GCE A LEVEL EXAMINERS' REPORTS

PHYSICS
A LEVEL

SUMMER 2018

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PHYSICS

GCE A LEVEL

Summer 2018

COMPONENT 1

The mean mark was an impressive 68.7%. Question 1 (about a sledge sliding down a slope) had the highest number of perfect answers; question 9 (on thermodynamics), the lowest. The extended response question, 5 (b) revealed some misconceptions about resonance, though there were many excellent answers. The last question (comprehension) required candidates to do – mainly straightforward – calculations in an unfamiliar context There was little evidence of candidates running out of time: the last question scored better than the one before. Detailed comments follow.

Question 1 (*mean mark*: 6.9/8 = 86%)

(a) Almost everyone showed the normal contact force and the frictional force correctly.

(b) (i) The component of W parallel to the slope was almost always found correctly.

(ii) There were a few more mistakes in the calculation of the normal contact force. Occasionally, for example, W was divided, rather than multiplied, by cos 20°.

(c) Most candidates gained 2 marks for showing that, for a constant acceleration of 2.5 m s^{-2}, either the sledge would travel a little more than 100 m in 9.0 s, or would take a little less than 9.0 s to travel 100 m. The last mark, for commenting on whether or not the calculation was conclusive, was often lost. We did not accept "It is conclusive assuming that the acceleration is constant", because this didn't answer the question. We needed to be told that the acceleration was unlikely to be constant, owing to imperfect evenness of the snow, or increasing air resistance. There was no reason to suppose, as sometimes asserted, that friction hadn't been taken into account. One or two candidates simply claimed – correctly – that the data were given to too few significant figures for the calculation to be conclusive!

Question 2 (*mean mark*: 5.2/7 = 75%)

(a) (i) Most definitions of angular velocity were satisfactory. We did not accept "angle swept out in a *given* time".

(ii) Establishing the equivalence of $a = \frac{v^2}{r}$ and $a = r\omega^2$ was usually done very well. A minority *started* by writing $\frac{v^2}{r} = r\omega^2$ and then made substitutions on one side. This is at best poor style and at worst poor logic. On *this* occasion we didn't penalise it as long as we could see the right substitution and the right algebra.

(b) (i) $F = m\frac{v^2}{r}$ was generally re-arranged successfully and the speed of Deimos determined correctly. A small minority of candidates calculated $\boldsymbol{\omega}$ instead of v.

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(ii) Most candidates, often citing $m\frac{v^2}{r} = \frac{GMm}{r^2}$, argued convincingly that a moon of twice the mass of Deimos but in the same orbit would have the same speed. A substantial minority (not alert to synopticity?) claimed that the force would be the same, and so the speed would be less.

Question 3 (*mean mark*: 5.5/8 = 69%)

(a) Most students gave good statements of Newton's second law, often, commendably, referring to the *resultant* force or to the sum of forces. Occasionally we were treated instead to statements of the principle of conservation of momentum.

(b) (i) Most candidates drew tangents to the graph at t = 10 s and determined the resultant force competently. A minority divided the momentum at t = 10 s by 10 s, and gave this *mean* force itself, or mysteriously halved, as their answer.

(ii) There was a pleasing success rate in finding the air resistance at t = 10 s,

(iii) and almost 100% success in stating its magnitude at the terminal velocity!

Question 4 (*mean mark*: 11.0/15 = 73 %)

(a) Almost all statements of the principle of conservation of energy were satisfactory.

(b) (i) I Most candidates applied $E = \frac{1}{2}kx^2$ to the graph of elastic PE, and found k correctly. A minority tried unsuccessfully to use $F = kx$.

II Almost everyone determined the mass correctly from the graph of gravitational PE.

III The correct value for the KE at x = 0.05 m was usually given. In that case the method was not scrutinised too severely, as the 'command word' in the question was 'calculate', but we withheld marks if the candidate had clearly equated the KE to the elastic PE without taking account of the (change in) gravitational PE.

(ii) About half the candidates sketched KE against distance fallen correctly – quite impressive as it needed careful thought, or dredging from the depths of SHM theory. The commonest mistake was to start with a non-zero KE at x = 0.

(c) Describing how to verify that x_{max} is proportional to m was well done. Occasionally candidates wrote of waiting for the mass to be in equilibrium, and sometimes, but not often, they did not specify how to use the results to check the relationship.

Question 5 (*mean mark*: 10.8/15 = 72%)

(a) (i) Almost without exception the length of the pendulum was calculated correctly.

(ii) I Displacement – time graphs were usually very good, though sometimes the final zero was not shown at 3.0 s.

II The displacement at t = 1.60 s was calculated correctly except by the small minority who had made slips such as leaving calculators set to receive angles in degrees.

