GCE A LEVEL EXAMINERS' REPORTS

PHYSICS
A LEVEL

AUTUMN 2020

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.

PHYSICS

GCE A LEVEL

Autumn 2020

COMPONENT 1 – NEWTONIAN PHYSICS

General Comments

The papers ranged from the excellent (one with almost textbook-like exposition) to the very feeble with many gaps. Generally, calculations scored more highly than parts of questions needing more words – though on some scripts the calculations needed a few words, to give a clue to the purpose of various floating fragments of arithmetic.

Comments on individual questions/sections

Question 1

Most candidates gained the two 'warm-up' marks in part (a), but many could not show whether a consistent value had been used for a car's deceleration. On the bright side, there were only two or three claims that the curved graph showed it not to be so. About half the entry applied $\boldsymbol{v^2 = u^2 + 2ax}$ at two points, often successfully.

In (b) the main fault was failure to use information from part (a), as instructed, e.g. by comparing the stopping distance at maximum permitted speed with 80 m – or even with 40 m, as the chevron notice is far from clear!

Question 2

More than half the candidates correctly defined mean acceleration as change in velocity divided by time to change, but not all who did so were able to calculate the proton's mean acceleration over a semicircle (part (b)(iii)). Calculating the proton's speed and its instantaneous acceleration at a point in its path caused few problems. Many candidates discussed only one of the two opinions about the mean force on a proton over one revolution.

Question 3

A graph of acceleration against displacement was given. Most candidates successfully identified the amplitude and calculated the period of the shm, but not everyone referred to the graph itself when asked what features showed the motion to be simple harmonic.

Hardly anyone spotted that the pendulum's length had not been measured to the centre of the bob, so the mark for (b)(i) was usually lost. This had not been intended to be tricky! A correct value for g was usually extracted from the graph of T^2 against l, but the calculation of percentage uncertainty was not so good; several candidates drew only a single, best fit, graph line rather than lines of greatest and least gradient allowed by the error bars.

Everyone knew that damping was associated with decreasing amplitude and attributed it to the action of resistive forces. Critical damping was less well understood. A bare majority knew that it brings the displaced body to rest without overshooting zero displacement, and only one or two candidates knew that the resistive force is the least possible that will do this (as a greater resistive force will result in a slower approach to zero). A good example, often given, was a car suspension. Suspension bridge damping was accepted on this occasion, but this is really to damp *forced* oscillations, and isn't necessarily critical.

Question 4

The power input to the piano hauling and the efficiency were usually calculated correctly, though elements of output and input were sometimes muddled together. Was the KE given to the piano a major reason for inefficiency? Calculating its KE (2.4 J) was a sensible start – made by about half the candidates.

Question 5

The kinetic *theory* calculations were very well done, and the momentum conservation and kinetic energy non-conservation parts, almost as well. Several candidates did not seem to know that gas molecules at a given temperature had a wide range of speeds. A surprising number of candidates used a wrong formula for the photon energy.

Question 6

Several methods were used, generally successfully, to show that the gas pressure data were consistent with an absolute zero of temperature at about –273 °C. We accepted that the kinetic energy of molecules was zero at absolute zero, though in a real substance, the particles have a residual *zero point* energy of vibration. Temperature and work calculations based on the p–V graph were very well done, but some candidates could not apply the First Law correctly to find the heat flow. There were – unfortunately no surprise – two or three claims that since the gas *temperature* was the same at C as at A, there would be no heat flow into or out of the system.

Question 7

There were some excellent answers (6/6) to this QER question. The bottom band (1/6 or 2/6) answers didn't deal with all four quantities mentioned in the question. In several scripts candidates confusedly referred to the heat *in* A and B. Sometimes the temperatures of A and B were (correctly) said to become constant, without it being stated that they became equal.

