Version 1.0: 0809

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Physics 1456

Specification B: Physics in Context

PHYB1 Harmony and Structure in the Universe

Report on the Examination

2009 examination - June series

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Set and published by the Assessment and Qualifications Alliance.

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

General Comments

Candidate should be reminded that in 'show that' questions the steps are at least as important as the final answer; in such questions candidates cannot be credited for producing numbers out of thin air. There were many instances of candidates using too many significant figures and, although many were not penalised, candidates should be aware of the relevance of significant figures to precision and the implication that this has for practical work.

Question 1

In part (a), the vast majority of candidates recognised signal **A** as being digital and signal **B** as being analogue.

Again in part (b), most candidates realised that it was easier to remove the noise from the digital signal and that because the analogue signal continuously varies it is particularly difficult to separate the noise from the signal. Only a minority of candidates were able to suggest why it would be easy to regenerate the digital signal by ensuring a threshold value above which the signal would be recognised as being '1' and below which it would be '0'.

Question 2

This question was answered well by many, who understood that all electromagnetic waves are transverse and therefore can be polarised whilst ultrasound, like sound, is longitudinal and therefore cannot be polarised.

Question 3

This question was generally answered well. Most candidates cited internet piracy as being a major loss of revenue to musicians and the music industry. Less were clear about the advantages of internet downloads although many mentioned the widening of potential buyer-base, reduced production costs or increased speed of distribution. There was often confusion relating to the quality of the downloaded material and often it was not clear whether the advantage or disadvantage related to the industry or the consumer.

Question 4

In part (a), most candidates selected the correct equation for the double slit but there was often confusion between the slit separation and the slit-screen separation. A sizeable number of candidates had trouble with calculating the fringe separation to the correct power of 10 and single figure answers and lack of units (each of which was penalised) were not uncommon.

Few candidates knew the definition for coherence in part (b); most interpreted the question as asking for the conditions for a clear interference pattern and so equal or nearly equal amplitudes were frequently mentioned. Many candidates simply expressed the need for constant frequencies, wavelengths, phase, amplitude and velocity. The idea of a *constant phase relationship* was not generally understood with many candidates incorrectly equating constant phase with constant phase relationship.

Question 5

In part (a), most candidates were able to continue both the relative intensity and temperature scales correctly.

Part (b) was generally well known and many candidates gained the three marks. The position of the white dwarf was almost always correct but the Sun was not always marked at a relative intensity of 1. The red giant was not always on the red side of the giant line.

Question 6

For part (a) (i), the majority of candidates were able to draw the fundamental mode of vibration of the string; however draftsmanship often left much to be desired. A limited number of candidates drew the second harmonic wave.

With error carried forward from part (a) (i), part (a) (ii) was often correct.

In part (a) (iii), nearly all candidates correctly calculated the speed relative to their calculated wavelength although some forced it to be the speed of light and then substituted the appropriate wavelength back into (a) (ii).

Many candidates performed the calculation for the tension in the string correctly in part (b) and to three significant figures. A significant number of others did not quote their final answer to three significant figures (the precision of all the data). Manipulation of the equation was beyond some candidates and square rooting instead of squaring was a common error.

The phenomenon of beats in part (c) (i) was well known by many candidates although not all calculated the beat frequency and several described regular rising and falling of frequency rather than amplitude. Of the others, many recognised that this is a superposition or interference effect and gained some credit for stating this. More worryingly a number of candidates thought that this is an example of the Doppler effect.

In part (c) (ii), most candidates recognised the need to adjust the tension in the string and many explained how doing this would eventually bring the beat frequency to zero. Others simply said that the tension would need to be adjusted until the two strings were heard to be in tune. Candidates talking about ‘tuning’ without reference to adjusting the tension were penalised.

Question 7

Most candidates were able to identify fibre optics using visible or infra red radiation as a long distance means of transferring information in part (a). Although sky waves and ground waves were commonly named, few candidates did more than to suggest that radio waves would be used. As with the satellite example more than this was expected and there needed to be a mention of the wavelength or frequency to allow credit. Candidates would be advised to gain detailed knowledge of the radio regions of the electromagnetic spectrum.