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III Similar remarks apply to the calculation of the velocity at t = 1.60 s.

IV Nearly half the candidates stated that the next time the sphere had the same velocity was at t = 4.00 s, that is a whole cycle later. A careful look at the graph, recognising its symmetry, shows the gradient to be the same at t = 2.00 s as at 1.60 s. To be fair, the correct answer (2.00 s) was the one most often given.

(b) Most candidates gave good explanations of resonance, starting by setting the scene: a periodic driving force is applied to an oscillatory system. Explanations that started "Resonance is..." could become tangled. 'Walkers on a suspension bridge' was a good choice of a case where resonance should be avoided, because the periodic driving force is easily identifiable. Other acceptable cases were cited, but quite a popular choice was a vehicle being driven on a bumpy road surface – which would not give forced oscillations of the vehicle on its suspension unless there were a regular pattern of bumps. Rather we would have uncorrelated start-ups of (highly damped) natural oscillations. Mention by some candidates of *critical damping* confirmed that there was confusion, as critical damping has no special significance for *forced* oscillations.

Question 6 (*mean mark*: 6.6/9 = 73%)

(a) Most candidates justified the equation $mz = M \times 0.150$ using the principle of moments, though not all pointed out that the resulting equation required dividing through by g. The origin of the 0.150 was well explained.

(b) A substantial majority realised that the gradient of a graph of m against $\frac{1}{z}$ would e $M \times 0.150$, drew the graph line and found a value for M. Sometimes a mark was lost for a poor choice of line or inaccurate determination of gradient

(c) Most candidates showed, for example by using their graphs, that an m of 0.050 kg would put the mass close to the end of the ruler, so significantly smaller values of m couldn't be used. A few candidates wrote about larger uncertainties with smaller masses. They had clearly missed the important point.

Question 7 (*mean mark*: 5.2/8 = 66%)

(a) Most candidates gave two relevant assumptions needed to derive $p = \frac{1}{3}\rho\overline{c^2}$. Occasionally we were told that molecules had to have a random distribution of speeds, or that they all had to have the same speed. Neither of these is necessary.

(b) (i) Calculating the rms speed of the argon molecules was not quite a routine exercise because, instead of the mass of gas, the rmm was given, together with the amount of gas in mole. Predictably some answers were adrift by factors of $\sqrt{1000}$ and / or $\sqrt{N_A}$.

(ii) I Some thought that doubling T would double the rms speed of the molecules, but more candidates gave the right answer (c_{rms} increases by a factor of $\sqrt{2}$).

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II There was by no means full agreement that this result would still hold if some gas escaped while T was being doubled. A seductive irrelevance was that more of the faster molecules would escape than of the slower. What matters is that the temperature doubles!

Question 8 (*mean mark*: 5.1/10 = 51%)

(a) (i) We deemed that the pV product ought really to be evaluated at 3 points to show convincingly that the graph represented expansion at constant temperature, but we gave full marks for evaluation at two points provided they weren't both end-points. The temperature also had to be calculated; sometimes this was done using a single point, ignoring the demand to show constancy: 1 mark only.

(ii) There were a few, usually successful, applications of integration, but almost everyone attempted to find the work done from the area under the graph. Quite a popular method was to link points on the curve by chords, and to add the areas of the trapezia 'under' these chords. The result was bound to be too large, but acceptable if three or four chords were drawn. An easier, and usually more accurate, way is to draw a straight line that, judging by eye, has the same area underneath it as the curve. In this case, the line might run from the point (0.10 m^3, 0.40 MPa) to point B.

(iii) Perhaps half the candidates realised that constant temperature implied constant internal energy (assuming the gas to be ideal), so a quantity of heat flows in equal to the work done by the gas. Some candidates claimed that constant temperature implied *no* heat flow.

(b) Discussions of the advantages and disadvantages of powering cars by compressed air were generally disappointing. Many candidates seemed to think that compressed air was a free resource: there were frequent (correct) claims that the cars would not pollute, but little consideration of the energy needed elsewhere to compress the air. Credit was available, but not always claimed, for 'adding value' to the data in the question, for example by pointing out that 'refuelling' would have to be much more frequent than for a petrol car.

Question 9 (*mean mark*: 12.4/20 = 62%)

(a) The common features of the electrons' motion with and without the electric field, and the differences, were usually summarised well.

(b) Almost everyone succeeded in calculating the temperature at which the electrons would have the given rms speed.

(c) Occasionally students didn't make clear the role of *force* in deriving $a = \frac{eE}{m_e}$.

(d) Few difficulties were encountered in finding E using the given equation, even with τ given in fs.

(e) Candidates derived the equation for resistivity in terms of τ from that for resistance in different ways, almost all valid.

