GCE A LEVEL EXAMINERS' REPORTS

PHYSICS
A LEVEL

SUMMER 2017

Grade boundary information for this subject is available on the WJEC public website at:
https://www.wjecservices.co.uk/MarkToUMS/default.aspx?l=en

Online 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.

Annual Statistical Report

The annual Statistical Report (issued in the second half of the Autumn Term) gives overall outcomes of all examinations administered by WJEC.

Component	Page
Component 1	1
Component 2	6
Component 3	11
Practical endorsement	19

EDUQAS

GCE A LEVEL PHYSICS

Summer 2017

COMPONENT 1

General comments:

The mean was high which confirmed the examiners' typical experience of a succession of impressive scripts. The mechanics (questions 1 – 4) was especially well done. Mistakes began to be more frequent in the gases question (5), especially with the calculation of rms speed. The explanation of gas pressure and its dependence on temperature produced some excellent answers, though giving a condensed mathematical treatment was not the wisest approach (see below). In Q6, justifying the gradient quoted for the heating graph proved more troublesome than expected, and the application of the First Law of Thermodynamics revealed some misconceptions. Almost everyone finished the last question, the comprehension, though the first part, on stationary waves in a pipe, was probably the least well done on the paper.

Specific comments:

Section A

Q.1 (a) (i) There was great success in calculating the sum of clockwise moments. Common mistakes were treating the weight of the bar as if it acted through the end of the bar, failing to multiply masses by g, and giving the unit as N.

(ii) The tension in the wire was usually found correctly, the commonest serious mistake being to write $T\sin\theta$ = 16.8 [N m], that is equating a force to a moment.

(iii) Most candidates explained clearly enough – either in words or with the help of an equation – why the tension would increase if θ were made smaller.

(b) Almost everyone used $v = r\omega$ successfully.

Q.2 (a) (i) Most candidates extracted a value for the acceleration of trolley A from the graph and applied $F = ma$, as intended. Mistakes were quite rare.

(ii) To find the work done by the force, the usual way was to multiply the force by the distance as determined from the graph. Quite a common mistake was to calculate the distance as $\frac{u-v}{2}t$ rather than $\frac{u+v}{2}t$.

(iii) Determining the velocity given to trolley B was done well. A minor slip was to use the wrong initial velocity for A. More serious was not taking account of A's change of direction.

(iv) Most candidates showed clearly that the collision was inelastic. Kinetic energy calculations were far more common than using the coefficient of restitution – not on our specification but perfectly legitimate.

(b) Thicker metal for cars? Many candidates considered the effect on passengers in collisions. The valid point was sometimes made that certain injuries might be avoided because the thicker metal would be less likely to deform. There were some poorly argued claims that injuries might be worse 'because of the greater momentum', but the more rapid deceleration of passengers due to less crumpling was quite often correctly given as a likely disadvantage of using thicker metal. [Some candidates claimed implausibly that the collision would be *more* prolonged and the passenger acceleration less.] Points not directly related to passenger injuries included the bad effects of mining more metal, and increased fuel consumption – sometimes related to more energy being needed to bring the car up to speed and/or more tyre resistance. Well-argued points were given two marks. Plenty of sound reasoning (and some sloppy reasoning) were displayed, as well as excellent awareness of environmental issues.

Q.3 (a) (i) Homogeneity of units in $a = \frac{v^2}{r}$ was demonstrated clearly by almost everyone.

(ii) Most candidates pointed out, as intended, that as r became extremely small, then (for a given v), a approached zero (one mark). The request to justify that this was a 'sensible' value baffled many candidates, though some correctly remarked that the body would be going almost in a straight line – or equivalent.

(b) (i) Almost everyone calculated the centripetal force on the car correctly.

(ii) I Although $\cos\theta$ was sometimes used by mistake instead of $\sin\theta$, there was a good success rate in determining θ.

II Most candidates calculated D correctly using $D = F\cos\theta$, but the reasoning was not always given clearly. We were looking for *no tangential (component of) acceleration*, but accepted *constant speed*. 'Constant velocity' or 'no acceleration' or 'no resultant force' was not acceptable.

Q.4 (a) Decreasing amplitude was usually given, correctly, as the hallmark of damping. Decreasing *displacement* was not accepted. As hoped for, air resistance was usually offered as the force responsible for damping, though wrong answers included 'gravity' and the force from the spring.

(b) Most candidates put the data from the stem of the question into $T = 2\pi\sqrt{\frac{m}{k}}$ and compared their answer with T as read from the graph, and commented on the close agreement – and gained 4 out of 4. A single significant figure was really not enough for a proper comparison (one mark penalty). A minority did no calculations at all, and could not be said to have done the required evaluation.