In part (b) (i), few candidates correctly labelled X and Y as the reflector and dipole respectively. Many called the reflector the dish – this is the whole of the device not just the reflector.

(b) (ii) Most candidates recognised that microwaves pass through the ionosphere but few recognised that the high frequency of the radiation permitted a high bandwidth, and even fewer gave consistent arguments relating to the footprint and the size of the reflector.

Question 8

There were many very good answers to this question. Candidates not only showed a good understanding of the physics relating to data storage and playback for a CD, but also strong organisational skills to produce a coherent and well-expressed answer. A significant number of candidates wasted their time (and space) in discussing the process of encoding CDs or how data is written on to a CD-R or CR-RW. Other answers were let down by a failure to discuss the physics behind the constructive and destructive interference resulting from reflections of the laser from 'bumps' and 'lands'. A large number of candidates misspelt 'laser' many using a 'z' instead of the 's'.

Question 9

Most candidates used the Doppler equation correctly in part (a). Many calculated the change in frequency correctly but either failed to add this to the original frequency or else subtracted it from the original frequency. Less able candidates attempted to use the wave equation $v = f\lambda$.

In part (b) (i), the majority of candidates recognised that red shift means that the Universe is expanding. Few, however, were able to give a coherent explanation of how the red shirt originates. Many talked about 'stars' or 'planets' having longer wavelengths as they moved away from the Earth. A limited number discussed how the spectrum of the light emitted by a local star or galaxy was found to be of shorter wavelength than that emitted by a more distant similar star or galaxy.

Part (b) (ii) was not well understood. Many answers were phrased in a manner which indicated that candidates believed the mass of the Universe was changing. A high percentage of candidates either failed to attempt this part or else wrote answers that made little sense. The best answers were often phrased in terms of the density parameter and related the mass of the Universe to a critical mass or the density to a critical density – these answers were often far more detailed than the expected answer that the actual mass in the Universe would determine whether the Universe would ultimately expand or contract.

Question 10

In part (a) (i), most candidates recognised that the exchange particle was something to do with the fundamental forces but few were able to express this fact clearly and unambiguously.

The gluon or pion (each correct) were by far the most commonly quoted exchange particle for the strong force in part (a) (ii).

In part (a) (iii) few candidates recognised the relationship between the mass of the exchange particle and its lifetime. Answers were usually confused and incoherent.

Many candidates correctly identified the proton and electron anti-neutrino in part (b). Knowledge of proton and nucleon numbers was variable. Credit was given to those candidates who identified correctly the electron anti-neutrino without quoting proton and nucleon numbers (as being common nomenclature) however identifying this particle as being the anti-electron neutrino was not deemed creditworthy.

In part (c), most candidates had a reasonable understanding of the conservation rules and many scored all three marks. The most common single mistake was to attribute the electron anti-neutrino and the muon neutrino as having charge. Answers could gain no credit unless the properties were in the same order as the particles. Better answers stated the confirmation of each conserved property.

Question 11

In part (a) (i) a good number of candidates correctly identified the energy change **B**.
A significant minority penalised themselves by marking the arrow upwards. Others were penalised for making the change on top of the change **A**.

Most candidates attempting part (a) (ii) identified the energy changes as being 7.06 keV correctly and many then went on to convert this energy into joules (some forgetting the factor of 1000). Of those that did not convert the energy into joules, many divided their answer by the Planck constant. A significant number of candidates interpreted this question as being an example of the photoelectric effect.

Although many candidates gained the correct answer to part (b) (i) using the de Broglie equation, a large proportion managed to juggle $c=f\lambda$ to obtain a speed of $3.00 \times 10^8\,\text{m}\,\text{s}^{-1}$. It was also common for the less able candidates to simply write down both these equations to gain no credit.

Part (b) (ii) was not done well and many candidates either completely missed it out or else said no more than the wavelength was small. Few candidates recognised that for effective diffraction the atomic spacing in the crystal needs to be of the same order of magnitude as the de Broglie wavelength of the incident particles.

Mark Ranges and Award of Grades

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