GCE Examiners' Report

Physics

GCE

Summer 2025

Introduction

Our Principal Examiners' report provides valuable feedback on the recent assessment series. It has been written by our Principal Examiners and Principal Moderators after the completion of marking and moderation, and details how candidates have performed in each unit.

This report opens with a 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 then looks in detail at each unit, pinpointing aspects that proved challenging to some candidates and suggesting some reasons as to why that might be.[1]

The information found in this report provides valuable 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 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 12 months after the examination.	Portal by WJEC or on the WJEC subject page
Grade boundary information	Grade boundaries are the minimum number of marks needed to achieve each grade. 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. For linear specifications, a single grade is awarded for the subject, rather than for each unit that contributes towards the overall grade. Grade boundaries are published on results day.	For unitised specifications click here: Results, Grade Boundaries and PRS (wjec.co.uk)

[1] ***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.***

Exam Results Analysis	WJEC provides information to examination centres via the WJEC Portal. This is restricted to centre staff only. Access is granted to centre staff by the Examinations Officer at the centre.	Portal by WJEC
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Executive Summary

The entry figures for both AS and A level Physics have seen another increase this series, particularly so for AS. The mean results for Units 2 and 5 were similar to previous series, whilst the means for Units 1, 3 and 4 saw an increase. Candidates answered quantitative responses far better than qualitative responses. Some excellent mathematical skills were seen across all units. There was a marked improvement in the mathematical skills seen in unit 1 with evidence of a return to the standards seen pre-covid. Qualitative responses lacked precision and the detail required to gain full marks. Answers often did not address the question being asked and suggested a lack of knowledge and conceptual understanding. There is more emphasis on written expression in unit 2 than in unit 1; although many candidates are mathematically able, some of them struggle to express themselves precisely in written language.

This is the reason why the unit boundaries in unit two are lower than in unit one. In addition, presentation was sometimes poor, with a significant number of scripts being difficult to read due to handwriting or disorganised layout.

In unit 3 some gaps in understanding were apparent in certain questions, e.g. on thermodynamics, and such as determining the distance to a Cepheid variable star. The section B comprehension passage, on a popular astronomical theme had a high mean mark of 13.2 out of 20 with some excellent answers seen. Candidates performed very well in unit 4 although the topic areas of electromagnetic induction and cyclotrons proved to be challenging. In the option questions there was a shift in entry from alternating currents to the physics of sports.

AO1 recall questions continue to cause problems for candidates, whereas AO2 questions where the data is provided that test the ability of candidates to apply their knowledge tend to score highly. The QER questions were very dependent on the topic area.

Candidates performed well in the practical examination. When practical questions are asked on the theory papers, they are answered far better on the A2 papers than on the AS papers, this is probably linked to the practical skills of the candidates being more developed by the end of Year 13.

Our digital resources website offers blended learning lessons and knowledge organisers, among other materials. Please ensure you are accessing the correct site with legacy resources (link here) and not the sister site for the new Made-for-Wales qualifications.

PHYSICS

GCE

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AS UNIT 1 – MOTION, ENERGY AND MATTER

Overview of the Unit

This unit provided a broad platform for candidates to demonstrate their understanding of key physics concepts, including toppling objects, density, moments, conservation of energy, kinematics, particle and stellar Physics. In addition, experimental skills were assessed through a practical task based on determining the Young modulus of a metal.
While certain sections of the paper were approached confidently, it was again clear that many candidates struggled to provide the level of precision and detail required for full marks in many parts of the paper. As in recent sittings, this contributed to lower overall scores than anticipated.

A notable concern was the performance on questions that should have been accessible to most candidates - particularly those requiring straightforward recall or involving familiar concepts. For example, Q1(a), which asked candidates to define “centre of gravity,” and Q5(c), focused on Newton’s Third Law, were poorly answered. These types of Assessment Objective 1 (AO1) questions revealed gaps in the secure recall of definitions and fundamental principles.

Assessment Objective 2 (AO2) questions, which required qualitative explanations or contextual application of physics concepts, also proved challenging. Responses to Q5(b) on work and energy transfer, Q2(b) on the application of moments, and questions exploring the difference between vertical and horizontal motion in projectile problems, frequently lacked clarity or accuracy. Vague and imprecise answers suggest a need for deeper conceptual understanding and greater practice in articulating scientific explanations.

The question assessing practical skills—analysis of a graph to determine the Young modulus - highlighted a general lack of confidence in interpreting graphical data and understanding experimental processes. However, it was encouraging to see that most candidates were able to draw graphs with correctly labelled axes and appropriate units.

Some progress was observed in questions involving the calculation of cross-sectional and surface areas. Nonetheless, confusion around the correct use of units remains an issue for many candidates and should be a focus for classroom reinforcement.

Particle physics continues to be a strength across the cohort. Many candidates demonstrated a solid grasp of the content, and responses to the QER question showed that some were capable of detailed analysis. However, only a small number achieved the depth and structure required for a top-band response.

In numerical questions, particularly those testing knowledge of kinematic equations and projectile motion, candidates generally performed well, with strong equation handling evident. That said, trigonometry continues to be a common stumbling block. Questions requiring the use of angles to determine side lengths - such as in Q1 (toppling) and Q3 (projectile motion) - were frequently answered incorrectly, indicating a need for more focused practice in applying trigonometric principles within a physics context.

Examiners also commented on the overall quality of written responses. Many answers lacked clarity, conciseness, and logical structure. In addition, presentation was sometimes poor, with a significant number of scripts being difficult to read due to handwriting or disorganised layout.