(c) Almost everyone ringed the first zero on the graph as the point of greatest speed, though there were a few bizarre choices. This speed was usually determined correctly, unless the candidate used the equation for v at the general time, t, in which case the calculation of $\sin\omega t$ was often mishandled. Having chosen the initial displacement as their value for A, most candidates correctly stated that their calculated speed would be too high, e.g. because of energy dissipation in the first quarter-cycle. A few very discerning candidates had used the mean of A read from $t = 0$ and $t = 0.30$ s, and were excused comment on whether their speed was too high or too low!

Q.5 (a) To gain entry into the lowest band (1 or 2 marks) it needed to be pointed out that gas pressure was due to gas molecules colliding with the walls of the container, that molecules' speed increased with temperature, and that this made the hits harder or more frequent. A minority of candidates gave no more than this. Top band (5 or 6) answers, and there were many of these, discussed the collisions in terms of momentum changes, pointed out that the random hits all over the container walls led to a uniform mean pressure, and mentioned both mean frequency of collision and mean impulse per hit as causes of increase of pressure with mean molecular speed and hence with temperature. Omission of one of these didn't automatically demote a candidate to the middle band. Several candidates gave mathematical derivations of $p = \frac{1}{3}\rho\overline{c^2}$. There was no specific penalty for doing this, but some derivations were (not surprisingly too) lacking in explanation to answer the question clearly.

(b) (i) The rms speed was calculated correctly by most candidates, who used $p = \frac{1}{3}\rho\overline{c^2}$. Those who used the alternative form $pV = \frac{1}{3}Nm\overline{c^2}$ very often made wrong substitutions for N and/or m, and finished up with answers that were wrong (e.g. by a factor of $\sqrt{N_A}$).

(ii) Calculations of the temperature were generally done very well, using $pV = nRT$. The commonest mistake was to make n (and hence T) wrong by a factor of 1000.

Q.6 (a) (i) Almost everyone drew the right circuit diagram for the electrical heating experiment, but there were a few instances of wrongly connected meters.

(ii) Heat loss to the surroundings was almost always recognized as the culprit, and insulation recommended. Slow response to the heater (offered by a few candidates) was unlikely to show up most at high temperatures.

(iii) Determining the maximum and minimum gradients was done competently by most candidates – who made sound judgements over which portion of the graph to use. A minority ignored the heavy hint and used the whole graph.

(iv) Many of the justifications offered for $\frac{VI}{mc}$ being the graph gradient were ponderous, but they were usually successful. Perhaps only a minority started with $VI\,\Delta t = mc\,\Delta\theta$. There were a few terrible blunders, such as confusing Q for heat with Q for charge.

(v) The specific heat capacity of the metal was usually found successfully from the mean graph gradient. Most candidates knew how to set about determining the absolute uncertainty, but there were many slips, such as failures to halve the spread of graph gradients, leaving the answer as a percentage uncertainty... We insisted on 2 or 3 significant figures for the specific heat capacity and 1 or, at most, 2 for the uncertainty. Many candidates gave too many.

(b) (i) Most candidates calculated the work done by the expanding gas. An appreciable minority gave it as their answer to the heat intake, without calculating and adding in the increase of internal energy.

(ii) The idea of different amounts of heat being needed in different circumstances was clearly unfamiliar to some candidates. Others understood well. Whereas many gave us the familiar example of needing less heat at constant pressure for a given ΔT, there were some unexpected but perfectly valid examples, such as raising the temperature by rapid compression without *any* heat being needed.

Section B

Q.7 (a) Drawing the stationary wave patterns for the two lowest notes caused some difficulty, even though the node/antinode status of the ends of the tube had been given in the passage. Nonetheless there were many good answers.

(b) The success rate was somewhat better for finding the frequency of the third harmonic; the wavelength gave a little more trouble.

(c) In explanations of the intensity curve when the analyser was rotated, credit was given for statements about zero intensity due to absorption by the analyser when crossed with the polariser, and maximum when polariser and analyser were in the same direction, but we did also need to be told that this happened because in the light emerging from the polariser, the (electric) vibrations were confined to one direction at right angles to the direction of travel. Some candidates omitted to do so, attempting to answer the question without saying anything about the light itself.

(d) (i) We expected candidates to substitute I = 340, θ = 0 into $I = I_0 \cos^2\theta$ in order to show that I_0 = 340. Many did so, while some, equally correctly, used data from other points.

(ii) This second check on the fit between the graph and equation was taken by almost all candidates as the gift that it was.

(e) There were many good discussions of the claim about the roughness of smooth and treaded rubber, with good use made of the quoted uncertainties for the experimental data, and some doubts raised about the relevance of the experiment to whole tyres.

(f) It was impressive to see, so often, Br^3 evaluated from each pair of data – with conclusion. There were some less elegant variations (no penalty), but few failures.

(g) (i) With few exceptions the velocity at 25 s was evaluated correctly.

(ii) The straight portion of graph up to 25 s was almost always correct, the part between 25 s and 30 s was sometimes drawn straight instead of curved, and the rest, though occasionally omitted, was usually drawn correctly.