Question 8

In (a) and (b), $\boldsymbol{u}\frac{\Delta \boldsymbol{m}}{\Delta \boldsymbol{t}}$ was not always recognised as the rate of change of momentum of the exhaust gases, and the constancy of u and $\frac{\Delta \boldsymbol{m}}{\Delta \boldsymbol{t}}$ often went unnoticed. In (c) the wrong unit for $\boldsymbol{t}^{\mathbf{2}}$ was usually spotted. The 0.02 s delay was identified and almost always explained correctly. In (d) most candidates realised that the relevant equation was $\boldsymbol{x} = \boldsymbol{ut} + \frac{1}{2}\boldsymbol{at}^{\mathbf{2}}$, but they didn't always show clearly why the graph gradient would be $\frac{2.8}{F}$. Parts (e) and (f) were handled very well. In (g) disappointingly many candidates couldn't clearly explain the meaning of *Doppler Effect*. Most could quote the relevant equation, but few attempted to "describe how the exhaust speed might be measured"; mention of where the light or infra-red *came from* would have been welcome.

Summary of key points

When drawing lines on graphs always check to see if a best fit line is appropriate or lines of greatest and least gradient can be drawn.

Always consider what uncertainty is required, is it the absolute uncertainty or the percentage uncertainty?

Make sure that all areas of book work are learnt e.g. a weaker area in this paper was critical damping and ensure that qualitative responses are carefully constructed e.g. is heat flowing in or out.

PHYSICS

GCE A LEVEL

Autumn 2020

COMPONENT 2 – ELECTRICITY AND THE UNIVERSE

General Comments

Responses to calculation based questions were generally good; however a significant number of candidates confused surface area and cross-sectional area across many questions where these quantities were required. In a few cases an expression for 'volume' was used rather than surface area. Candidates are reminded that expressions for area and volume are provided in the data booklet. Written responses were often well-presented, but in too many cases, marks were not credited as key marking points, common to many scripts, were not picked up. Synoptic questions (5(c) and 8(c)(iii)) were poorly answered, as were pure recall and theory based questions. Practical analysis questions, including the handling of uncertainties were answered well by the majority.

Comments on individual questions/sections

Question 1

Many candidates were able to distinguish between thermal and drift motions of electrons in a metal. Very few however made any reference to the comparative magnitude of these velocities. Around half of the candidates were able to derive the formula $I = nave$ fully from first principles, using an appropriate diagram. In part (c), only a minority were able to clearly determine the ratio of velocities correctly. An inability to convert the given data regarding diameters into cross-sectional area was the main cause of error for many.

Question 2

Only a minority of candidates fully explained how the given readings could be used to determine the length of error bars. Fewer still used appropriate data from the graph to illustrate their answers. Subsequent questions testing uncertainties and error analysis were answered well however, with the majority of candidates showing confidence in error analysis and the significance of the gradients provided. Providing a 'final answer' with uncertainty to an appropriate number of significant figures was not well answered and resulted in many candidates losing one mark. In part (c), candidates used a variety of approaches to show that the given data were consistent.

Question 3

Few candidate responses allowed access to the top band of marks for the QER question. The majority did however give 'solid' middle band responses but failed to provide the extensive detail required to access the upper marks e.g. candidates might state that a graph of R vs l should be drawn and that the value for the resistivity could be gained from the gradient, which is correct to an extent, but the added detail of requiring the gradient to be multiplied by the cross-sectional area was often missing. In (b), many candidates were able to show that the heating unit would work as planned using the given data. The few candidates who failed to do so were often confused between the resistance of one strip and that of the full heating unit.

Question 4
The majority of candidates were able to describe the microscopic structures of the materials and to give an example of each type. Likewise, many candidates were able to make correct reference to the molecular structure of rubber at points A and B on the graph, but few were able to relate the structure changes to the gradients at these points. Nearly every candidate was able to recall and explain the term ‘hysteresis’ correctly, and to sketch a correct ‘unloading’ curve.

Question 5
Nearly all candidates were able to confirm the maximum extension possible for the wire without exceeding the elastic limit. Far fewer were able to give a correct and logical argument as to whether the maximum extension depended on the radius, with many unable to make the connection between changing radius and the corresponding change in tension. In (b) however, the majority of candidates gained all of the marks available for determining the value of k and also the required mass. Part (c) was synoptic in nature testing SHM as applied to the situation given. Good attempts were made to determine the period of oscillation and the maximum velocity of the mass. However nearly all candidates used an incorrect value for displacement when determining velocity and were deducted one mark. No correct responses were seen showing graphically how the stress varied in the wire over one complete oscillation. Many candidates however did gain some credit for using appropriate scales and/or for providing a general shape for the expected curve (with no reference to time and stress values).

