the majority of candidates, but because the car was moving downhill, the answer frequently seen was that the acceleration would increase as a result of increasing resultant force, both of which gained no marks. There were some good answers, giving a reason which was well understood and clearly expressed.

PHYSICS

GCSE

Summer 2023

Unit 2: Forces, space and radioactivity – Higher tier

Overview of the Unit

This paper was based on the unit 2 content. Many candidates seemed well-prepared for the paper, and it was pleasing to see most questions attempted.

Questions allowed candidates to:

- demonstrate and apply their knowledge and understanding of scientific ideas, processes, techniques and procedures;
- analyse, interpret and evaluate scientific information and evidence, including making judgements and reaching conclusions;
- demonstrate their proficiency in handling ratios, calculating uncertainties, substituting numerical values into equations and solving them, rearranging equations and analysis of data in tabular and diagrammatical forms.

The quality of extended response was assessed in a question about absorption spectra. Two questions were set in a practical context. These were investigating the penetrating properties of alpha, beta and gamma radiation, and the relationship between the force applied to a spring and its extension.

Questions based on application of knowledge tend to be better answered e.g. Q 2a,b(i)(ii).

Recall questions tend to have lower mean marks than other types e.g. Q3 and 6(b). Candidates must read questions carefully and follow instructions e.g. 1 and 6(b)(ii). Rearranging equations was one area of the paper that was sometimes poor and, in cases, candidates lost marks for failure to show their workings e.g. Q7(b)(iii). Candidates also answer questions based on analysis and evaluation quite well but often fail to state a conclusion or include data in their response e.g. Q7(d) – road safety.

Comments on individual questions/sections

Q.1 In some parts of this question, candidates failed to read the instructions carefully enough.

Responses to (a) were generally poor. The risk should include the potential harm that could be caused and the action involved. Most answers omitted the action. It was common to see 'wear gloves/goggles' as a control measure.

Part (b)(i) directed candidates to use data in their explanation. Just over half of candidates recognised that paper did not affect the count rate. Most of the others just stated that alpha particles cannot pass through paper. Recall of this fact did not earn credit unless the data was referred to. Another group of candidates stated that cobalt-60 doesn't pass through paper. Part (ii) also required use of the data. About half of answers failed to do this and statements such as aluminium blocks beta particles and lead blocks gamma rays were seen. These answers scored zero.

Some candidates earned partial credit by recognising aluminium and lead lowered the count rate. To earn full credit candidates needed to link the drop in count rate using an aluminium absorber with beta radiation and similarly the drop using lead with gamma radiation. A minority of candidates achieved this.

In the last part the majority of candidates knew that background radiation should be deducted from the data in the table. Some quoted a value that should be subtracted and this was acceptable. Errors included: add it; find the value but no mention of a deduction; determine the count rate without an absorber.

Q.2 Very little recall was required for this question. All equations were given in the form required to answer the questions. As a result, performance was generally good.

In part (b)(i) mostly correct answers were seen. However errors were made and these included adding 2000 and 5000, finding the sum of or difference between 2000 and 5000 and then multiplying by 1000. In (ii) the unit of acceleration was not well known. The most common answer was m/s.

In the first part of (b)(iii) few correct answers were seen. Most candidates believed that the resultant force increased including those that stated air resistance increased. In II most answers incorrectly stated that acceleration increased.

In (c)(i) a minimum of candidates could state a cause of energy loss. Others stated that potential energy decreases as the car moves down the hill, which is true, but this did not answer the question. In the last part most candidates calculated the correct braking force to earn both marks. Some candidates substituted 12 m/s as a distance into the equation even though the units were not compatible.

Q.3 This question depended on recall which depressed the mean mark.

In part (a) about half of candidates answered correctly. Others included the incorrect unit i.e. 4.37 light years.

In (b)(i) candidates were required to recall the named forces acting on Alpha Centauri and they maintain its stability because they are balanced. A minority of candidates gained both marks. Another group either named the forces or mentioned they are balanced but not both. The term 'gravity' was not accepted as the name of a force. The majority of answers did not refer to forces but included statements such as Alpha Centauri is a similar size to our Sun or that it is a main sequence star. A few responses stated that Alpha Centauri is a helium nucleus. A minority of candidates earned both marks in (ii) for referring to forces and naming red giant as the next stage in the life of Alpha Centauri. There was no penalty for using gravity in this question part. A larger group scored one mark for stating red giant but failed to refer to forces. Some candidates described intermediate stages in the life cycle but these were treated as a neutral part of the answer. The remainder of candidates thought the next stage in the life cycle was one of supernova, red super giant, white dwarf, red dwarf or neutron star.