EDUQAS

GCE A LEVEL PHYSICS

Summer 2017

COMPONENT 2

General comments:

The examination contained questions from nearly all sections of the specification along with questions specifically related to experimental technique, data handling and uncertainty analysis. In addition, questions were set to test candidates' ability to provide accurate, logical and well-constructed extended responses and to test candidates' understanding of ethical issues related to science in our society.

Examiners were very encouraged by candidates' responses to most questions. Responses to questions on potential dividers, resistor networks, experimental technique (though not uncertainty analysis), Kepler's law, gravitational fields and the Young modulus were particularly encouraging. A significant number of responses to questions on materials (plastic deformation in ductile metals), current flow in different materials, and the handling of uncertainties did not score as well as expected. The paper also highlighted a lack of understanding of the term 'resolution' with a significant number of candidates believing that an instrument with a high resolution has a high uncertainty, for example. Details are provided below.

Candidates displayed good mathematical skills, especially in substituting, re-arranging equations and using exponential decay in capacitor equations. However, many weaker candidates were unable to use the formula for adding resistors in parallel. Candidates could interpret data from graphs and tables well. However, examiners felt that the candidates' use of significant figures was not well understood. Again, details are given below.

Examiners commented favourably on candidates' ability to communicate ideas clearly and succinctly. Responses to the QER question in particular were clear, unambiguous and logically structured, though not always scientifically correct. Spelling, punctuation and grammar was usually very good.

Specific comments:

Q.1 (a) Surprisingly few candidates could provide a correct definition of potential difference. Many omitted 'per coulomb' (or equivalent) of charge.

(b) Nearly all candidates applied the formula for potential dividers correctly to determine the resistance of the thermistor. A minority gave correct solutions from first principles and using $V = IR$.

(c) (i) Nearly all candidates could interpret the graph to show the effect of a change in temperature on the resistance of the thermistor. The majority of these correctly linked this change in resistance to the expected change in pd across the thermistor and were credited with one mark. However, only a few candidates could provide clear explanations as to why the voltmeter reading would increase consequently.

(ii) A variety of approaches were possible to check the claim made by the engineer, all of which were seen in the scripts. Better candidates could provide clear and logical explanations with suitable conclusions. Many candidates scored 2 or 3 marks for attempting to determine relevant values of pd and/or current, but often did not give correct conclusions. Weaker candidates usually gained 1 mark for determining the resistance of the thermistor at 30 °C from the graph.

(d) Most candidates scored 1 out of 2 for identifying the correct temperature range (0 °C to 10 °C) and for giving a simple reason in terms of a larger change in temperature or steeper gradient. Few candidates referred to the change in temperature per °C (or equivalent e.g. sensitivity) within the given ranges.

Q.2 (a) (i) A significant number of candidates incorrectly applied the formula for resistance in parallel when determining the resistance of the network. Those that did **apply** the formula correctly often made arithmetical errors when attempting to use it.

(ii) Nearly all candidates correctly identified the resistor which dissipated the greatest power. However, significantly fewer could give valid reasons for their choice in terms of either current or voltage.

(b) Nearly all candidates calculated the length of nichrome wire correctly.

(c) (i) A disappointing response. Few candidates could state the meaning of n correctly. In many cases the term 'free' (or equivalent e.g. delocalised) and/or 'per m^3' (or equivalent) were omitted.

(ii) Few candidates gained full marks for these sections. About half gave correct values for the ratios $\frac{n_X}{n_Y}$ and $\frac{I_X}{I_Y}$ providing clear explanations for their answers. Very few candidates gave the correct answer of ¼ for $\frac{v_X}{v_Y}$. ½ was a common incorrect answer.

(iii) Few candidates could provide clear and logical responses. The most common mark was 1 out of 3 for attempting to merge $R = \frac{\rho l}{A}$ with $P = I^2R$. Most candidates failed to recognise that doubling the diameter lead to a factor 4 change in cross-sectional area.

Q.3 (a) A significant number of candidates gave clear and concise explanations as to how each plate on the capacitor is charged in terms of the movement of electrons (or negatively charged particles) around the circuit. A common misconception however was to state that '*the electrons jumped the gap from one plate to the other'.*

(b) (i) Nearly all candidates could use $V = IR$ appropriately to show consistency in the values given.

(ii) Candidates usually scored one out of two marks here, usually for stating that the error bars would be too small to be plotted on the given scale. Candidates also needed to identify the resolution of the voltmeter as being the uncertainty (or refer to the 0.01 V given). A few candidates suggested wrongly that error bars could not be plotted as *'a mean uncertainty had not been calculated from multiple readings of the voltmeter'.*

(iii) Nearly all candidates referred correctly to the error bars as representing the resolution of the stopwatch.

(iv) Most candidates used appropriate values from the graph to find the time constant.

(v) Most candidates could determine a correct value for the capacitance of the capacitor. Only the better candidates could determine the absolute uncertainty in C correctly. A common error was to ignore the uncertainty in the time constant. Also, many candidates gave their final answers to C and its absolute uncertainty to an inconsistent number of significant figures. One mark was deducted in this case.