Comments on individual questions/sections

Question 1

Part **(a)**
This AO1-style question required candidates to explain the meaning of the term "centre of gravity" of an object. Overall, it was poorly answered with a significant number incorrectly referring to *mass* instead of *weight*. Additionally, the term "gravity" was often used imprecisely, with many candidates failing to identify it as a force.

Parts **(b) (i), (ii)** and **(iii)**
While many candidates were able to draw a suitable arrow from the approximate centre of the cylinder through its bottom right-hand corner, a significant number drew arrows either from incorrect starting points or in entirely the wrong direction**.** Similarly, although many candidates correctly used the tangent trigonometric function to calculate the diameter of the cylinder, a notable number incorrectly applied the sine or cosine functions instead.

In part **(b)(iii)**, many candidates successfully used their answer from part **(b)(ii)** - or the provided diameter value from that part - to correctly identify the metal from which the cylinder was made. There was confident and accurate application of both the volume of a cylinder formula and the density equation. It is worth noting that candidates who incorrectly used the sine function in part **(ii)** typically arrived at a diameter of 4.8 cm. When this value was used in part **(iii)**, it led to a density falling midway between that of copper and brass. In such cases, either metal was accepted as a reasonable conclusion under the principle of error carried forward (ECF).

Part **(c)**
Candidates were expected to explain that the angle of toppling would remain unchanged (or provide an equivalent explanation), supported by one of the following valid reasons:

- The angle of toppling depends on the diameter and length of the object
- It is determined by the object's dimensions or shape
- It depends on the position of the centre of gravity (or centre of mass was accepted here)
- It is independent of the object's density

However, a significant number of candidates incorrectly stated that the angle of toppling would change.

Question 2

Part **(a)**

Nearly all candidates correctly calculated the force applied to the spring. Among those who did not, a common error was the incorrect conversion of centimetres to metres.

Part **(b)**

A variety of valid approaches was possible for this question. In all cases, candidates needed to apply the principle of moments correctly - either to verify that the force was approximately 5 N, or to use the given value of 5 N to demonstrate that the anti-clockwise moment was equal to the clockwise moment. Generally, candidates made good attempts; however, common errors included miscalculating the distance from the pivot to the bolt, or failing to recognise that a calculated value such as 5.12 N is approximately equal to 5 N.

Part **(c)**

Nearly all candidates understood the energy conservation concepts here and proceeded to determine the energy stored in the spring and then equate that to kinetic energy. In a minority of cases some candidates lost one mark for omitting the 20% factor.

Question 3

Part **(a)**

The response to this question was disappointing, with few candidates achieving all four correct answers. As in previous years, the most common error was the incorrect response that acceleration in the vertical direction *increased*.

Part **(b)**

As in previous years, candidates generally demonstrated a high level of confidence and understanding when applying the equations of motion. In part (i), nearly all candidates successfully calculated the time of flight as 0.78 s.

In part (ii), most candidates correctly determined the vertical velocity of the upper cannonball, although a notable number incorrectly used a vertical displacement of 4 m instead of 7 m in their calculations. As highlighted in the summary at the beginning of this report, a significant proportion of candidates were unable to use the information and angle provided in the diagram to determine the horizontal component of velocity using trigonometry. Nevertheless, in part (iv), nearly all candidates correctly applied the equation for constant speed to determine the range - often using incorrect values carried forward (ECF) from earlier parts.

Part **(c)**

The majority of candidates were able to state that the cannonball would strike the water at an angle less that 10° and give a valid reason for their answers.

Question 4

Part **(a)**

Responses to this question tended to fall into two groups: those candidates who demonstrated an understanding of why the wires were made from the same material, and those who appeared less familiar with this concept. Fewer candidates than expected provided the correct answer, which may indicate that this important experimental technique is not emphasised equally across all schools. Consequently, examiners generally awarded either full marks (2) or no marks for this part.

Part **(b)**

Nearly all candidates made good attempts at drawing the graph from the provided data. Most used appropriate axes with clear labels and included the correct units. The majority successfully plotted the points accurately and drew a suitable line of best fit. Nearly all candidates correctly stated the resolution of the micrometre. While fewer were able to accurately calculate the cross-sectional area of the wire, there was a noticeable improvement in responses to this type of question compared to previous years, as noted in the summary. Common errors continued to include incorrectly converting diameter to radius and difficulties with converting millimetres to metres. The response to part (iii), which required determining the gradient to calculate the Young modulus of the wire, was generally disappointing. This is considered a standard and well-recognised task, yet many candidates struggled with the key experimental analysis skill involved. Common issues included incorrectly using data from the table to calculate stress and strain separately, often with errors in unit conversions. Additionally, final answers were seldom given to the correct number of significant figures, despite this being a requirement.

Calculating a physical value from the gradient of a graph is an important skill that candidates should be confident with at the A/S level.

Part **(c)**

As in part (a), it was surprising how few candidates fully appreciated the experimental significance of removing the weight after each reading of the vernier scale. Encouragingly, those who demonstrated some understanding mentioned the importance of ensuring the wire did not exceed its elastic limit (or an equivalent wording), earning one mark. However, many did not fully explain how to confirm this, such as noting that the wire returns to its original, unstretched length.

Question 5

Part **(a)**

Few candidates appeared to know where to begin with this question or understood the connection between change in momentum and the area under the graph. Those who did, showed good understanding and often reached the correct answer. Many candidates attempted to apply kinematic equations and $F = ma$ at different sections of the graph to calculate the final velocity, which is a valid approach. However, very few were successful in doing so, with most earning only one or two marks.