In the last part about half of the candidates gained both marks for recalling hydrogen was undergoing fusion and producing helium. The others either stated one or the other fact, usually the reference to helium production. Candidates who failed to get a mark referred to the burning of hydrogen and sometimes fission.

Q.4 Some very well-written, top band responses to this QER question were seen with candidates producing coherent and well-structured responses demonstrating excellent knowledge and understanding of absorption spectra. Candidates were able to describe the origin of the dark lines, use the data in the table and the diagram of the spectrum to identify whether each element listed was present or not and some even suggested another element is present because of the existence of a line at a wavelength not listed in the table. These appeared in a minority of cases. Middle band answers were more common and these omitted some of the details, such as each element having its own set of specific dark lines, or not accounting for the presence or absence of each element listed in the table. Lower band answers were the most common type seen and typically these stated the elements present without referring to the wavelength values. Some answers stated all elements were present. At this level, some of the misconceptions that appeared were:

- only one dark line is required to show that an element is present;
- hydrogen is present four times and sodium is present once;
- lines further to the red end mean that element is more abundant;
- wavelengths absorb elements;
- the dark lines represent missing elements.

Q.5 In (a)(ii) the majority of candidates calculated the uncertainty correctly including those where an ecf was allowed from part (i). About a quarter of candidates failed to divide by 2.

In (b) only a minority of candidates gave a correct answer. One of the incorrect answers that appeared most often was the suggestion that the experiment should be repeated. Another common incorrect answer was changing the spring after each measurement.

Few candidates scored full marks in (c). Methods described included the use of a force against extension graph or calculating values of k and then determining a mean. The loss of a mark was because most failed to realise that the loading and unloading values allowed for a calculation of a mean extension for each force. Other candidates either gave vague responses so it was unclear what was being added or found the mean of all the loading values and then of the unloading values or found a mean by dividing by 6 or 12 because of including 0.0.

The last part was assessing candidates' knowledge and understanding of the term accuracy in the practical context of comparing a determined value of spring constant with its true value. A minority earned any credit and even fewer achieved both marks. Most responses explained the difference between the two values by using terms such as unreliable results, anomalous results and errors in measurements.

Q.6 About half of candidates gained three marks in (a) but most of these failed to get the fourth because of an error in determining the number of neutrons after fission. The most common answer was three. There was another small group of candidates that scored one mark and, surprisingly, this was for balancing the equation with 4 neutrons. The remainder of candidates either failed to use the data in the table to determine mass and atomic numbers or inverted the values when completing the equation. For these candidates, answers such as ${}_{92}^{143}\text{U}$ or ${}_{235}^{92}\text{U}$ were seen.

Part (b)(i) was a recall question but only a minority of candidates obtained both marks. A larger group earned one mark for stating they slowed neutrons down but didn't continue to say why this is necessary. The largest group of candidates described the role of control rods.

The fact that the rate of reaction in a nuclear reactor is controlled by control rods was not well known in (ii). Candidates stated that the rate could be increased by raising the temperature, using a catalyst or removing the moderator. Of the candidates who did include control rods in their answer, some failed to read the question carefully which asked how the rate of reaction could be increased. Their answers would lead to a decrease in the rate. Only a minority of answers earned full marks.

The question parts in (c) were based on application of knowledge and were well answered by most candidates with many scoring full marks. It was pleasing to see the use of 2^8 or 0.5^8 in calculations involving half-life. Even when candidates gained zero in one part they usually scored marks on the other part(s). Occasionally errors were seen. For example, in part (i): $\frac{131072}{64}$; in part (ii)I.: $64 \rightarrow 32 \rightarrow 16 \rightarrow 8 \rightarrow 4 = 4$ half-lives; in (ii)II.: arriving at an answer of 4 g by confusing a sequence of eight numbers halving with eight half-lives.

In the last part the majority of candidates compared the half-lives but could not determine how this affected the ratio. The best answers worked out the ratio after 64 s.