(vi) Many candidates applied the decay formula correctly to determine the pd at 55 s and concluded correctly that their answer was consistent with the trend shown in the graph.

Q.4 (a) Many candidates drew horizontal lines between the plates, but a significant number either showed the field going from right to left or did not identify a direction at all.

(b) (i) Only a minority of candidates could determine the force on an electron.

(ii) Few candidates realized that the gain in kinetic energy of an electron was equivalent to the work done by the field. 1 800 eV was accepted as a correct answer, but rarely seen.

(iii) Good attempts were made by many candidates to determine the time taken for an electron to travel from Y to X. Many candidates scored at least one mark here, usually for an appropriate 'first step' in their calculation. This could either be for determining acceleration from their answer to (i) or velocity from their answer to (ii). In many cases, the mark was awarded as ecf. Unfortunately, a significant number of candidates used the equation for constant velocity to determine t, rather than an equation for accelerated motion.

(c) Few candidates provided a clear, logical and unambiguous argument to verify the claim made. Many options were possible when answering this question, including analyses using $W = Fd$ and $W = QV$.

Q.5 (a) (i) Nearly all candidates scored well here. Advantages and disadvantages of both methods were usually laid out clearly and logically. However, the question highlighted a misconception with some candidates when using the terms 'high' and 'low' resolution. Many candidates confused high resolution with high uncertainty or vice versa for example. Comments such as: *'Ben's ruler has a higher resolution so is less accurate'* and '*The resolution of the callipers is high so the uncertainty will be high'* were seen.

(ii) Most candidates could suggest a valid improvement which would lead to an increase in accuracy when measuring r.

(b) (i) Nearly all candidates used the Coulomb equation correctly to determine the value of Q_1Q_2. A few candidates did not convert mass to weight and failed to make progress.

(ii) Again, nearly all candidates could show that the area under the graph was consistent with the product Q_1Q_2.

(iii) Nearly all candidates were successful in estimating the number of electrons on one sphere. Sometimes the mark was awarded as ecf from (ii).

Q6. (a) To gain the three marks on offer candidates were expected to refer to 'the line joining the central star (or Sun) to the orbiting planet' and to the fact that the areas shown were equal ($A_1 = A_2 = A_3$), each taking 6 months to complete. Most candidates made correct reference to the areas and time periods. Far fewer candidates referred to the line joining the star and the planet. The most common mark awarded was 2 out of 3.

(b) Most candidates could equate an equation for centripetal force and the equation for the gravitational force between two masses to derive the required expression.

(c) (i) Most candidates were confident when using the Doppler shift formula and were successful in finding the radius of the low mass star.

(ii) Those candidates who realised that the mass of the low mass star could be considered to be negligible went on to answer the question successfully. A few candidates, who did not make the assumption, became 'bogged down' in algebra and were unsuccessful.

Q.7 (a) (i) A disappointing response. Few candidates could explain clearly and unambiguously why potentials had negative signs. Many candidates talked about *doing work against attractive gravitational forces* without making any reference to the potential at infinity. Without this context, their explanations carried no meaning.

(ii) I. Nearly all candidates stated that the change in potential was zero and made correct reference to equipotential in their answers.

II. Most candidates could calculate the change in gravitational potential energy of the spacecraft when moving from B to C, however a significant minority only determined the change in potential, omitting to multiply this by the mass of the spacecraft.

(iii) Only the better candidates calculated the speed with which the spacecraft impacted with the Moon successfully. Both approaches outlined in the mark scheme were seen in the scripts.

(b) It was expected that candidates would provide one benefit and one cost to society in their answers. Many candidates opted for the 'advancing science/knowledge or aiding human habitation of the Moon' options in reference to benefits. Fewer acceptable answers were seen in reference to costs, with the majority of candidates stating simply that the exercise was 'too expensive' without expanding on their answers. This was not credited.

Q.8 (a) Few candidates succeeded in being awarded 6 marks for the QER question, although many candidates' responses were good enough to be placed into the higher marking band (awarded 5 or 6 marks). Many candidates made credible attempts at describing plastic deformation, making correct reference to the movement of dislocations in their responses. However, a significant number of candidates made explicit reference to the movement of (whole) planes of atoms, involving the breaking of bonds across the whole plane. This is incorrect, the forces required would be many times what is observed if this were the case. This highlighted a clear misunderstanding of the science behind plastic deformation in ductile materials and was not deemed credit worthy. Most candidates gave one or two methods for increasing the strength of ductile materials, often, describing the effect of foreign atoms in terms of inhibiting dislocation movement. Few candidates referred to the effect of further dislocations on the movement of dislocations within the crystal.

(b) (i) Most candidates used appropriate data from the graph to confirm the value of the Young modulus provided. In a small number of cases candidates calculated the cross-sectional area of the wire incorrectly.