(f) There were a few arithmetical slips and occasional algebraic blunders, but the calculation of τ was generally done well.

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(g) Explaining why resistivity was proportional to $\sqrt{T}$ was the most challenging part of this question. Candidates had to realise that τ was inversely proportional to the mean speed (and therefore to the rms speed). Occasionally mean speed was confused with drift velocity. There were, though, many good answers.

(h) It required a certain amount of courage to assign a charge to a lattice vibration, but many candidates correctly attributed the attractive forces on the electrons to a positively charged lattice vibration.

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COMPONENT 2

This was the second component 2 examination to be taken of the new specification. The paper contained questions from all sections of the component 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 their understanding of ethical issues related to science in society.

Examiners were encouraged by candidates' responses. Responses to questions on resistor networks and experimental technique, including uncertainty analysis, were particularly pleasing to see. A significant number of responses to questions on potential dividers, capacitors, electric fields and stellar physics did not score as well as expected. Details are provided below.

Candidates displayed good mathematical skills, especially in substituting, re-arranging equations and vector analysis when determining field strengths. However, many weaker candidates were unable to use the formula for adding capacitors in series or to determine the radius of a sphere (the Sun in this case) from a known surface area. Candidates were able to interpret data well from graphs and tables. However, examiners felt that many candidates' did not handle significant figures well. Again, details are given below.

Examiners commented favourably on candidates' ability to communicate ideas clearly and succinctly. Responses to the QER question were, on the whole, clear, unambiguous and logically structured, though sufficient detail was not always given and which consequently did not allow access to the higher marking band. SPG was usually very good.

It is a requirement that some synoptic style questions are given in the paper. These can be identified in 6(c), 7(a), (b)(i) and (d). In general, candidates responded well to most of these questions.

Detailed Comments

Question 1 (mean mark: 4.4/7 = 63%)

(a) (i) Nearly every candidate stated that the resistance of the LDR increased as the light intensity decreased. Fewer candidates proceeded to explain the impact this would have on the current in the LDR, as the question required.

(ii) Most candidates used the potential divider equation correctly. A significant number of candidates, in attempting to use the potential divider equation, used the incorrect pd-resistor combination. A minority determined the value of R correctly from first principles.

(b) Only a minority of candidates explained that the increased light intensity caused the pd across the LDR to fall below the activation voltage, hence turning off the lamp. For the second mark, candidates were required to refer to the repeating nature of the process to explain why the lamp kept turning on and off.

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Question 2 (mean mark: 9.3/14 = 66%)

(a) (i) The majority of candidates gave a correct explanation for the term '*electric current'*. Common reasons for not awarding the mark included giving an equation in symbol form without defining the symbols, describing electric current merely as a flow of electrons or making more than one reference to time e.g. *'The rate of flow of charge per unit time'* was not accepted.

(ii) This was very well done. Nearly all candidates used the definition of current and voltage correctly to show that the ohm could be expressed a J s C^{-2}. A significant number of candidates approached the question from an energy perspective, that is by analysing $P = I^2R$ or equivalent in terms of units. Again, this was usually done successfully.

(b) (i) Those candidates who realised that the currents through P and T were 1.2 A and 0.8 A respectively had little trouble in showing that $V_P = 1.5V_T$. Some candidates took the potential divider approach which involved determining an expression for the parallel resistor network. Candidates who took this approach were usually, successful.

(ii) Many approaches were possible to show that the value of each resistor was 4.5 Ω. Examiners commented on the confident understanding of circuit theory shown by the majority of candidates in their different approaches. Nearly all candidates were successful.

(c) Again, nearly all candidates calculated the energy dissipated per second in the whole circuit and also in resistor Q correctly, and most proceeded to compare the two values appropriately.

(d) Only a minority of candidates were able to fully explain the effect of removing T. Some thought that the change would short circuit Q and S and that as a consequence the ratio would become infinite. Others correctly stated that the current in the remaining resistors would be the same, but incorrectly stated that it would be 1.2 A.

Question 3 (mean mark: 14.5/20 = 73%)

This question tested candidates' experimental skills and was the highest scoring question in the paper. Examiners commented favourably on the confidence and skill showed by the majority of candidates in their approach to this question.

(a) Most candidates gained one mark here for stating that any change in temperature would affect both wires the same. Far fewer candidates referred to the fact that both wires were made of the same material.

(b) and (c) Nearly all candidates took the resolution of the micrometer and the ruler as the uncertainty in their calculations. In (b), nearly all candidates calculated the cross-sectional area correctly and were successful in determining the % uncertainty in r (6.25% or 6.3%). However, a small minority did not account for the squaring of r, failing to double their values accordingly. A few candidates used half of the resolution to determine the percentage uncertainty in the cross-sectional area. This was not credited but, in (c), those candidates who again used half of the resolution gained the mark on the 'error carried forward' (ecf) principle. Nearly all candidates showed that the percentage uncertainty in the metre ruler reading could be considered negligible.

