Version 1.0

General Certificate of Education (A-level)
June 2012

Physics B: Physics in Context PHYB4

(Specification 2455)

Unit 4: Physics inside and out

Report on the Examination

Set and published by the Assessment and Qualifications Alliance.

The Assessment and Qualifications Alliance (AQA) is a company limited by guarantee registered in England and Wales (company number 3644723) and a registered charity (registered charity number 1073334).
Registered address: AQA, Devas Street, Manchester M15 6EX.

GCE Physics, Specification B: Physics in Context, PHYB4, Physics Inside and Out

General Comments

Too many students ignore the space allocated for answers and write in an un-scanned region of the script; although this will be picked up, it does mean that answers are often far too long and cumbersome and that students run the risk of correct answers being subsequently negated by contradictory arguments. The examiners spend considerable time in making sure that there is enough space for a full response, even written by a student with large handwriting.

Many students were unable to give formal definitions and lost marks with loose descriptions when a definition was required. Single step calculations were in general done well with stronger students also completing the multiple stage calculations to a high standard.

There was no evidence that students were unduly troubled in completing this examination in the time allowed.

Question 1

Many students failed to define amplitude precisely in part (a)(i). Many described displacement not amplitude and the word 'maximum' was frequently omitted. Most students gained the mark for part (a)(ii) but 12 was a relatively common incorrect response. Most students used multiple oscillations to allow the period to be calculated reasonably precisely in (a)(iii) – a minority tried to use the simple pendulum formula using the amplitude as the length.

All parts of (b) were almost invariably done well. A minority of students failed to square the 2π factor in part (b)(iii).

Most students recognised that part (c) was a resonance situation and either stated this or else described the effect in terms of energy transfer.

The effects of friction at the moving parts or air resistance acting on the gondola were usually mentioned in part (d); most students went on to explain that lubrication or a streamline shape reduced these factors and increased the time that the gondola would naturally come to rest in.

Question 2

In part (a)(i) most students appear to have understood the need for the fibres to retain a constant position relative to each other in the coherent bundle and the lack of need for this in the non-coherent bundle. Many were unable to phrase this unambiguously. Few students failed to appreciate that both bundles carry light and so it was essential that they referred to the coherent bundle as carrying light to form images and the non-coherent bundle doing it in order to provide illumination in part (a)(ii). In many cases it was unclear that the student understood these purposes.

Part (b) was generally reasonably done with most students recognising that having more fibres would give a clearer image and many correctly suggested that the bundle would be more flexible. Unless students were explicit that that equal numbers of fibres would produce as smaller bundle, a vaguer 'smaller bundle' was not credited. Many students were aware that a lower refractive index is needed for total internal reflection and many discussed the avoidance of light passing between the fibres within the bundle. There were a high proportion of answers which were too vague to allow credit – avoiding light leaving the fibre (without mentioning entering an adjacent fibre) was common.

The calculation, in part (c),was correctly done by the great majority of students but many lost the mark for drawing the total internally reflected ray passing through the fibre; this was often because of poor draftsmanship (freehand drawing or inconsistent angles) or because reflected angles of much less than the value calculated for the critical angle were shown. Most students could suggest at least one advantage of using CCDs compared with film. Too many reworded a single advantage (often ambiguously) to give two very similar answers when there were a wide range of acceptable answers.

Answers to part (d)(ii) were polarized with only a slight majority of students appearing to have a clear idea of how the CCD operates. There was frequent confusion between photons and electrons and many students appeared to believe that they were answering a photoelectric effect question.

Question 3

Although a significant number of students understood how to determine the whether the relationship in part (a)(i) was valid, many did not. Frequently coordinates were misread and a significant number only considered two points. A range of inappropriate techniques were used including comparing gradients and comparing changes in *v* with changes in *x*. Most students made a good attempt at part (a)(ii). There were some misreadings from the graph and many subtracted their velocity values before squaring. Part (a)(iii) tested a difficult concept and not many students answered it well. The situation was not a satellite in stable orbits but a moving space module. The Earth's gravitational field does work on the module which causes the kinetic energy to increase by the same amount as the gravitational potential energy decreases. Few students were able to demonstrate that they had a good understanding of potential energy or potential. Answers to part (a)(iv) were frequently phrased in terms of gravitational forces and there was confusion between the gravitational field strength and potential or potential energy. Few students were able to give formal definitions of either potential energy or potential to aid their discussion.