(ii) Many candidates could show that a 0.2% strain corresponded to an extension of 4.4 mm. Far fewer could use the graph and appropriate equation to estimate the work needed. Most unsuccessful attempts omitted the factor ½ in their calculations.

(iii) Few candidates drew a straight line from an appropriate point, parallel to the original line and back to the x-axis.

EDUQAS

GCE A LEVEL PHYSICS

Summer 2017

COMPONENT 3

General comments:

The general standard of performance of candidates is to be commended. This was a difficult paper and the mean mark was remarkably high. The statistics once again indicate that the paper was of the right level of difficulty and provided good differentiation for the cohort of applicants. There was little evidence of candidates struggling with time restrictions this year.

Topics. The topics that caused most problems this year were lasers, two-source interference and fibre optics.

Language. The golden rule of using short sentences still applies but few candidates lost marks due to linguistic skills. The tough explanations this year were 1(b), 1(c), 3(b)(ii), 7(a), and 9.

Mathematics. Very few problems with algebra were encountered.

Show that. Candidates should realise that the final answer is given so extra proof is required. Either they should provide one more significant figure than is given in the question or they should show the last substitution step before the final answer.

Evaluative questions - many instances of good answers e.g. 2(c), 3(b)(ii), 4(d), 5(c)(i), 7(c)(ii).

Practical skills - there is some room for improvement on handling uncertainties and drawing lines of best fit. See for instance 5(c)(ii), 8(b)(i)&(ii). Also, the subtleties of the notation *(quantity±uncertainty)unit* need clarification, see also 5(c)(ii).

Specific comments:

Section A

Q.1 (a) As expected, nearly universally correct.

(b) A tough question to answer and most candidates just explained how the 4-level system works followed by how the 3-level system works. However, this question was about the advantage of the 4-level system over the 3-level system. The essential difference is that the lower level of the population inversion is (initially) full for the 3-level system but empty for the 4-level system. This leads to minimal pumping being required for the 4-level system but more than 50% pumping being required for the 3-level system.

(c) Another question that seemed innocent enough but was difficult to find an appropriate answer. Too many candidates tried generic answers that could apply to any laser energy question e.g. “to get a population inversion” or “to get as many electrons as possible in the metastable state.”

Q.2 (a) (i) Generally very well answered. Conservation of charge caused a few more problems than baryon number and lepton number. The fact that the nitrogen is initially positively charged caused problems to those candidates who insisted on considering the electrons. It is far easier to ignore the electrons and accept this as being a nuclear reaction.

(ii) Very well done in the main.

(b) (i) Similarly well answered with three marks the most popular mark attained.

(ii) Obtaining the correct number of nuclei was by far the most difficult step. This is usually the case in these types of questions – using the equations rarely causes much difficulty at this level.

(iii) Taking logarithms to obtain the correct answer rarely causes problems nowadays which is a credit to modern day physics teaching. However, the first step (realising that $\frac{N}{N_0} = 0.34$) provides most difficulty with these types of questions.

(c) Very well answered with an equal tendency to drop marks on each of the 3 marking points.

(d) Some very relevant comments made.

Q.3 (a) Very well answered but, again, I would advise candidates to forget about atomic electrons here. The masses provided should always be nuclear masses and, in any case, the helium-3 would be positively charged initially meaning that no allowance is required for the mass of an electron.

(b) (i) Very well answered although a small minority forgot to divide by the nucleon number. Also, those who converted to kg and used $E = mc^2$ were far more likely to make a mistake than those who used u and 931 MeV/u.

(ii) The point that was missed by most candidates was the most obvious – that tritium decays to helium-3.

Q.4 (a) Well answered with nearly all candidates providing an extra significant figure in their final answer.

(b) Generally well answered. Some candidates did not calculate the cross-sectional area but proceeded by mysteriously obtaining a resistance of 480 Ω (which gave a current of exactly 25 mA). These answers usually only missed one step and were rewarded with two marks.

(c) Using the total number of turns instead of the number of turns per unit length was the most common mistake.

(d) Surprisingly well answered. The most common omission was to calculate a large current or pd and then not make a sensible comment.

Q.5 (a) (i) No problems with stating Faraday's law but more candidates should have made reference to the circuit being complete so that a current could arise.

(ii) This is a slightly odd case where the flux cutting explanation is easier than the flux changing approach. Many candidates stated that the horizontal field lines were not being cut. It was rarer to find a candidate that wrote "the flux due to the horizontal field is zero."

(b) The difficult step here was

$$\frac{\mathrm{d}A}{\mathrm{dt}} = \frac{\mathrm{d}(lx)}{\mathrm{dt}} = \frac{l\mathrm{d}x}{\mathrm{dt}} = lv \qquad or \qquad \frac{A}{t} = \frac{lx}{t} = l\frac{x}{t} = lv$$

The non-calculus route is equally valid at this level.

(c) (i) Quite well answered but it was rare to award all 4 marks. Most often, candidates omitted to state that B, ℓ and R were constants.