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(d) (i) Examiners commented favourably on the high degree of accuracy with which candidates added error bars to the graph and with the drawing of lines of maximum and minimum gradients. Most candidates proceeded to determine the gradients of both lines accurately.

(ii) the majority of candidates understood how to use their answers to (d)(i) to find the mean gradient. Candidates were expected to find the mean gradient by calculating half of the sum of the maximum and minimum gradients and the majority did so successfully. Fewer candidates correctly determined the percentage uncertainty in the mean value. Examiners felt that many candidates were unaware of the fact that this could be calculated from half of the difference between the maximum and minimum gradients.

(e) The majority of candidates made good attempts to determine the Young modulus of the metal alloy using their answers to previous sections. Nearly all candidates understood that E = gradient $\times \frac{l}{A}$ and the majority understood the need to add together their percentage uncertainties in the gradient and cross-sectional areas. Many candidates however lost a mark for not giving their final answer with uncertainty to an appropriate number of significant figures.

(f) Many candidates stated correctly that diameter contributed most to the overall uncertainty and proceeded to suggest that 'using a wire of greater diameter (or equivalent) would reduce this uncertainty. A significant number of candidates referred to the extension as contributing most to the overall uncertainty. This was probably based on the fact that, for small values of load, the percentage uncertainty in extension can be shown to be greater than that of the diameter. This was accepted as a viable alternative.

Question 4. Mean Mark 8.7 out of 13

(a) (i) In order to gain the first mark, it was expected that candidates provide some context: e.g. 'consider matter within a radius R (or shell)'. A simple diagram depicting a shell of radius R would have been credited. This was rarely seen with nearly all candidates opting to begin with an equation showing energy conservation as applied to this context. The derivations on the whole were very good, and consequently most candidates scored 3 out of 4 here.

(ii) Nearly all candidates could show that the critical density of the universe corresponded to approximately 5 atoms of hydrogen per m^3.

(b) (i) Most candidates stated correctly that the increase in wavelength was due to the expansion of the universe or equivalent.

(ii) Nearly all candidates used the appropriate equation $\frac{\Delta\lambda}{\lambda} = \frac{v}{c}$.

However, a significant minority did so incorrectly, with many giving 116% rather that 16% as their value for $\Delta\lambda$.

(c) Nearly all candidates gained at least two marks out of three here. Stating an incorrect assumption (or not stating one at all) or forgetting to convert the age of the universe from seconds to years were the most common reasons for not awarding marks.

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Question 5 (mean mark: 3.2 = 53%)

Good, well argued and logical responses were seen to the QER question. Candidates who scored well usually referred to appropriate equations and explained the features in the diagram in terms of mathematical theory and expectation. They proceeded to explain clearly that the observed curve did not follow the expected relationship and further suggested, in terms of missing mass, why this is the case. They also referred to measuring techniques. Middle band answers tended to focus entirely on the observed curve with little or no reference to the theory surrounding the expected curve. Lower band answers tended to focus on the idea of dark matter with little or no reference to the graphs.

Question 6 (mean mark: 6.6/12 = 55%)

(a) Nearly all candidates were able to define capacitance either in words or using defined symbols.

(b) (i) Disappointingly, the majority of candidates wrote down different charges for plates Q, R and S. Reasons were often invalid and incorrect. The idea that capacitors connected in series carry the same charge was poorly understood.

(ii) A significant number of candidates failed to calculate the total capacitance of the two capacitors in series. However, many more achieved the second mark (as ecf) for correctly determining the pd across A and B

(iii) Candidates who carried out a logical analysis using one of the equations for the energy stored in a capacitor usually scored well here. The majority of candidates displayed a poor understanding of capacitor theory however and gave vague and ambiguous answers which, more often than not, agreed with the students' statement (which was incorrect).

(c) Surprisingly, this was the best answered section of the question. Good, clear and logical approaches were seen leading to the 90 N m^{-1} spring's being identified as an appropriate spring to use. The majority of candidates chose to use the equation for a parallel capacitor to determine the change in distance between the plates. They then proceeded to use Hooke's law to determine the spring constant. Some candidates applied 'trial and error', taking each of the springs in turn to determine a value for distance and then using the parallel plate capacitor equation to determine the corresponding capacitance, which was then matched with the value given in the question. Although this approach would have taken longer, it is perfectly valid and many candidates scored full marks.