Part **(b)**

In (b)(i), many candidates demonstrated a good understanding that the work done against friction is equivalent to the change in kinetic energy and were able to calculate this change correctly. However, a common mathematical error involved calculating $(2-1.2)^2$ instead of correctly computing $2^2 - 1.2^2$. In (b)(ii) the majority of candidates correctly found the mean resistive force between points A and B by dividing their answer from part (b)(i) by 8, often receiving credit through error carried forward (ECF).

In (b)(iii) satisfactory attempts were made to determine the mean rate of energy transfer between A and B. Many candidates recognised the need to calculate the time taken to travel from A to B and did so successfully, and then most went on to divide their answer from part (b)(i) by this time. Frustratingly, it was common to see candidates correctly calculating the work done against friction in this part even when they had not done so in part (b)(i), where it was specifically required.

Part **(c)**

This question, which was considered a relatively straightforward bookwork-style task, received a particularly disappointing response. Surprisingly few candidates were able to correctly provide the full names of forces X and Y. Similarly, only a small number could explain why the forces shown did not constitute a Newton’s Third Law pair.

Question 6

Part **(a)**

A variety of responses were seen for this QER question. Successful candidates provided coherent and logical answers, fully describing the particles involved and offering a thorough explanation based on a strong understanding of the conservation laws. They also gave a comprehensive account of the force involved in the interaction and a detailed breakdown of the process in terms of quarks. Middle-band responses typically included a complete analysis of the conservation laws along with either a limited discussion of quarks or the force involved. Lower-band candidates generally focused mainly on the conservation laws, often providing only a partial explanation, sometimes accompanied by a brief mention of the forces involved

Part **(b)**

Around half the candidates were able to show that this quark combination led to an overall charge of +1. Fewer proceeded to state that this is the only combination which would do so. In (ii), the majority identified the proton as both a baryon and a hadron, although this was fewer than expected.

Question 7

Part **(a)**

Nearly all candidates used Wien's law correctly to determine the wavelength of peak spectral intensity. However, a significant number failed to obtain the second mark as they gave their answers incorrectly in terms of units. For example, it was expected to see an answer of 500 nm (or equivalent), however answers such as 500×10^{-9} nm, 500 m, 5×10^{-7} nm or 500 Nm were seen.

Part **(b)**

Many correctly determined the Sun's surface area; however, as in previous years, some candidates used an incorrect formula for surface area, frequently omitting the factor of 4.

A few candidates complicated their approach by attempting to use Stefan's law to estimate the surface area using an approximation from the graph. This method was accepted only for temperature values between 0.95 and 0.98 ($\times$ 5800 K).

Many candidates appropriately used their answers from parts (b)(i) and (b)(ii), along with Stefan's law, to calculate the 'new' temperature and then subtracted this from 5800 K to find the temperature change. Candidates who relied solely on the graph approximation for this part were capped at 2 marks, as this approach was deemed insufficiently accurate for the calculation required.

Part **(c)**

Responses to this question were encouraging, with many candidates addressing the three key marking points. Candidates were expected to state that the decrease in the Sun's temperature (1 mark) leads to an increase in the peak spectral intensity emitted (1 mark), resulting in the Sun appearing more orange / red (1 mark). Numerical answers that covered the first two points were also accepted.

PHYSICS

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AS UNIT 2 – ELECTRICITY AND LIGHT

Overview of the Unit

Questions 3, 6 and 7 provided the highest mean marks. These questions covered the topics of dc circuits, refraction of light, and photons. Question 5 on the topic of diffraction and interference had the lowest percentage mean mark. The next weakest answer was for question 2, on resistance. This question included the QER.

As in previous Unit 2 papers examiners were generally encouraged by the mathematical skills shown by candidates, particularly when handling equations. Candidates also had opportunities to demonstrate their extended writing skills with the majority of candidates giving good, clear and concise explanations. It was noticeable that a number of responses were either poorly communicated or did not show the required mathematical ability for AS physics.

Key points:

- Candidates should be aware of the case sensitivity of terms in physics equations. T and t represent different quantities as do R and r.
- Candidates should appreciate that for in-phase sources, a point of constructive interference can be found along the central anti-nodal line and it has a path difference of zero.
- Candidates should develop use of data when explaining whether a relationship is proportional.
- Candidates are advised to explore the methods involved in the specified practicals for a deeper understanding.
- Candidates should appreciate that for single readings the resolution may be taken as the absolute uncertainty. For multiple readings, $\frac{x_{\text{max}}-x_{\text{min}}}{2}$ can be used to calculate the absolute uncertainty. Also, in uncertainty questions the final absolute uncertainty should be written to 1 or 2 significant figures.
- Candidates should use pencils (and rulers where appropriate) when drawing diagrams and graphs.
- Candidates should know that stimulated emission involves a passing photon triggering an excited electron. They do not collide. Furthermore, only one photon is emitted from the process and the original incoming photon remains at large.
- Similar to last year's report, candidates should try to develop use of units within problem solving. It can allow candidates to find their way through a calculation without the need for an equation from the data booklet.

Comments on individual questions/sections

Question 1

Part **(a)**

(i) Instead of a complete drift velocity derivation candidates were asked to firstly give a complete meaning of n in Gwen's derivation. Around half of the candidates were able to refer to free electrons or delocalised electrons. Some that did sometimes spoiled their response with reference to 'per m^2' instead of 'm^3'.