- Q.7** Part (a) tested candidates' knowledge of one of the factors affecting thinking and braking distance plus they were introduced to impact speed. Mostly correct answers were seen. A small fraction of candidates did not read the question carefully so did not earn credit for their responses. These either ignored the phrase 'tyre treads worn' or defined the three terms.

In part (b) marks ranged from 1 to 10. Marks at the lower end of the range were usually obtained in part (i). Errors in the table in part (i) were carried forward into parts (ii) and (iii). A group of candidates gained full marks in parts (i) and (ii) but failed to handle the equation of motion provided in part (iii). Another group managed to obtain additional credit in part (iii) by either identifying that v was equal to zero or correctly substituting values into the equation.

Candidates needed to read the questions carefully in part (c), so they explained each part using the stated Newton's law. Recall of the relevant Newton's law earned one mark if not applied to the scenario. In (i) a minority of candidates earned both marks here. About half of candidates earned one mark because they omitted the term resultant force from their response. The remainder of candidates answered in terms of Newton's 2nd law. Candidates were more successful in answering part (ii) compared to parts (i) and (iii). However, some omitted using the word opposite when stating the forces were equal. A minority of candidates earned both marks in (iii). An equivalent number lost a mark by either only including force = mass \times acceleration, less force or increased collision time in their answers. The remainder of candidates gave answers such as crumple zones absorb the force.

In the last part a minority of candidates earned full marks for their answers but most scored at least a mark. Some of the misconceptions of reducing the speed limit that appeared are slower speeds give more thinking time and more stopping time. The fact that there would be less accidents and of less severity were often not included. To gain full marks in this question, a conclusion was required. Its omission prevented some candidates from achieving three marks.

PHYSICS

GCSE

Summer 2023

UNIT 3: PRACTICAL ASSESSMENT

Overview of the Unit

In this unit candidates are assessed on their practical skills including, forming hypotheses, recognising and preventing hazards and risks, recording and presenting data, understanding the variables that are involved in experiments, evaluating the success of the experiment and planning improvements.

The tasks all proved to be accessible for most candidates who usually attempted all sections of the tasks. Certain tasks proved more popular than others within the suite in particular the resistance of the wire task probably due to the familiarity with the experiment itself.

Comments on individual questions/sections

Section A – Hypotheses and risk assessments

Most candidates were able to make a sensible hypothesis in each of the 9 tasks, which linked the independent and dependent variables. In producing risk assessments, the most successful candidates linked the risk with a particular action in the method, such as spilling chemicals onto skin whilst pouring, and were able to suggest a sensible control measure for that risk. Less successful candidates often did not link the risk to an action or referred to chemicals splashing into eyes which could not be credited. In the springs task and in the yeast task it was rare to see no significant risk as a response and many spurious risks were seen.

Section A – Tables of results

Most candidates produced well organised tables of results and recorded all their data. It was pleasing to see that most candidates included units in the table headings and not in the body of the table. Although not commonplace, incorrect units or use of incorrect abbreviations of units (e.g. secs for s / seconds) were seen. In some cases, headings lacked detail and could not be credited. In the sodium thiosulfate task, many candidates simply had the heading concentration and did not refer to sodium thiosulfate. This was required to distinguish between this and hydrochloric acid. There was evidence that candidates often do not read the instructions provided, for example in the springs task candidates were instructed to record the length at 0 g which many failed to do. Where required, means were generally calculated correctly. In the spring task, some candidates calculated and recorded extensions which was not required of them.

Section B – Variables

Each of the nine tasks included a section on variables. Candidates were able to identify the independent and dependent variables across all the tasks and most were able to state the range of these variables. Less successful candidates simply listed all the values of the variable when asked for a range, but this was seen less often than in previous series. One area for development that was noted was the resolution of the instruments used. Where this was asked it was common to see incorrect values given.

Many of the tasks explored either how or why certain variables were controlled, and this was less well-answered than other areas of the section on variables. For example, in the sodium thiosulfate task, candidates were required to explain how the volume of the sodium thiosulfate was controlled but most candidates didn't state either the volume of the solution used or the instrument used to measure this volume. In the resistance in a wire task, candidates were asked to explain why the thickness of the wire was controlled. This was poorly answered with most candidates not linking a change in thickness with a change in resistance and current.