(ii) A good differentiating question and it was very rare to award full marks. However, most candidates were able to score a good number of marks. Candidates should be reminded that percentage uncertainties should be added here. It was relatively common to see the following bad mistake: 1.25% × 6.67% = 8.33%. On this occasion, this gave an answer that was very nearly correct and so the markers had to be particularly vigilant. Perhaps most problems arose when expressing the final answer.
(58 ± 5) μT, 58 μT ± 5μT, (57.6 ± 4.6) μT, 57.6 μT ± 4.6 μT, (5.8 ± 0.5) × 10^{-5} T, 5.8 × 10^{-5} T± 0.5 × 10^{-5} T were all perfectly acceptable. However, these were rarities. Common unacceptable answers were:
(58 ± 4.56) μT, (58.0 ± 5) μT, (58 ± 4.6) μT, (57.6 ± 4.56) μT, 5.8 × 10^{-5} T ± 4.6 × 10^{-6} T, (57.62 ± 4.56) μT and even 58 ± 5 with the unit omitted. At this level, candidates should be able to quote the answer in the form *(quantity ± uncertainty)unit*. The following answers would have been accepted this year but, in truth, they are not quite good enough at this level:

I. (5.80 × 10^{-5} ± 4.6 × 10^{-6}) T. Although this answer satisfies the criteria for 2 significant figures (or 1 sig fig) in the uncertainty and that the decimal places are consistent, it is not immediately apparent that they are consistent and it is cumbersome to read. No publication would ever present data in this manner.

II. 58 μT ± 5 or 58.0 ± 4.6 μT. These answers are unideal because the unit only appears in the answer or the uncertainty but not in both (note that 58 μT ± 5 μT is fine).

Q.6 (a) In general, this derivation was answered poorly. This is one of the few derivations on the specification that needs to be learned but this point was missed by the majority of the candidature.

(b) All in all, about as tough a diffraction grating question as can be asked. Nonetheless, it was generally well answered. The most difficult step proved to be obtaining d from 250 lines per mm.

(c) Those who understood the small angle approximation immediately wrote down the answer of 125 lines per mm. Those who did not spent a bit longer going through the necessary calculations.

Q.7 (a) Not quite as well explained as might be expected. It was rare to see an explanation that incorporated the principle of superposition, coherent sources and the concept of path difference.

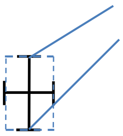
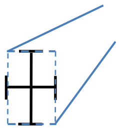
(b) Mostly well understood even though it was quite a tough diagram to analyse.

(c) (i) Most candidates did not make use of more than one wavelength to obtain a more accurate value.

(ii) Quite well answered but obtaining appropriate values of D, a and Δy from the diagram proved to be the most difficult step by far.

Q.8 (a) Very well answered.

(b) (i) A good differentiating question with the full range of possible marks awarded. It was rare to see all the error bars correct. It was also common to see the lines of best fit reaching the top/bottom middle of the error bar instead of the corners of the error bars.

i.e.  is wrong and  is correct

(ii) Another differentiating question with few completely correct answers. The biggest cause of lost marks was not calculating two gradients. Calculating the refractive index using one point and then attempting the uncertainties almost invariably led to one mark (for obtaining a value of n).

Q.9 This question achieved the full range of available marks. Candidates were rewarded for what they knew and it was rare to encounter answers that were not constructed logically. Some misconceptions that appeared were:

I. “Monomode fibres are quicker because data travels via the most direct route.” Although this is correct, the effect is negligible - a 1% improvement in the speed of light pulses is useless compared with a tenfold increase in bit rate.

II. “Monomode fibres restrict the number of allowed angles of propagation.” The number of allowed angles of propagation is one - straight along the axis.

III. “Monomode fibres are cheaper because they are thinner.” Monomode fibre systems are more expensive because of the associated transceivers.

IV. “Graded index fibres (as opposed to step index fibres) are single mode fibres.” This is not usually the case and graded index fibres are not on the specification.

Section B

Alternating Currents - Q.10

General comments:

The performance on the evaluative part (b) was particularly impressive and an indication of the strength of the candidature.

Specific comments:

(a) (i)&(ii) Well answered although the rms conversion did cause problems to many candidates.

(b) Very well answered. These were evaluation marks but this year's cohort made light of this question. It was quite rare to encounter answers that were not well structured and complete in every way. A very small minority were incorrect in their frequency dependence of the reactance and concluded that Helen was correct.

(c) (i) Very well answered although a small minority did not provide a simple justification for why $I = \frac{V}{R}$ could be used.

(ii) No algebraic problems were encountered and only a small minority were unable to obtain the correct answer.

(iii) Generally well answered but there were more instances here of wrong answers, which is understandable. A very small minority of candidates added the reactances of the capacitor and inductor.

(iv) Well answered although most explanations should have been clearer or more complete.

Medical Physics – Q.11

General comments:

The option question was generally well answered. In particular the mathematical parts of the question were well done. Candidates experienced a few problems in expressing themselves in some of the more descriptive sections such as (d)(i).