In **(ii)** the majority of candidates were able to define electric current. Some may have needed the data booklet for support but, on this occasion, we did allow $I = \Delta Q/t$ if words describing the letters were used. Weaker responses included reference to electric current being the pd running through the circuit or simply saying it is electrons. It should be noted that case sensitivity of letters was poor when candidates were finishing the derivation. We were generous this time, but candidates should be reminded of the standard use of letters in physics. A small number of candidates decided to complete their own derivation and use $l = vt$. This was not required but was credited if completed correctly.

Part **(b)**

(i) The marking space provided plenty of room for clear workings. AS level candidates should be reminded of the importance of this. There were some correct, well-structured responses using the resistivity equation twice. There were some errors with multipliers and confusion between diameter and radius on occasion. These were condoned in the 1st and 2nd marking points (MPs). Some candidates used ratio techniques but many of these could not find their way through the mathematics. There were some that did have the mathematical skill to do this which was pleasing. Unfortunately, there were also several non-attempts.

In **(ii)** part I more than half of candidates were able to correctly show the direction of electron flow however, it was disappointing to not see more correct responses. Part I was intended to lead candidates into II but all too often this was not seen. Many candidates were unable to identify that the current would be the same in the two resistors. Of those that did, stating 'resistors were in series' or similar was not regularly seen. Good responses showed the current was the same through both and often went on to state that a larger cross-sectional area leads to a smaller drift velocity (or visa versa). Fewer candidates explained this with mathematical reference to $v \propto \frac{1}{A}$. There were a small number of excellent responses.

Question 2

Part **(a)**

Candidates were given an opportunity to analyse I-V data. The 1st and 3rd MPs were usually attained in good responses. However, these candidates did not always use values in their responses. A significant number of candidates did not see the subtlety of Ohm's law being obeyed between 0 and 2 V. If they stated that it didn't obey Ohm's law for higher voltages, they were fine, but a more generalised statement for the entire data set was not credited. There were a few references to Hooke's law in responses which was surprising.

There was lots of variation in the QER question, and we saw a full range of marks awarded. Bottom band responses were often limited to 'current is the flow of electrons', 'electrons bumping into ions' and limited links to E_k of particles. As well as the above, middle band responses also included 'free electrons pushed towards the positive', 'ions vibrating', 'ions vibrating more' and 'more collisions'. Additionally, top band responses would have additional content including 'more frequent collisions', 'increased force', 'increased KE' and 'accelerate between collisions'. A note on punctuation. Capital letters and full stops are important, and future candidates should be reminded of this.

Part **(c)**

Correct responses explained that as the temperature decreases, the resistance drops to zero. We were not accepting that it is the temperature when the resistance is zero. A small number of candidates thought this was linked to a state of matter change. As stated in the specification, a typical value should have been a few kelvin. We did not accept zero kelvin because the graph suggested otherwise. We did include a range of acceptable temperatures as a few metals have transition temperatures above 30 K. Some candidates confused ℃ with K and were not awarded the 2nd MP. It is worth noting for future candidates that °K is not a suitable unit.

Part **(d)**

This was generally answered well. 'Repeat' was regularly seen or implied. Comments regarding reproducing the experiment were less common. There were some weaker responses that included 'use of better equipment' that did not gain credit.

Question 3

Part **(a)**

The responses for this AO1 question were generally positive. Some candidates only attained the 1st MP as there was no reference to 'per coulomb'. Other candidates did not achieve the 1st MP because there was no reference to the energy transfer. Limited responses often involved a general 'energy transfer between two points of a battery'. They were not awarded credit.

Part **(b)**

In **(i)** we were somewhat generous with this show that question. In this question type, candidates should be careful with their use of upper and lower case letters. R and r represent different quantities. They do have the data booklet for support. Some responses were not clearly presented but sometimes arrived at 2.0 Ω. The 1st MP was awarded for good use of the emf equation and clear communication. This involved correct substitution of values into the equation. We often saw a $V = IR$ calculation first, or at least somewhere on the page. The 2nd MP was awarded for a point being chosen from the graph and r being calculated. It was good to see candidates using construction lines or similar on their graphs to highlight the point that they used.

In part (ii) we saw good use of $P = I^2R$ by many candidates. Those that used different versions of the electrical power equation sometimes used the emf value of 6 V which didn't allow for any credit. Others thought the gradient had a bearing on the answer, but this was also incorrect. Correct calculations of the power at 2 Ω allowed the 1st mark to be awarded. They then needed to calculate the power either side of this. This often led to values less than 4.5 but in the instance where candidates used values fractionally larger than or less than 2 Ω, their value may have been greater than 4.5. These candidates were given credit for this.

Question 4

Part **(a)**

This question part produced a range of responses. The 1st MP required candidates to describe the sound wave reflecting off the surface of the water. We accepted an answer of ‘waves travelling in opposite directions’. As this is a version of a specified practical, candidates should understand how the standing wave is created for this particular set up. Unfortunately, several candidates thought that the standing wave was set up in the water. The 2nd MP was the tougher mark to get. We were looking for the fact that the two waves have the same frequency or wavelength and amplitude. We wanted more than ‘they are identical’. They were all stand-alone marking points, and the 3rd MP was sometimes attained in relatively weak responses. Many candidates did know that a standing wave is formed through the process of superposition or interference.