Question 7 (mean mark: 9.4/16 = 59%)

(a) Fewer than expected candidates managed to provide correct definitions for both electric field strength and electric potential and also to correctly identify them as a scalar or vector. In many cases, no reference was made to unit charge (or equivalent), and in the case of electric potential, many candidates incorrectly referred to the work done to take a unit charge **from a point in the field to infinity.**

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(b) (i) and (ii) nearly all candidates drew correct arrows showing the directions of the field strengths and the resultant field strength.

(iii) The majority of candidates were successful in calculating the individual field strengths due to the charges at A and B. Far fewer candidates proceeded successfully to determine the resultant field strength and its direction. Often, when a correct direction of travel had been correctly calculated as an angle, it was not possible to award the mark as the candidate had not clearly identified, either in a diagram, or as statement, where the angle referred to.

(c) (i) Nearly all candidates used the appropriate equations correctly to determine the individual potentials due to the two charges. Most then proceeded to successfully determine the overall potential at P.

(ii) Nearly all candidates calculated the gain in kinetic energy correctly.

(d) It was hoped that candidates would link the gain in E_k to a gain in momentum and then use the de Broglie equation to explain the change in wavelength. It was pleasing to note that a significant number of candidates did this. However, many candidates incorrectly provided responses in terms of the energy of a photon, using $E = \frac{hc}{\lambda}$ to attempt to explain their answers. No credit was given for this.

Question 8 (mean mark: 7.2/12 = 60%)

(a) (i) Nearly all candidates correctly referred to the expected relationship i.e. $I \propto \frac{1}{R^2}$. Many, but not all, then proceeded to take appropriate values from diagram 1 to validate this relationship.

(ii) Nearly all candidates substituted appropriate corresponding pairs of values into the equation to determine the Sun's luminosity.

(b) Nearly all candidates scored at least two marks (out of 5) here, usually for finding the peak wavelength from diagram 2 and using Wien's law to determine the surface temperature of the Sun. Candidates could then use Stefan's law either to determine the radius of the Sun or to confirm its luminosity by using the given value of radius. Approaches seemed to be divided evenly with the majority of candidates successfully confirming the consistency of the information given. As stated in the general comments section, candidates who chose to calculate R using Stefan's law often equated their value for A (surface area) to πR^2 as opposed to $4\pi R^2$ and as a consequence lost one mark.

(c) This was the 'ethical issues in science' question. Many good and valid points were given as to the difficulties experienced in measuring the Sun's diameter. The majority of candidates gained at least one mark here.

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PHYSICS

GCE A LEVEL

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COMPONENT 3

The general standard of performance of candidates is to be commended. This was a difficult paper but the mean mark was 75.3%. The statistics 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.

General Points

Topics. The weakest topics this year were binding energy per nucleon, the cyclotron and electromagnetic induction.

Language. Many of the questions requiring explanations were answered well this year e.g. 3(a), 3(c)(i), 4(a), 4(b), 5(d), 10(a) & 10(b). The golden rule of using short sentences still applies but few candidates lost marks due to linguistic skills. Explanations that proved more difficult were the following: 3(c)(ii), 5(a), 7(a), 8.

Mathematics. Few problems with algebra were encountered again this year but algebra must be laid out neatly for "show that" questions.

Show that. Candidates now realise that extra proof is required and they invariably provide more significant figures than are given in the question. However, the last substitution step before the final answer is sometimes missing and can be penalised. Many answers to these questions are incomplete e.g. 5(b)

Evaluative questions - many instances of good answers e.g. 2(b), 6(c)(i). Perhaps the poorest answers were those to 7(b).

Practical skills - some basic skills still need practice e.g. 5(c) stating straight line through all error bars and lines straddling the origin.

Detailed Comments

Question 1 (mean mark: 6.6/9 = 74%)

(a) Well answered but a minority stated "in phase" (which is a special case) or "monochromatic" (which is incomplete).

(b) Very good answers but a small minority thought that Young had discovered wave-particle duality (they extended the experiment to electrons passing through double slits one at a time - good physics but unfortunately incorrect in the context of this question). Perhaps this question could have counted as the "issues" question.

(c) (i) Generally good but some candidates only measured the distance between adjacent fringes. A small minority counted 11 fringes for 8.0 cm when there were 10 fringe separations present.

(ii) Very well answered with some rare power-of-ten slips.

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(iii) Surprisingly well answered - most candidates realising that the fringe separation would increase but that they would become dimmer.

Question 2 (mean mark: 5.3/6 = 89%)

(a) Extremely well answered.

(b) Very well answered with 4/4 being the most common award. Failing to obtain the correct angle of incidence was the most common problem.

Question 3 (mean mark: 7.1/12 = 59%)

(a) Well answered but many candidates omitted to mention that the photons were of a high enough energy or that the electrons arrived at the (collecting) electrode.