Specific comments:

(a) This was not answered as well as expected with a number of candidates describing the electron gun (heating element) rather than describing the deceleration of electrons at the target element.

(b) (i) This also proved to be less well answered than expected. The main problem being that a number of candidates did not show clearly where negative signs were cancelled, many candidates just ignored the sign and so lost one of the three marks available.

(ii) This part also caused some problems, in particular, many candidates had problems with units and orders of magnitude.

(iii) This was generally well done with most candidates identifying an MRI or PET scan as a suitable alternative.

(c) This was generally well answered.

(d) Both sections of part (d) were well answered with almost all candidates calculating the acoustic impedances correctly and then going on to identify bone and fat as having the biggest difference in impedance.

(e) This was new to the specification and so was the first time it had been set as a question and so, as expected, it caught a few candidates out. Some didn't include units with their answer and a few confused the MRI with a CT scan so stated large radiation exposure as being a problem.

The Physics of Sports – Q.12

General comments:

All the candidates attempted parts of the questions with very few parts left with no answers. Candidates displayed good mathematical skills and an understanding of the requirements of the options.

Specific comments:

(a) Both parts were answered well.

(i) Some candidates did not use the correct component of velocity.

(ii) Some did not realise that the time of contact between the ball and racquet was in ms. A surprising number determined the range correctly but then stated that the ball was not in play.

(b) (i) The definition of the coefficient of restitution was given correctly though some candidates omitted the factor 0.74 in their answer.

(ii) Some candidates did not realise that the height required was after the second bounce even though this was highlighted in the stem of the question. A number of candidates used the relevant equation of motion to determine the velocity after impact and the value of e given in the question to determine the heights at the various stages.

(c) (i) This was not answered well. Candidates did not label all the forces correctly as well as indicating their directions. Whilst the majority were able to describe the direction and the origin of the lift; the responses did not then follow to describe the effect on the height of the ball or the time of flight. Very few candidates stated that the spin or speed would change and its consequent effect on the lift.

(ii) Some candidates opted to use the equation for the moment of inertia of a solid sphere rather than a thin spherical shell as noted in the question. Error carried forward was applied as well as for the value of the angular velocity when determining the rotational kinetic energy.

(iii) A significant number of candidates opted to use the equation for the surface area of a sphere rather than the cross-sectional area when determining the drag force on the ball.

Energy and the Environment – Q.13

General comments:

Candidates were well prepared for this option and responses were of an appropriate standard. Answers to the more descriptive aspects of this question sometimes lacked structure and as a result, candidates did not always confine their responses to the questions asked. Candidates should be reminded that when a question of a descriptive nature is asked, the mark allocation for the question gives an indication of the number of different observations that need to be made to obtain full credit.

Specific comments:

(a) (i) The calculation of the peak wavelength of the radiation emitted by the Earth caused few problems. Most candidates selected the Wien's law formula and substituted into it correctly. A mark was sometimes lost because candidates did not back up their calculation with a confirmatory statement.

(ii) I. The observations made by candidates from the given greenhouse gas absorption spectra for methane, carbon dioxide were poor. Candidates were unable to analyse the three spectra and pick out the relevant data from them. Many candidates misunderstood the question and merely compared the absorptivities of the different gases at a wavelength of 10 μm, instead of across the whole range of wavelengths given in the diagrams. Most answers were very general, and no numerical data from the diagrams was provided. This restricted the credit candidates could obtain, to one mark out of the three available.

II. This part was well answered and most candidates were able to give correct reasons as to why the concentration levels of two of the given greenhouse gases are increasing.

(b) (i) Most candidates made some headway with this problem and started by equating the loss of gravitational potential energy of the water per second to the power output of the power station. The fact that the process was only 85% efficient defeated many, with either the omission of the efficiency factor, or the factor appearing on the wrong side of the equation they had set up.

(ii) The calculation of the daily time that the power station was in operation caused problems. Only the more able candidates realised that the problem reduced to the simple ratio of the given annual output energy in watt-hours to the power output of the station in watts.

(iii) Most candidates supplied a valid reason as to why the power station would not be able to produce significantly more than 240 GWh of energy per year. The most common correct answer was that the output is limited by the mass of water available in the upper lake.

(c) (i) The main cause of error here was the failure to subtract the area of the window from the total surface area of the wall when calculating the heat loss through the bricks. Another common mistake was the failure to add on the rate of heat loss through the window at the end of the calculation to find the total rate of heat loss.

(ii) I. Candidates usually substituted the given data correctly into the thermal conduction equation and were able to show that the temperature difference across the glass was approximately 0.3 °C. The main cause of error was the failure to convert the thickness of the glass into metres before substitution.

II. The main difficulty in this more testing calculation was to use the given information and the fact that the thickness of the layers of air on each side of the glass was the same, to determine the temperature drop across one of the layers of air. Candidates who were able to deduce this thickness correctly, usually proceeded to solve the problem.