Part **(b)**

In (i) there were many responses that involved $\frac{(x_{\text{max}} - x_{\text{min}})}{2}$. Some candidates failed to divide by 2. Some thought that multiplying 0.008 by 100 would give the percentage uncertainty. Weaker responses divided 0.001 by the mean and multiplied by 100. Candidates should know that the resolution can be considered as the absolute uncertainty for single readings but when multiple readings have been recorded, $\frac{(x_{\text{max}} - x_{\text{min}})}{2}$ should be used.

In (ii) there was minimal manipulation required in this question. If $c = f\lambda$ and $\lambda/2$ as the internodal distance were seen, the candidates usually managed the final step of showing us that $2x = \lambda$. There was some confusion as some candidates used c as 3×10^8 m s^{-1}. Careful reading of the question should eliminate this. In (iii) it was good to see candidates adding percentage uncertainties. Some went back to first principles which would have been fine, but they did not always incorporate both the 2% and the 2.35% in their solution. The final absolute uncertainty should be written to 1 or 2 significant figures. This was missed by some. When the absolute uncertainty's significant figures have been chosen, candidates should then write their value of c to the same place value e.g. 337±13. This shows the absolute uncertainty to 2 sf which is to the nearest unit. 337 has been written accordingly. Candidates should also be reminded of orderly presentation in their responses.

Question 5

Part **(a)**

There were many good responses here. The spreading of waves due to a gap, obstacle or even a slit was enough for the mark. We did not accept reference to boundary in place of gap, obstacle or slit. This was because of the confusion between diffraction and refraction shown by some candidates. ‘It is the bending of waves’ was not accepted.

Part **(b)**

There were mixed responses to drawing wavefronts. There were some good diagrams showing an understanding of constant λ. Less candidates showed increasing straight portions with straight edges. Miniature ripple tanks offer an excellent resource for candidates to explore and see these patterns live. There were too many poor attempts scribbled out because drawn in pen. Future candidates should be reminded of the necessity of using pencils, erasures and rulers in physics examinations. In (ii) some candidates did respond with ‘semi-circles’ however a significant number of candidates thought there would be less diffraction occurring which is incorrect. Candidates who wrote ‘more curved’ were close but this was not deemed enough. ‘Spread around 180°’ was accepted.

Part **(c)**

In (i) many correct responses were seen. In phase was not credited but seen. We did see lots of ‘coherant’. The spelling mistake was not penalised, but this may be something for future candidates to consider. In (ii) it was disappointing that so many candidates thought that point A showed destructive interference. A is situated on an anti-nodal line and the dynamics of this line were clearly not well understood. Some better responses thought that ‘equal path difference’ was the reason for constructive interference however this is not the same as ‘zero path difference’. It should be noted that to be awarded 4 marks, the response needed to include correct use of ‘phase’ which meant the 4th MP was the most demanding. ‘180° out of phase’ or ‘antiphase’ were accepted but rarely seen. Part (iii) was also demanding. We accepted that red laser light was coherent for the 1st MP. This meant that the slits acted as coherent sources, but we did not hold out for this. The 1st marking point was more readily accessed than the 2nd which is a tough mark to achieve. Light from the lamp is not coherent so the slits do not act as coherent sources. The red and the blue laser are not coherent. This is correct but to explain this fully we wanted reference to them being monochromatic.

Question 6

Part **(a)**

Many candidates were able to achieve full marks in (i). A minority of candidates missed the fact that the light slowed down in the plastic before entering the water. They were often awarded 2 marks. Other two mark responses achieved the 1st and 2nd MP's but '$\frac{1.9 \times 10^8}{1.33}$ = 1.4×10^8' did not allow them to get the 3rd MP. A 1-mark response usually involved a good description of the speed changes without any calculations. It was good that candidates were able to see this from the n values given, but the question specifically asks for calculated values. In (ii) we saw a full range of responses. A good number of candidates were able to calculate the critical angle for the water-air boundary. Those that used $\frac{1}{1.57}$ lost the 1st and 2nd MPs but other MPs were still available. Some candidates rather frustratingly, did everything but mention TIR. We accepted 'TIR' in place of 'total internal reflection' on this occasion. Weaker responses did not show any calculations, but they were able to be credited for a good understanding of TIR. There were a small number of 'Total Internal Refraction' responses which did not receive credit. There were several blank responses here which was disappointing.

Part **(b)**

The responses to the explain question were very mixed. Some candidates fully described the need for a population inversion but it was not credited in this instance. It should be noted that during the process of stimulated emission, the incoming photon does not hit an electron. We were not awarding MP1 if this was written. Two photons are not emitted from the process. If candidates wrote this, they were unable to achieve the 2nd MP. For the 3rd MP we were looking for the link to the energy difference the electron experiences but we accepted reference to the two photons having the same energy or frequency or wavelength. Writing 'they are coherent' or 'in phase' was also accepted. We did want more than identical. Unfortunately, it was clear in some cases that candidates were explaining spontaneous emission instead of stimulated emission. In (ii) some candidates did not go further than the photon energy calculation. There were a few factor of 10 slips here which meant 1 mark was lost. Einstein's photoelectric effect equation was seen on a few scripts showing a limited understanding of the physics being examined. It may be worth noting for future candidates that where the data booklet only provides limited support, a consideration of units can allow further progress. This concept led some candidates to recognising that the units of P were $J\,s^{-1}$ and the units of photon energy were J. Candidates then spotted that the units of $\frac{P\lambda}{hc}$ were s^{-1}.

