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General Certificate of Education

Physics 1456

Specification B: Physics in Context

PHYB1 Harmony and Structure in the Universe

Report on the Examination

2009 examination - January series

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Dr Michael Cresswell Director General.

GCE Physics, Specification B: Physics in Context, PHYB1, Harmony and Structure in the Universe

General Comments

Physics B: Physics in Context is aimed to excite and motivate candidates by providing the study of physics with many interesting contexts upon which to develop the understanding of physics. On the evidence of this first examination, many candidates are interested by this style of teaching and many answers went well beyond the bounds of what candidates might be expected to answer in relatively short questions. Nevertheless, the responses of the majority of candidates indicated that they had not fully assimilated the range and depth of knowledge relating to the course and many answers were of a superficial nature. Little heed was often given to writing equations before substituting values and many candidates took a lackadaisical approach to use of an appropriate number of significant figures. Answers could often have been laid out more effectively and too often what appeared to be random jottings were not creditable when the final numerical answer was incorrect. There were also many slips with prefixes to units such as ‘nm’ and ‘Mpc’.

Section A of the paper was usually answered much better than Section B and, what often appeared to be rushed answers to question 10, offered some evidence that candidates had not paced themselves as well as they might. It was surprising to see a significant number of blank answers for question involving the selection of star types or the threshold of hearing values.

Question 1

In part (a), the vast majority of candidates could name three flavours of quark with *up*, *down* and *strange* being far from the only examples offered.

The substructure of the neutron was understood well by all but a very small number of candidates in part (b).

Question 2

In part (a), many candidates had a good idea of the minimum frequency of ultrasound, however, 20 Hz instead of 20 kHz etc. was a relatively common error. Many candidates did not use a capital ‘H’ in Hz and a significant minority of candidates failed to quote any unit at all.

Part (b) (i) was almost universally well done, with manipulation of the equation being the only mistake and even that was fairly uncommon.

Most candidates seemed to recognise the building as being of a similar wavelength to the infrasound in part (b) (ii).

Question 3

In part (a), most candidates had some idea of how data was stored on these digital media. Use of the word ‘groove’ was often confusing when candidates were talking about ‘pits’. Credit was given for the idea of holes being burned in recordable CDs and DVDs. Often candidates referred to ‘bumps’ or ‘pits’ without giving reference to the ‘land’. This was credited only when there was a clear indication of different reflections or when the process of making pits or bumps was described or clear. Less able candidates avoided using the word ‘binary’, often rephrasing the wording in the question. Reference to both 0 and 1 was condoned as being binary code even when ‘binary’ was not directly mentioned.

The majority of candidates knew that DVDs have a greater storage capacity than CDs in part (b). A significant number stated that DVDs stored both visual and audio data while CDs stored only audio without relating this fact to the overall capacities of the two discs. Others mentioned the number of layers on DVDs, again without explaining that this meant greater storage capacity. More worrying was the handful of candidates who appeared to believe that CDs store analogue data.

Question 4

Most candidates used the appropriate equation for part (a) but less able candidates inverted the two refractive indices to achieve a ratio for which they could not take the inverse sine. A very significant minority of candidates suffered a penalty for not using two or three significant figures in their answers.

Few candidates were awarded two marks for part (b). Too many seemed confused by the properties of reflection and refraction (and to a lesser extent diffraction). Talk about ‘total internal refraction’ was common. Several candidates talked about multipath dispersion or the idea of this, but most thought that the cladding was a graded index and the cladding was there to increase the relative speeds between the waves. Few recognised that total internal reflection can occur without cladding and that the cladding actually increases the critical angle meaning that transmitted rays are more ‘parallel’ than they would otherwise be and that this reduces multipath dispersion. Candidates were credited for referring to cross-talk avoidance (or a clear understanding of cross-talk avoidance) between fibres but not for simply saying that light can leak in and out without cladding. Other candidates suggested that they believed that the cladding is the sheath.

Question 5

In part (a), most candidates recognised that exchange particles have something to do with forces but often it was not clear that the particle carries the force. Many thought that exchange particles carried energy and only the better answers explained that exchange particles are thought to carry the four fundamental forces. Other good answers gave an example of a field (other than gravity) and the appropriate exchange particle for that field.

Although ‘gravity’ or ‘gravitation’ were by far the most common answers to part (b) there were many incorrect responses including ‘lepton’, ‘electromagnetic’, ‘Higgs field’ and ‘mass’.

Part (c) was not well known. A number of candidates were able to correctly identify the W and Z bosons and credit was given for simply ‘boson’ but most answers appeared to be random guesses of pretty much any particle.

Question 6

Answers to part (a) often indicated some degree of confusion. Few candidates were able to define intensity unambiguously although many knew that loudness related to the observer's perception of the sound. Several answers indicated that the candidate believed that loudness was to do with amplitude whilst intensity was related to frequency (or vice versa).

Part (b) (i) was not answered well by most candidates who often suggested a typical frequency range for human hearing or else the minimum audible frequency. Other candidates stated ambiguously that it was the 'lowest' audible sound to gain no credit. Some candidates believed that it was the loudest audible sound before damage occurs to the eardrum.

Answers to part (b) (ii) were consistent with part (b) (i) and indicated that few candidates understood the decibel concept. A number of answers were given as a range and, despite being asked to give the answer in dB, several were frequency ranges.

Part (c) (i) was done well by many candidates. Those less successful, usually either did not realise that an inverse square law relationship was needed or else set their work out so badly that it was difficult for them to follow through to a conclusion. Calculating a value for P or else $I \times d^2$ was often a successful route to the final answer.