(b) Very well answered - this is an equation that the cohort understands and applies with confidence.

(c) (i) Very well answered but some candidates forgot to mention that the polarity of the supply should be reversed.

(ii) This was a good differentiating question - it was very rare to award all 3 marks. Candidates would often realise that the alpha particles had the opposite charge but would then talk about the collecting electrode becoming positive - this was a dead end and almost invariably resulted in zero marks. Candidates should have explained in terms of the current - the photo-electron current is decreased so that the stopping potential is reduced. The last mark for reducing this effect proved very difficult. Most candidates thought that absorbers would get rid of the alpha particles without realising that the photo-electrons are low energy and less penetrating than alpha particles! However, some very able candidates gave excellent answers e.g. measuring the dark current and obtaining the stopping potential when the current drops to this value rather than zero.

Question 4 (mean mark: 9.4/13 = 72%)

(a) Well answered.

(b) Well answered with most candidates realising that the probability of stimulated emission needs to be greater than that of absorption.

(c) All parts well answered. In part (iii) the factor of 2 due to reflection was sometimes missed. In part (iv) minor slips were common with only a tiny minority unable to cope with the synopticity here.

Question 5 (mean mark: 8.5/15 = 57%)

(a) Describing the phase relationships proved more difficult than the amplitude explanations which, in turn, was far more difficult than explaining the differences in terms of energy. A common statement for the phase of a progressive wave was that points a wavelength apart are in phase. Although this is true, it is also true for a stationary wave and so could gain no credit.

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(b) This was a classic case of incomplete responses to “show that”. A majority of candidates noticed that $\frac{2L}{n}$ must be the wavelength but only a small minority could explain why.

(c) Candidates over-complicated their responses to this question - “best fit line is straight, through the origin and all error bars” would have scored all 3 marks.

(d) Very well answered even though quite a tough little part question.

(e) Responses were of a very high standard.

Question 6 (mean mark: 9.3/13 = 71%)

(a) Unexpectedly, a large number of incorrect answers were encountered. Some through arithmetic slips, others through using the wrong numbers for an electron.

(b) Extremely well answered with the vast majority gaining all 5 marks. As usual, the most common failure was not being able to calculate the correct number of nuclei.

(c) (i) Not an easy question but superbly answered by a large majority. The most common reason for dropping a mark was checking 2 half lives rather than 3.

(ii) Nearly all students realised that smaller numbers were involved but few were attributing the scatter to the random nature of decay (or dice throwing).

Question 7 (mean mark: 3.4/6 = 57%)

(a) Generally well answered.

(b) Quite a discriminating question and it was common to see mistakes in baryon numbers (pions counting as 1 and -1), charge (neutrons or pions being wrong) and mass-energy (usually anti-particles having negative rest mass-energy).

Question 8 (mean mark: 2.6/6 = 43%)

The main problem was not answering the whole of the question - many candidates did not explain the concept of binding energy per nucleon before explaining how it relates to fission and fusion.

Question 9 (mean mark: 4.9/9 = 55%)

(a) Almost universally correctly calculated.

(b) Tough to get completely correct. All omissions happened regularly - using e instead of $2e$, using 1 kick, 2 kicks or 12 kicks instead of 24 kicks (these could all receive part marks).

(c) Most candidates could derive the relationship for the frequency. The most common mistakes were using the wrong charge or the wrong mass.

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Question 10 (mean mark: 5.9/11 = 53%)

(a) Very well explained in general with 4/4 being a common mark. However, there was a small minority that thought this question was about magnetic attraction between a ferro-magnetic metal and a magnet.

(b) Extremely well answered generally. There, again, was a small minority talking about ferro-magnetism (of silver!). However, they were joined this time by another very small minority who thought that the oscillations would now increase in amplitude - thus solving all future energy problems.

Option questions

Question 11 Alternating Currents (mean mark: 14.5/20 = 73%)

(a) (i) Extremely well answered by nearly all. The root 2 factor was rarely missing neither was multiplying by 2 mV.

(ii) Not quite as well answered as (a)(i) but the vast majority were completely correct answers. Perhaps the most common mistake was stopping after obtaining the period.

(b) (i) Very well answered with the vast majority obtaining full marks for using calculus. However, it was common to see completely correct answers without calculus too.

(ii) Well answered but it was surprising to see so many correctly derived answers by calculus then state incorrectly when the induced emf would be a maximum or zero. A common answer for 1/2 marks was "the induced emf is $\omega BAN \sin \omega t$ which is clearly dependent on $\theta = \omega t$ The induced emf is a maximum when the flux is a maximum and $\theta =$ 0."

(c) (i) Very well answered and the explanations were clear too.