Question 7

Part **(a)**

Candidates regularly calculated the energy difference of 2.1 eV. Some of these candidates then multiplied by e but went no further. Others saw the final step and calculated 592 nm or variants due to rounding. It was more regularly seen as 5.92×10^{-7} m but some candidates missed the last mark because they did not consider the unit. Future candidates should be reminded to state units with all responses where appropriate to do so.

Part **(b)**

There were many good responses from candidates here. We were accepting bright or yellow or colourful lines for the 1st MP. This was well accessed. A dark or black or darker background was enough for the 2nd MP. We did not accept a black spectrum.

Part **(c)**

We were looking for photons of a particular frequency or wavelength or energy for the 1st MP. For the 2nd mark the candidate had to describe the absorption of the photon by either a sodium atom or its electrons. These two MPs were well accessed. We did not give credit for a simple reference to the sodium gas doing the absorbing. The 3rd MP was more demanding but important. The reason there appears to be a black line is because the wavelength is reemitted by the excited atom in random directions. This limits the intensity at that wavelength so it appears black.

Question 8

Part **(a)**

This was found demanding by candidates. There were quite a few non-attempts unfortunately. It didn't appear that candidates were short of time. Ideally, we would have liked to see 'concentric circles', but we accepted 'circles' on this occasion. There were some confusing responses in the 2nd part of the question. The demonstration does not show that light behaves as a wave or that light has properties of both waves and particles. The experiment shows that electrons behave like waves. We did accept reference to the wave particle duality of matter.

Part **(b)**

We saw improved use of the de Broglie equation over previous years. Candidates accepted the hint and calculated the momentum for the 1st MP. They then had to rearrange the de Broglie equation for the 2nd. A good number of candidates accessed this, but some were clearly unable to locate the mass of an electron in the data booklet. These candidates were still able to access the 2nd MP. The final MP proved tougher as they were asked to present their final answer in pm. Some candidates struggled with this. The ENG button on most scientific calculators can prove useful for some in these instances.

PHYSICS

GCE

Summer 2025

A2 UNIT 3 – OSCILLATIONS AND NUCLEI

Overview of the Unit

The general standard of performance of candidates is to be commended. This was not an easy paper, but the mean mark was 65% (4% higher than last year). The statistics indicate that the paper, although slightly skewed given the mean, provided good differentiation for the cohort of applicants. There was little evidence of candidates struggling with time restrictions this year with more than 95% of candidates attempting the final parts of the comprehension question. No individual topic provided cause for concern this year but the lowest mean mark was attained for the kinetic theory question 2.

Comments on individual questions/sections

SECTION A

Question 1
All parts were competently answered except for part (b)(iii). There were the usual minor problems with the definitions in (a). Part (b)(i) was also well answered but there were some careless omissions e.g. forgetting to make a simple final comment for the conclusion or analysing only the start and the end of the process without checking a middle point.

Question 2
This question was generally well answered but part (a) was far more successful than part (b). As usual, (a)(ii) caused most problems. The most common deficiency is the problem of the relative molecular mass. Sometimes candidates believe that the mass of a molecule is 4 kg, sometimes candidates believe that the mass of a mole is 4 kg but most get this right.

Question 3
Very well answered in general with a mean mark of 70%. Part (a) was slightly novel and caused most problems. Of parts (b), (c), (d) and (e), part (c) caused most problems. Part (c) is a standard derivation which should be well known. With a mean mark of 73% one could argue that it was well known. However, the more difficult part (d) had a mean mark of 78%. This is a reflection of genuine improvement over the last 20 years when the expected mean mark for this type of question would have been well below 50%.

Question 4
Very well answered as the mean mark (66%) would suggest. Part (c) was the QER and was quite well answered with a mean mark of 57%. However, given the high mean mark for the overall paper, one might expect better responses given that this is based on a popular topic. Part (e), the issues question had a low mean mark of 42%. This was often due to vague points such as “clean energy” instead of stating no acid rain. Also, the mark scheme might have been slightly different from that which was expected - there was no conclusion mark this year, just a mark each for 3 good, relevant points. Some candidates were happy to make one or two points and move on to question 5.

Question 5
This question was extremely well answered except for parts (a), (b) and (c)(iii), see the exemplars available.

Question 6
Extremely well answered except for parts (a) and (b)(iii). In (a), one would expect more candidates to be able to identify “air resistance” (or drag) as the resistive force and that this leads to energy being dissipated. Part (b)(iii) is more difficult and these type of AO3 marks can be elusive.

However, there are some standard things that candidates should always do:

1. Describe the line of best fit (straight, negative gradient)
2. Discuss the intercept (agrees or not)
3. Does the LOBF pass through all error bars?

SECTION B

Question 7

This is an extremely high mean mark for a tough comprehension passage.
The part questions that proved tough were:

(a) Many candidates did not realise that they had to use $v = f\lambda$ here (Unit 2 synopticity).

(b) Explaining why $2 \times \frac{3}{2}kT \times \frac{M}{m_\mathrm{H}}$ is 2× the kinetic energy of the particles of the star is quite tough (Unit 3 synopticity combined with $\frac{M}{m_\mathrm{H}}$ being the number of hydrogen atoms).

(g) A tough explanation of how the distance to a Cepheid variable can be calculated (Unit 1 synopticity combined with novel material).

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A2 UNIT 4 - FIELDS AND OPTIONS

Overview of the Unit

The general standard of performance of candidates is a record high this year – from a mean last year of 46%, the mean this year is over 60% for the first time ever. This was a difficult paper, but perhaps a little more accessible than last year. The statistics indicate that the paper, despite its high mean mark, provided good differentiation for the cohort of applicants.