Question 6
Few responses made reference to a continuous spectrum superimposed by a line spectrum, with even fewer stating where in the star these arise. Many candidates identified three key differences between Polaris and Chi Pegasi, with nearly all being able to give the expected colours of the stars. Good attempts were made by many candidates to calculate the radius of Polaris. However, as in other questions in this paper, a significant number of candidates used the wrong expressions for the inverse square law, or for the surface area of the star. In a few cases the expression for the volume of a sphere was used instead of the surface area. Consequently error carried forward was often applied. In (c), candidates merely had to explain that a variety of em wavelengths provided additional detail of the processes within the galaxy, compared to the earlier optical image. It was expected that candidates made reference to the term ‘multiwavelength astronomy’ in their responses, which few (if any) did.

Question 7
In explaining Kepler’s second law of planetary motion, it was expected that responses referred to ‘equal areas’ swept out in ‘equal time intervals’. Candidates were expected to add to the given diagram to reinforce their answers. The majority of responses either focused on the ‘time’ aspect or the ‘area’ aspect, but few linked both together to give a complete answer. In (b), fewer than expected candidates were able to show that $T^2 \alpha r^3$ starting from Newton’s law of gravitation. Good responses were seen for part (c), with nearly all candidates able to determine the mass of Mars and also confirm the gravitational potential at the Phobos orbit. Fewer candidates were able to determine whether or not the spacecraft should attempt the manoeuvre described, however the majority were able to obtain some credit for responses which were partially correct. Nearly all candidates gave a correct response as to why it was not possible to use the equation $\Delta E_p = mg\Delta h$.

Question 8
Nearly all candidates calculated the critical density of the universe correctly, giving appropriate units. It was noted that a significant number of candidates gave the units as $s^{-2}\,N^{-1}\,m^{-2}\,kg^2$, using the terms directly from the critical density equation it would seem. This was credited. Few candidates were able to show the increase in separation of two objects as a fraction of their original separation over a period of 2 billion years. Surprisingly, a

significant number of candidates also failed to calculate the radial velocity in (c)(i), with a significant number using 475 nm as the reference wavelength instead of 410 nm. No credit was given for this fundamental error; however error carried forward was applied to (ii) where the majority of candidates were able to correctly calculate the distance of the star from the Earth. Part (c)(iii) was a further synoptic based question requiring knowledge from outside of this component. Only a few candidates correctly calculated the mean kinetic energy of particles in the photosphere.

Summary of key points

Surface area or cross-sectional area are two quantities that are frequently being confused, encourage candidates to think carefully before answering questions requiring one of these quantities.
It is a requirement that synoptic questions appear on all three examination papers, candidates need to be reminded of this.
Expressing a 'final answer' with its uncertainty to an appropriate number of significant figures is an area that needs to be developed.
The term multiwavelength astronomy was unfamiliar to many candidates.

PHYSICS

GCE A LEVEL

Autumn 2020

COMPONENT 3 – LIGHT, NUCLEI AND OPTIONS

General Comments

A small cohort for obvious reasons this autumn and a very varied standard of response. There were many questions left without being attempted but not at the end of the paper where one might expect.

Comments on individual questions/sections

Section A

Question 1

Part (a) was quite well answered but some did not mention “without transferring matter” or did not refer to oscillations. In part (b) most realised that the holes were too small for the microwaves to pass through (at $1/60^{th}$ of a wavelength, the intensity passing through is negligible). It was rare to encounter a candidate who said that the 2 mm holes were far greater than the wavelength of light. A surprising number said (incorrectly) that the wavelength was longer and the energy greater. Part (c) was surprisingly well answered with most candidates obtaining full marks, however, some candidates could not add the displacements.

Question 2

Surprisingly badly answered with the majority of candidates calculating the wavelength of a photon of 2 200 eV. The experiment was not well known with the majority scoring only 1/3 marks.

Question 3

Part (a) was very well answered with most candidates obtaining full marks for both parts. The weakest candidates were unable to obtain the spacing of the slits. Part (b) was very well answered with most candidates explaining that the value was inside both ranges of uncertainties. In part (c) many talked about decreasing the uncertainty when it was the percentage uncertainty that was decreasing.