(ii) No problems in this question part either other than rare calculator slips

(iii) This is a classic example of ensuring that the last substitution step is shown and the answer given to an extra decimal place. What is an examiner expected to do when confronted with

$$I = \frac{V}{\sqrt{\left(X_{\mathrm{L}} - X_{\mathrm{C}}\right)^2 + R^2}} = 42 \text{ mA ?}$$

There is no substitution and no evidence of obtaining an actual value other than the one given in the question.

(iv) Surprisingly, this question proved to be a good discriminator - many candidates thought that the given calculation was correct. Candidates should realise that only the resistor can dissipate power so that the power is always given by $P = I_{\mathrm{rms}} R^2$. The calculation given is often called the "apparent power" and does not take into account that the current is out of phase with the pd.

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Question 12 Medical Physics (mean mark: 7.4/20 = 37%)

12. (a) Descriptions of the purpose of the metal filter were generally not well done with many candidates failing to mention that it was intended to block low-energy X-rays. The description of the lead grid was much better answered. A minority of candidates mistakenly talked about the absorption of alpha, beta and gamma rays.

(b) (i) This was a discriminating part of the question with only about half of the candidates completing it successfully.

(ii) This was not very well answered. The majority of successful candidates equated kinetic energy with eV in order to calculate the velocity of the electrons and then used Newton's second law to find the force exerted. This part of the question was intended to challenge the higher ability candidates and this proved to be the case.

(c) The responses to this question were rather varied. At the lower end many candidates just stated either that each test would or wouldn't work without giving any scientific reasons for their decision and so did not obtain any marks. Others described how each technique worked without giving any advantages or disadvantages. The candidates who did answer the question correctly were generally very good at describing the advantages of each technique and the disadvantage for ultrasound but many missed out disadvantages for the other techniques.

(d) (i) Some candidates were too generalised when answering this question, talking about checking for 'blockages' or 'tumours' rather than referring to a specific part of the body

(ii) This calculation was not intended to be easy but it was really pleasing to see that the majority of candidates were able to answer it correctly

(iii) This was reasonably well answered. As expected a number of candidates missed out the factor of two and so were penalised one of the two marks available

Question 13 The Physics of Sport (mean mark: 14.3/20 = 72%)

(a) This was answered poorly by all the candidates with only very few references to the centre of gravity. The most common answer given was that the the clockwise moments equals the anticlockwise moments.

(b) (i) The definition of moment of inertia was answered satisfactorily though most candidates only gave partial answers or simply quoted the equation without giving definitions of the symbols used.

(ii) Many candidates were able to gain marks on this part and determine the angular velocity.

(iii) This was also answered well by all candidates with clear application of conservation of angular momentum stated and used.

(c) (i) This was answered well with nearly all candidates able to determine the torque.

(ii) All candidates were able to gain some marks. The common errors in some of the parts were that candidates did not determine the difference correctly e.g. $(220 - 170)^2$. Also candidates did not determine the total rotational kinetic energy lost for all the wheels.

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(d) All the candidates were able to gain some marks for this part. As was expected the common approach was to determine the forces involved. However some candidates did not appreciate the magnitude of the force is very large.

Question 14 Energy and the environment (mean mark: 11.8/20 = 59%)

(a) (i) The majority of candidates correctly stated the principle. Some candidates, having made reference to an upward force, did not relate this to the weight of fluid displaced.

(ii) (I) Most candidates did this well with good use of unit conversions. Some students used the correct conversion of volume and some instead converted density.

(II) Candidates correctly found different ways to justify the 8m. Some candidates calculated the rise and some used the rise to find the volume increase. A small number of candidates incorrectly used the volume of the ice sheet as the volume of the water.

(b) (i) This was well answered in general with candidates identifying the mass per second or the mass in a certain time interval.

(ii) This was generally well accessed by candidates. A small number of candidates did not realise that doubling the length of the blade would quadruple the area and thus the power.

(iii) This proved more demanding. A common mistake was the velocity being squared instead of cubed. Some candidates failed to show an appreciation of the power into the turbine being the difference between the calculated powers from the given velocities.

(iv) This too proved to be demanding. Some students correctly referenced the energy transfers due to the moving parts in the turbine.

(c) (i) This question was well answered by the majority of candidates. Most chose the thermal conductivity equation and went on to show convincing algebra. As an example, the cancelling of m's was regularly seen.

(ii) Most candidates realised the heat flow per second was the same through both materials. Many students showed very good algebraic skills. A small number of candidates were not convincing in their algebra and were unable to arrive at a final temperature of 13°C.

(iii) The majority of candidates were able to calculate the rate of flow of heat for the concrete or the carpet which lead to the claim's being correct. Some candidates, having calculated both rates separately, went on incorrectly to add these values to find the claim to be false.