There was little evidence of candidates struggling with time restrictions again this year (more candidates attempted 6(b)(i) than any other part question and there was little dwindling of popularity of part questions in the options towards the end of the paper).

The two topics that caused a little concern this year were the cyclotron and em induction. On this occasion, it was completely understandable because those questions were tough.

Comments on individual questions/sections

SECTION A

Question 1
The mean performance on this question was strange. Parts **(b)** and **(c)** would appear to be the most difficult but these provided the highest mean marks.

Question 2
An excellent mean mark despite many poor definitions of the gravitational field and many candidates unable to explain why the age of the Universe is approximately $\frac{1}{H_0}$. These should have been easy AO1 marks but seem to have caught many candidates unawares. Otherwise, this topic is both well-liked and well-answered.

Question 3
Reasonable responses, on the whole, to this quality of extended response base on Kepler's Laws.

Question 4
The mean mark for this question dropped below half marks. Parts **(a)(i)** and **(c)** were the toughest. To some extent, a drop in performance is expected when the cyclotron appears because it is inherently synoptic. Nonetheless, **(a)(ii)** was answered quite well. Part **(b)**, surprisingly, was poorly answered - 2 simple marks for converting 1.2 keV to J? It proved more difficult for candidates than anticipated. Part (d) was the issues question and had a mean score of 48%. Answers, in general were too vague. It was surprising how few candidates named particle accelerators that are in general use as reasons for why particle accelerators are not a waste of money e.g. neon signs, oscilloscopes, magnetrons, X-ray tubes, old TVs etc.

Question 5
This is possibly the most difficult of all applications of em induction to explain and goes some way to explain the low mean mark for part **(a)**. The calculation in part **(b)** was far more successful.

Question 6
Candidates in Wales are particularly adept at the practical questions. The capacitor is also a favourite topic on unit 4 and this was an extra contributing factor to the high mean mark. It should be noted that this was a tough question with many devilishly difficult uncertainty skills. Part (a)(i) is a gentle start but combines 2 different equations and evaluation skills - mean mark 88%! Part **(a)(ii)** was easier but the mean mark was lower at 78% - this equation $\left(E = \frac{V}{d}\right)$ is not as well-known as it should be.

Parts **(b)(i-iii)** are all very difficult practical skills but the overall mean mark here was 77%!

Part **(b)(iv)** was slightly disappointing. Not many candidates were aware that 5 time-constants is usually plenty of charging/discharging time (99.3% complete).

SECTION B - OPTIONS
Alternating Currents - Question 7

Reponses were varied to part (a), with many candidates omitting reference to the volts/div or seconds/division. Many marked relevant values on the diagram to support their answers.

Good responses were seen in (b)(i) but some candidates confused the equations for the reactance of an inductor with the reactance of a capacitor. In (ii) there were good responses again but some confusion between the reactance of an inductor and capacitor. In (iii) although most candidates got the correct answer, the method was sometimes unclear – this was compounded by the 2.0 V value in the question. Part (iv) was answered well. In (v) most candidates were able to explain that the that the difference between X_L and X_C was the same for both circuits, leading to the same value for Z. Many correctly calculated the value for both circuits. A minority mistakenly referred to resonance concluding that X_L and X_C cancel each other out. In the final part most candidates were able to use the equation for resonance frequency to calculate L correctly, with many going on to use an appropriate equation to calculate the correct value for R.

Medical Physics – Question 8

The equation in part (a)(i) was generally rearranged well and clearly shown. The calculation was given in volts or kV which was good providing it was consistent. Part (ii) was generally well done, very few started the graph at (0,0). Again (iii) was well done, the line spectra were drawn in different places or were missing. Both were correctly credited, however if the line spectra were in the same place this lost one mark. In (iv) many candidates stated that CT gave 3D images or also caused a lot of ionising radiation. Some candidates stated that CT scans would cost more, this was also credited. There were varied responses to (b)(i), some failed to state that an alternating voltage / current was required, and fewer said that the ultrasound was at the same frequency as the voltage. Part (ii) was well answered mathematically but some candidates lost the last mark for not stating that the gel needed a closer acoustic impedance to the skin. Part (c)(i) was well done by most candidates who realised the need for a short half-life and for it to be a gamma emitter. Parts (c)(ii) and (d) were well done.

The Physics of Sports – Question 9

The context of this question was based on golf with rotational mechanics as well as projectile motion being tested as part of the option. In general, the candidates performed well and were able to provide answers for all the sections of the question. The discussion on how backspin affects the flight of the golf ball was answered poorly. The projectile motion part was well answered with many candidates scoring full marks and concluding that the golf club was the correct choice. The definition of the moment of inertia was not known satisfactorily by many candidates as well as the definition of the coefficient of restitution.

In **(a)(i)** a significant number of candidates could not give an explanation on what is meant by the moment of inertia and apply it to the golf club as shown in the diagram in the question. It was expected that candidates refer to the sum of the product of the mass and distance from the axis of rotation squared and be applied to give some context of the golfer in the diagram. Candidates frequently omitted the square of the distance factor or did not refer to the sum. In **(ii)** most candidates were able to give the answers in relation to the ratio of the speeds but frequently omitted that these speeds are relative in order to gain the full marks for this part.

Part **(b)** was answered well by several candidates who gained full marks for this part. Many candidates took the approach to determine the time using the equation $x = ut + \frac{1}{2}at^2$ and then determined the horizontal range. If the equation $v = u + at$ was used to determine the time to reach the maximum height then the candidates forgot to double this value for time.