Part (c) (ii) was not understood well and many candidates did not attempt it. A small number of excellent answers illustrated a good understanding of the concepts and that it was quite possible to do this calculation without the use of logarithms providing the candidate remembered the 3 dB doubling rule. The ratio of the intensities was eight which meant that the intensity needed doubling three times (1→2→4→8) thus meaning in increase of 3×3 dB (= 9 dB).

Question 7

The question was well answered by a good number of candidates. Few however, explained clearly that the energy of the uv photons exceeded the work function of the zinc plate ejecting one electron per photon. Several candidates suggested that the leaf and stem would end up being positively charged which would mean that the leaf fell. A number of candidates appeared to believe that photons carry charge.

In part (b) (i), most candidates realised that it was the ultraviolet radiation being absorbed. Along with more common incorrect responses of 'visible', 'photons' or 'electromagnetic', a small minority of candidates suggested that it was alpha, beta or gamma radiation that was absorbed by the glass.

There were many good answers to part (b) (ii) which explained that the visible light photons had insufficient energy to overcome the metal's work function. Other answers indicated that the candidates may have understood the mechanism but did not explain it in sufficient detail to convince the examiners of their understanding: typically candidates giving this type of answer said little more than that it was ultraviolet which was causing the photoelectric effect.

Few candidates gave answers which demonstrated that they fully understood the concepts in part (c). Many felt that although the plate was positively charged the leaf was negatively charged, others that the positive charge meant that there was an excess of protons rather than a deficit of electrons. A common belief was that all the electrons had been emitted in causing the plate to become positively charged thus there were no electrons available for emission.

Part (d) was either well answered very, with candidates getting all the way through to the final answer, or else very poorly answered, with hardly any attempt made to use the photoelectric equation. Too often final answers were quoted to an unrealistic number of significant figures but, in this instance, there were no mark penalties applied for this.

Question 8

Most candidates gained a minimum of one or two marks for part (a). Answers varied from the vague notion of the relevance of cosmic microwave background radiation to a clearly expressed understanding of the link to the Big Bang. The majority of candidates talked about red shift and the Big Bang being the start of the known universe. Only a limited number of answers were truly cohesive and spelling, punctuation and grammar were generally poor.

Answers to part (b) were generally polarised between those who appeared to have no knowledge of quasars at all (particles made of quarks, being a common misnomer) and candidates who were able to describe quasars with a great deal detail. There was a fairly even split between these groups of candidates.

In part (c), most candidates made some headway towards calculating the distance of the galaxy in Mpc although many were not able to convert this into light years. It was disappointing to see a number of candidates failing to manipulate the Hubble's law equation to make *d* the subject and silly numbers of significant figures were all too commonplace. Those candidates who attempted to convert the Hubble constant into ms^{-1} ly^{-1} often did not work out the correct power of ten.

Question 9

In part (a) (i), the correct 'blue' was the most common response but a number of candidates gave 'white', 'red' or 'O'. A surprisingly large number of candidates did not answer this part at all.

Again, in part (a) (ii), the correct response was by far the most common, but there were a smattering of 'red giants', 'white dwarfs' and 'M's.

G was less well known than the other answers to part (a) (iii) but was still the most common response. 'Main sequence' and 'yellow' were fairly common responses but otherwise there was a fairly even spread between the other incorrect spectral classes. Again there were several blank responses.

For part (b) (i), although most candidates gave answers within the accepted range, 575 nm was common and not accepted. With a grid of such low precision it is unreasonable to make a reading to three significant figures. 520 nm and 530 nm were quite common responses.

The vast majority of candidates made use of Wien's law in part (b) 9(ii) but a surprising number did not rearrange the equation. Many believed that nanometres are micrometres, millimetres and even picometres. A large number of candidates arrived and an answer consistent with their λ_{max} value.

In part (b) (iii), most candidates understood the difference between absolute and apparent brightness's; a large proportion, however, reversed their logic into believing that **Q** was brighter in absolute terms and therefore **P** was larger than **Q** and closer to the Earth. A significant proportion of candidates answered this in general terms without any reference to **P** or **Q**.

Question 10

Microwaves was the favoured answer for part (a) (i), but radio waves was a very common response.

Part (a) (ii) was not answered well. Most candidates simply listed random properties relating to electromagnetic waves with no real consideration of the wavelength and frequencies of microwaves and how these properties make them effective – for example, the relative shortwave length meaning that small dishes could be used, the relatively high frequency giving a large bandwidth. Many candidates were imprecise and talked about the waves passing through the atmosphere (rather than ionosphere).

Too many candidates simply repeated the stem of the question in part (b) without developing the ideas. The examiners were looking for answers that explained that the dish of the satellite behaved as an aperture and therefore caused the signal to spread (as from a single slit) and that the footprint was determined by the boundary of the first minimum of the single slit diffraction so produced. There were not many answers of this nature.

A significant number of candidates did not complete part (c). Of those who did, many gained credit for calculating the half angle, although a number of these used the diffraction grating equation instead of the single slit equation. A reasonable proportion of candidates then went on to double their angle.

In part (d), most candidates understood that satellites' footprints would cross international boundaries but many discussed the use for spying, suggesting this to be something which would require international liaison – thus missing the point of the satellites being communication satellites. A limited number of candidates recognised the need for control of bandwidth or the possibilities of uncontrolled satellites colliding with each other of space debris. In many instances, candidates discussed the satellite as if it were the signal.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results statistics page of the AQA Website.