III. Most candidates realised that on a windy day, the insulating air layer would be removed so that there would be a greater temperature gradient across the glass. They then went on to state that the rate of heat loss through the window would increase.

EDUQAS

GCE A LEVEL PHYSICS

Summer 2017

COMPONENT 4 – PRACTICAL ENDORSEMENT

General comments:

JCQ was responsible for allocating centres with GCE A level entries to awarding organisations to monitor. Unless the centre was defined as being a large centre, one A level subject was monitored in the first round of visits.

Lead Monitors from the different awarding organisations met on a number of occasions over the first two years to ensure that they maintained a common and fair assessment of CPAC as well as to share information. These meetings will continue into the second round of monitoring. The second series of visits to centres will commence from September 2017. Approximately 90% of all centres visited by Eduqas passed on their first visit. This outcome is very close to that from other awarding organisations. Centres which failed the first monitoring visit were given support and were visited a second time in the same subject. All centres who failed the first visit made by Eduqas subsequently passed the second visit. In the event that a centre fails a second visit then a first visit is triggered in all the other science subjects offered at A level. Since none of the Eduqas centres failed a second visit this was not triggered.

Centres need to be commended for the way in which they have approached the practical endorsement and assessed CPAC. There was plenty of evidence of good practice and it was evident from conversations with teachers that the practical endorsement has enabled most centres to offer a wider range of practical experience to their candidates than the previous A level model of assessment. There was evidence in a number of centres that additional investment had been made to facilitate the wide range of practical work that candidates now need to complete over the two years.

The monitoring visit requires that the monitor examines evidence that the centre has planned to complete the necessary range of practical work required by the specification; check records of candidate assessment; examine a sample of candidate laboratory books and observe a practical class in which assessment of CPAC is taking place.

The following points describe some key features observed in centres where the practical endorsement was successfully implemented:

- There was clear planning of practical work and the CPAC statements to be assessed in each practical.
- Candidates were well informed about the practical endorsement and the meaning of CPAC statements. Please do not leave candidates in the dark about CPAC; they need to understand it!

- Practical books were used in ‘real time’ and at the bench by candidates when completing an observed practical. (I should note that their books may get stained as a result of this; that’s fine! We want candidates to move away from writing on scraps of paper, filter paper or on the back of the hand. Data should be recorded directly to their books. Practical books are therefore not expected to be in immaculate condition.)
- The teacher targeted appropriate assessment of CPAC in the practical lesson monitored. Do not be over ambitious in your assessment. Early on in the course give your candidates time to settle in before assessing practical work and then start with the more straight forward CPAC statements (e.g. 1 and 3).
- Suitable feedback was given to candidates particularly about why they may have failed to achieve a CPAC statement and what they need to do next time to evidence it. For example, if they do not get CPAC 4 because their table omits units then please tell them the reason.
- There was use of peer assessment and self-assessment to reflect on practical work. Candidates can self-annotate work to facilitate learning and save teacher time, where necessary. This is also an important skill candidates need to acquire for future learning.
- There is evidence of good communication between staff teaching the same qualification in a centre. For example, information from CPD was fed back to other members of the team delivering the qualification.

CPAC statements

CPAC 1 This was generally well assessed by centres.

CPAC 2 Although this is the most difficult CPAC for candidates to evidence since it involves higher level skills there are a relatively large number of practicals in physics where they can be assessed. Please make sure that you know where you are going to develop this CPAC and where you intend to assess it. It is important that you give your candidates opportunity to develop the necessary skills before assessing it. Generally we do not expect to see this CPAC assessed in the first two terms of an A level.

CPAC 3 There is no need to assess it every time. Please try to choose practical work where there is some significant hazard. Candidates do not need to write a risk assessment but they should be able to identify the risks and hazards and work accordingly.

CPAC 4 There are two elements to this: (1) making accurate observations and (2) obtaining accurate, precise and sufficient data.

Please see the earlier comment about recording data into practical books. You also need to make sure that they are making appropriate tables to present this data.

There were a number of times where this CPAC statement was awarded but not fully supported by candidate work; often because data was not recorded to the expected precision or units were omitted from the table.

CPAC 5 Occasionally CPAC 4 and 5 were confused by centres. CPAC 4 is about recording data whereas CPAC 5 has two main elements: (1) processing data and (2) referencing information.

Processing data may involve making the use of graphs or calculations. Centres may use software (e.g. Excel) to draw graphs if they wish. It is probably a good idea from the point of view of the candidates' development that they use software and also draw graphs by hand over the two years.

The second element is also important. Candidates should get used to referencing sources of information whether it is a data value (e.g. they may have a value for g from the internet) or a statement from a text book or website. It is not necessary to use the Harvard system for recording websites but we do expect to see the URL and date accessed.

A few candidates tended to confuse referencing with a bibliography. There is an important difference.

Many documents to support the teaching of the practical endorsement are available on the Eduqas A level science web pages.

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