Part **(c)(i)** was answered well with many candidates able to gain marks by determining the rotational kinetic energy but many did not include the linear kinetic energy to determine the total kinetic energy. A few candidates used the speed of $35\,\text{m}\,\text{s}^{-1}$ in their linear kinetic energy calculations rather than the horizontal component of speed. Part **(ii)** was not answered well by nearly all candidates with only a few able to gain full marks for this part. The diagrams of the forces were poorly drawn with some including an additional force from the club. Most candidates were able to explain that backspin was able to provide a lift force but did not fully explain the effect of lift on the height gained or the horizontal distance which is a fundamental requirement to the game of golf. In general, the last part was answered well with nearly all candidates able to gain marks. They were able to recall the drag force equation and then were able to use the increase of 42% correctly to determine the correct factor for the increase in the drag force.

Energy and the Environment – Question 10

In (a) most candidates used, or attempted to use, the equation $P = \frac{1}{2} A\rho v^3$. Comments on efficiency were vague with many candidates simply referring to heat, with no further explanation. Some candidates referred to varying wind speed rather than the efficiency of the transfer. In (b) many candidates were unsure how to use the 4.5 hours in their calculations with some candidates confusing two different methods resulting in incorrect answers. In part (c) the most common answers referred correctly to the cost and suitable locations. Although most candidates were able to explain the formation of H_2O in part (d), it wasn't always clear that the candidates understood the path of the electrons and H^+. In (e)(i) many candidates omitted the value 0.18 in their answer, giving a more general definition.
In the last part, most candidates calculated the rate of heat loss through the wall correctly but not all were able to calculate the heat loss through the wall and window combination, leading to an incorrect conclusion.

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Summer 2025

A2 UNIT 5 – PRACTICAL EXAMINATION

Overview of the Unit

This unit is based on an experimental task and involved a simple pendulum using a washer as a mass. The candidates were asked to investigate the relationship between the period of one oscillation and length, $T = kl^n$, and then to determine the constant n from their data. In addition, candidates were expected to measure the outer diameter of the washer and compere their results with manufacturer's data.

In general, the candidates performed well and were able to provide answers for all sections of the paper. Candidates need to further develop their skills in writing a clear method for the task. Trial readings need to be taken to inform ranges and intervals and candidates need to include these in their method section. Candidates need to use appropriate scales when plotting graphs as well as taking care to draw lines of best fit.

In the practical analysis task the candidates showed very good mathematical skills with tables, graphs and gradients being very well completed.

Comments on individual questions/sections

EXPERIMENTAL TASK

Part (a)

In part (i) the first mark was generally well done with most converting correctly to log values. Some candidates correctly compared their conversion to $y = mx + c$ which was obviously accepted. The third mark was not as well done as many candidates stated they would take trial readings but didn't note them down and so lost the mark. It was expected that a pair of trial readings was to be included so that the range could be decided. In addition, many candidates used a relatively short range of only 40 cm whilst it was expected that the minimum range used should be 50 cm. Nearly all the candidates used a minimum of five oscillations with repeat readings to determine the mean time. The last mark was for a scientific method e.g. using a fiducial point, small amplitude of swing to allow for overcoming the transient stage, this was often omitted. The risk assessment was assessed by teachers and was correctly applied in all cases. Some candidates referred to not pulling the washer to great angles which would risk the clamp toppling over. This was not given any credit.

Part (b)

Tables were generally well drawn, with only a few, incorrectly, giving units for log values. Most candidates gave correct resolutions for the stopwatch and metre ruler as asked for in the question. A few however gave an estimate of reaction time which was not accepted.

Part (c)
Graphs were well done generally, if a mark was lost it was usually for the line of best fit. The use of an appropriate scale so that the data points occupied at least ½ of the axes was not awarded for many candidates. If candidates used low values of length of the pendulum, then the corresponding log natural values gave negative values. Nearly all candidates were able to proceed and plot these values correctly on the graph.

In part **(ii)** the gradient was calculated correctly by nearly all the candidates and triangles used to show clearly the points being used for their subsequent calculations. The triangles drawn on the graph need to be close to the extremities of the line.

In part **(iii)** most candidates compared the gradient to 0.5 and commented correctly on their conclusion. Some candidates used data points to determine the time period and were not given credit for this approach.

Part (d)
The first mark was teacher assessed and was well done. The outer diameter needed to be measured at least twice preferably three times. The mean was determined correctly but some candidates were able to determine the absolute uncertainty correctly using the maximum and minimum values. Also, the absolute uncertainty was not recorded with appropriate significant figures appropriate to the raw data which is the diameter measured. Part **(ii)** was discriminating, with many varied responses received.

PRACTICAL ANALYSIS TASK

Question 1

For the second mark the units stated needed to be consistent with the candidate's calculation. The last part of the question was well done, we allowed improved resolution of the stopwatch or scales.

Question 2

In part **(a)** the majority gave correct answers to consistent significant figures. The graphs were generally well done. It was good to see a large number of candidates drawing rectangles for the error bars as they were present for both the x and y axes.

In part **(d)** not all candidates realised that the graph didn't pass through (0,0) as the temperature scale was in °C and some didn't use a convincing attempt to show that values were not doubling.

In **(e)(i)** most candidates correctly rearranged the equation and many went on to use their mean gradient correctly. In the last part the first mark for improving the resolution was often awarded but the second mark for ensuring the air column and thermometer where at the same temperature / or stirring the water was often lost.

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