Section B – Graphs

Graphs continue to produce a mixture of results with the same errors consistently appearing:

- axes labels missing or without units or with incorrect units (see tables above);
- less than half the graph paper area being used for scales, the origin left blank, using scales with multiples of 3 or 7, (this was not enforced for the x -axis in the resistance of the wire practical).
- line of best fit was varied in standard with thick or wispy lines common place.

The subsequent description of the graphs was generally well answered when a basic description of the relationship between independent and dependent variables was required. However, when a second mark was sought for a more detailed description of the curve many candidates found this more difficult and often did not attempt to do so.

Section B – Calculations

Across all the tasks, where candidates were asked to use equations, calculations were answered well by most candidates, this included calculations of spring constants, resistance, power, RQ values, heat energy released and uncertainty.

Section B – Analysis and evaluation of results

Compared to previous series, it was far more common to see candidates describing their data in detail. In the resistance in a wire task, many were able to describe the current decreasing at a decreasing rate. Similarly, the meaning of the term proportional was better understood, with a pleasing number of candidates able to analyse data from the same task to determine if two quantities were proportional. In the sodium thiosulfate task, many candidates were able to select and use appropriate data to evaluate a claim about reaction time halving as concentration doubles. Similarly, in the best responses candidates were able to sensibly compare spring constants in series and in parallel. Weaker candidates tended to be vague in their responses and needed to consider the specific factor by which variables change in relation to each other to make valid conclusions.

Section B – Improvements

Many candidates were able to suggest suitable improvements, for example using a thermostatically controlled water bath to control temperature in the sodium thiosulfate task or ensuring that they work at eye level when measuring a spring. Where candidates were less successful, they suggested invalid improvements such as only measure the spring when it has stopped moving, which they should have done anyway or referencing controlling the temperature of the entire room in the rates of reaction task.

Section B – Use of practical terms

Most candidates demonstrated clear understanding of practical terms such as repeatability, reproducibility, and accuracy. Similarly, candidates were confident in identifying anomalous results. Other terms, such as systematic error, were not well understood and most candidates had difficulty in clearly explaining the effect of a systematic error. The glossary of practical terms is a good reference that candidates should use when revising for these tasks.

Section B – Planning

The most effective responses to questions that asked candidates to plan another experiment, included: investigating the effect of a different variable, a list of apparatus, controlled variables and a clear and valid method that could be followed. Less successful attempts at this type of question provided more of a narrative response and frequently did not identify how the independent variable was to be changed and did not state the variables to be controlled and it would not have produced valid data. Simply stating 'repeat the experiment from section A' and then stating one change is not detailed enough to be credited. Candidates should be encouraged to include a chronological list of steps, including stated values of the independent variable, along with reference to what measurements are required.

Section B – Science theory

Theory based questions, such as those involving collision theory in the rates of reaction and enzyme tasks, were often not well answered. Although candidates had a broad understanding, they often didn't use detail and correct terminology in the answers to gain credit. For example, the distinction between collisions and successful collisions was not clearly distinguished or understood.

Supporting you

Useful contacts and links

Our friendly subject team are on hand to support you between 8.30am and 5.30pm, Monday to Friday.

Tel: 029 2240 4252

Email: science@wjec.co.uk

Qualification webpage: [GCSE Physics](#)

See other useful contacts here: [Useful Contacts | WJEC](#)

CPD Training / Professional Learning

Access our popular, free online CPD/PL courses to receive exam feedback and put questions to our subject team, and attend one of our face-to-face events, focused on enhancing teaching and learning, providing practical classroom ideas and developing understanding of marking and assessment.

Please find details for all our courses here: <https://www.wjec.co.uk/home/professional-learning/>

WJEC Qualifications

As Wales' largest awarding body, at WJEC we provide trusted bilingual qualifications, straight-forward specialist support, and reliable assessment to schools and colleges across the country. With more than 70 years' experience, we are also amongst the leading providers in both England and Northern Ireland.

We support our education communities by providing trusted qualifications and specialist support, to allow our learners the opportunity to reach their full potential.



WJEC
245 Western Avenue
Cardiff CF5 2YX
Tel No 029 2026 5000
Fax 029 2057 5994
E-mail: exams@wjec.co.uk
website: www.wjec.co.uk

ⁱ *Please note that where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.*