Question 4

Explanations of stimulated emission were surprisingly incomplete. Part (b) was quite well answered, especially the point that E1 has a short lifetime. Obtaining a second reason was more difficult e.g. stating that E1 is above the ground state or that the level above has a long lifetime. It was rare to encounter a candidate who explained that the 1 % loss on reflection is balanced by a 2×0.5 % gain each time the beam passes through the amplifying medium.

Question 5

Part (a) was very well answered apart from part (iv)I because most candidates did not start from: $\text{Count rate} = \frac{k}{\text{distance}^2}$ so they struggled to obtain any more than 1 mark.
Parts (b) and(c) were well answered but only a surprisingly small number in part (c) mentioned that X-rays were ionising. Some candidates mentioned that it might be ethical to experiment on dead bodies (with consent) but I’m not sure how they would inform their fellow researchers as to whether or not the “blue-grey” glow appeared.

Question 6
A successful QER question with all candidates having a good attempt and a wide range of marks awarded. Some misconceptions were observed but nothing consistent to report. The most common mistakes were wrong quark make-ups of neutron, anti-proton and the pi-meson.

Question 7
In part (a) a surprising minority wrote ${}^{2}_{1}\mathrm{He}$. In part (b) the most common omission was not combining the BE/nucleon of Bi-209 with the mass of its nucleons to obtain the nuclear mass of Bi-209. These candidates were still able to obtain 3/5 marks. Part (c)(ii) is an example of a calculation when the “Computer says no!”. Candidates put the numbers in their calculators and obtained the answer zero (because -λt is such a small number). However, the bright candidates made the correct approximation of multiplying the activity by the time.

Question 8
A few candidates obtained full marks but by using numbers rather than by using algebra in the first part. No candidate was able to obtain full marks in part (b) because nobody did part (a) using algebra. Had they done this, they would have seen that the result is independent of charge and mass.

Question 9
Some candidates failed to apply Einstein’s equation. Others failed to discuss the stopping potential. Many candidates jumped straight in with the equation $E = \frac{V}{d}$ which is the equation for a uniform field. However, they obtained the correct answer if they used the radius as d. This was probably just good fortune on many occasions because it is true that: $E = \frac{kQ}{r^2} = \frac{\frac{kQ}{r}}{r} = \frac{V}{r}$

Question 10
In part (a)(iii) some candidates wanted to increase the number of turns when it would be far easier to put in an iron core (after all the question did ask for “increased greatly”). Part (b)(i) was well answered but many candidates did not mention that the circuit was complete (or had low resistance). The easiest way to answer part (ii) was to explain it with FRHR. Those who explained using FLHR or the right-hand grip rule were usually unclear in their explanations (as opposed to being incorrect). In part (iii) there were the usual instances of using $B = \frac{\mu_0 I}{2\pi a}$. In the last part a few candidates did everything perfectly and then concluded that the force was in the wrong direction.

Section B
Comments in section B are not as detailed because of the small number of candidates that attempted each question.

Question 11 – Alternating Currents
No candidate answered this question

Question 12 – Medical Physics
All parts in (a) were answered quite well. Part (b) was quite well answered and there are no problems to report. The evaluation questions are always difficult to answer so in part (c) justifying the choice of imaging technique was problematic.

Question 13 – The Physics of Sports
The definition of moment of inertia was not well known. Part (b)(ii) was not well understood with few candidates trying to discuss force. In part (c)(i) the most disappointing aspect of

these answers was the force diagram. Very few diagrams had weight, drag and magnus force. In the second part candidates needed to remember that the area in the drag equation was the cross-sectional area (πr^2).

Question 14 – Energy and the Environment
In the last part of (a) nearly all candidates talked immediately about greenhouse gases without mentioning the atmosphere. Part (b)(i) was not well known. Most candidates only knew one factor - the temperature. The definitions in part (c) were very poor. Candidates looked at the unit of the thermal conductivity and then said, “The rate of heat transfer per metre and per ^{o}C.” The second part of (c) was very poorly answered with most candidates only attempting to verify the first part of Jack’s statement and they did this incorrectly.

Summary of key points

Certain topic areas were poorly understood such as de Broglie wavelength and electron diffraction, electric fields.
In qualitative responses a lack of clarity sometimes resulted in candidates not gaining all of the marks available.
Recall questions on definitions which were testing assessment objective 1 often were not well answered, this highlights the importance of candidates learning their work.

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