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PHYSICS

GCE A LEVEL

Summer 2018

PRACTICAL ENDORSEMENT

General

September 2017 saw the commencement of the second cycle of Monitoring visits. Each monitoring cycle lasts two years and therefore some centres allocated to EDUQAS will be visited in the 2018-19 academic year.

So far, just over 90% of centres passed on the first monitoring visit in the second cycle. This is compatible with the outcome from the first cycle of visits and also similar to other Awarding Bodies. Centres which failed the first monitoring visit were given support and were visited a second time in the same subject. All centres which failed the first visit made by EDUQAS subsequently passed the second visit. In the event that a centre fails a second visit then the other Awarding Bodies are informed. A first visit is then triggered in all the other science subjects offered at A level.

Centres need to be commended for the way in which they have approached Practical Endorsement. Centres have embraced the philosophy behind Practical Endorsement and taken the opportunity to widened the scope of practical work they do with candidates. There was a lot of evidence of good practice and assessment.

The Monitor is required to examine the following evidence during the visit:

- plans for completing and assessing practical work. The centre should have planned to complete the necessary range of practical work required by the specification.
- records of candidate assessment
- a sample of candidate laboratory books
- observe a practical class in which assessment of CPAC is taking place. The Monitor will also need to speak to the teacher about the assessment.

Monitors are asked to monitor the evidence from a year 13 class (i.e. a 2nd year A level group) whenever it is offered in a school/ college.
The following points describe some key features observed in centres where 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 practical endorsement and the meaning of CPAC statements.
- Practical books were used in ‘real time’ at the bench by candidates when completing a practical. In such cases we do not expect to find practical books in immaculate condition.
- The teacher targeted appropriate assessment of CPAC in the practical lesson monitored.
- 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.
- There was use of peer assessment and self-assessment to reflect on practical work. Learners can self-annotate work to facilitate learning.
- There is evidence of good communication between staff teaching on the same qualification.
- Information from CPD was fed back to other members of the team delivering the qualification.

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CPAC statements

Centres are reminded that in order to award a pass, a candidate needs to ‘consistently and routinely meet the criteria’. This means there needs to be evidence of multiple occasions where a candidate evidences a pass for each CPAC statement. Please ensure that you have built in suitable opportunities into your assessment plan to allow candidates to generate this evidence.

CPAC 1 This is generally well assessed by most of the centres visited. In a few cases, Monitors observed that candidates did not always carefully follow instructions. Please ensure that you carefully observe how a candidate does his/her work.

When assessing more complex procedures consider the use of a check list to aid assessment.

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. However, there should be evidence of assessment of CPAC 2 when a Monitor looks at year 13 work.

CPAC 3 There is no need to assess this skill every time a practical is completed. Do not use practical work where hazards are minimal; rather select practical work where there is some meaningful hazard / risk.

CPAC 3(a) requires learners to identify hazards and asses the risks associated with the hazards. Some centres choose to assess this by asking candidates to write a risk assessment. This is a valid means of assessment although it goes beyond what is required for the strand. If a risk assessment is not written by the candidate then it will be necessary to consider how to assess this. A simple method used by some centres is to ask candidates to identify to the teacher the hazards / risks of a technique while they do the experiment. Successful completion could then be marked on a tick sheet.

CPAC3(b) is best assessed by observation of learners doing the practical work.

CPAC 4 There are two elements to this:

(a) making accurate observations and

(b) obtaining accurate, precise and sufficient data …….

Observations should be made directly into their practical books. They should not be written on to scraps of paper and copied up at a later time. Tables of information should have appropriate headings and units. Units were not always observed in tables. This is a requirement to achieve the CPAC statement.

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CPAC 5 CPAC 4 and CPAC 5 are still occasionally confused by centres.

- CPAC 4 is about recording data 'live' into appropriate tables.
- CPAC 5 has two main elements: (a) processing data and (b) referencing information.

There should be evidence of learners processing data using graphs and calculations. Centres should use require candidates to use software (e.g. Excel) to draw graphs and, on other occasions, to draw them by hand.

The second strand of this CPAC is also important. Candidates must show evidence of referencing sources of information. The information referenced may be, for example, a data or a quote; the information may come from a text book, journal or website. The evidence produced towards this aspect of the CPAC varies considerably among centres. Some have candidates demonstrating referencing on multiple occasions, even using the Harvard System (which exceeds our requirements), while, in other centres, it is rarely evidenced.

A few centres, and therefore candidates, still confuse referencing with a bibliography. There is an important difference.

Centres are reminded to download the following documents which provide support on interpreting CPAC.

- 'The Practical Endorsement Standard'
- 'Pen Portraits' (available on the Secure website)

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