In part b)(i) most students had a good idea of what constitutes the payload although a number thought it was the space which the passengers occupied whilst others thought that it included the fuel. Many answers regarding the jettisoning of spent fuel tanks made it unclear that the jettisoning occurred once the fuel has been used and few answers went on to say the at the reduced mass because of this meant that there would be increased acceleration for the same thrust or else that the rocket would be able to take the payload further. Answers relating to the payload/fuel ratio were often inverted.

Part (b)(ii) was a more accessible question and most students gained the mark available however, since the examiners allowed 'astronauts breathing' as well as the expected 'to allow the fuel to combust' vague answers were penalised. The calculation in part (b)(iii) was generally well done although answers were usually to three rather than the expected two significant figures. A large number of students were penalised by a mark for subtracting the weight from the overall thrust. In part (b)(iv) most students mentioned that the mass of the fuel was reduced but missed the point that the weight therefore was also reduced meaning a larger overall upward force was acting on a smaller mass; thus acceleration was increased because of both the reduced mass and the increased upward force.

Question 4

The relationship between the centripetal force and the physical forces which provide them is not generally well understood by students. Many confused the direction of the forces and many implied or stated that the centripetal force is actually centrifugal. In part (a)(ii) most students related the weight to the centripetal force but it was clear that many did not realise that there was no reaction happening in this limiting case (with very few referring to reaction at all). It was common to see that candidates thought that *R*, in the equation '$mg + R = mv^2/r$ ', was the air resistance not the reaction. The vast majority of students correctly calculated the velocity needed at **T**; but then most failed to recognise that the marble had a combination of kinetic energy and gravitational potential energy at T, producing a value 0.32 m lower than the correct answer.

In part (b), a high proportion of students believed that height *h* could be reduced whilst still allowing the marble to stay on the track. Others recognised that *h* needed to be increased but then talked about increasing the velocity; this question proved to be a very good discriminator. Formal definitions of moment of inertia were quoted infrequently and there was considerable reference to opposition to change of motion, rather than angular motion. Frequently students referred to the torque and angular acceleration as being the quantities upon which the moment of inertia depends (rather than mass and its distribution about the axis of rotation).

Part (c)(ii) was done well with most students being able to calculate the correct rotational kinetic energy. Many students did not recognise that the principle of conservation of angular motion needed to by applied in part (d); those that did almost invariably went on to score full marks. Many tried to use the conservation of angular kinetic energy or, failing to find the time for the interaction, went on to calculate a bogus torque by multiplying the moment of inertia by the angular speed (taking it to be the angular acceleration).

Question 5

The time difference between the pulses was not universally measured precisely with several students being satisfied to work to the nearest millisecond. A common mistake was for students to forget that the time difference represents twice the distance between the near and far surfaces of the stomach. Answers to part (a)(ii) were frequently vague and did not mention any physical processes. Simply saying that the signal attenuates more as it travels through a greater thickness of material is true but fails to give the reason for the attenuation.

Although there were some excellent descriptions of this use of ultra sound in part (b) too many answers gave large quantities of irrelevant detail regarding how ultrasound is produced. Other answers did little more than repeat the information given in the previous part of the question. The use of a gel was well understood although often it was not clear if the student really understood the term acoustic impedance. Few mentioned the fact that the ultrasound is of such high frequency that it was good at resolving fine detail. A significant minority of students referred to ultrasound as being electromagnetic. Many students' handwriting was poor and difficult to decipher; too many used shorthand and abbreviations which did not help the quality of their communication.

Question 6

Clear definitions of magnetic flux density were few and far between with many being vaguely correct but too loose to gain any credit. There was virtually no reference to the need for the conductor to be perpendicular to the magnetic field to use $B= F/IL$ or for the flux to be perpendicular to the area when using $B=\Phi/A$. Most students recognised the tesla as the unit of flux density but (although not penalised) most wrote it with a capital T (as Tesla). A minority suggest the weber or weber per metre squared (although the latter is dimensionally correct it is not the unit of flux density). A significant number of students appeared not to understand what was required in part (a)(iii) and there were a large number of blanks or answers that really made no sense. Of those replying 'vector' or 'scalar' the majority knew the flux density is a vector but not all of these stated that direction needed to be considered. Many students were happy to simply say that a magnetic anomaly is a variation in the magnetic field strength; it is essential to mention that the variation does not match the pattern in the region surrounding the anomaly. A number of students failed to gain credit by using a more generic definition of anomaly.

In part (b) most students were able to make a reasonable attempt at quoting Faraday's laws; frequently Lenz's law was often referred to but was not relevant to the magnitude of the induced current in the sensor coil. A good proportion of students were able to make a convincing argument that increasing the (frequency of the) alternating current, increased the rate of change of flux linking the sensor coil and therefore increased the induced emf and current in the sensor coil. The great majority of students correctly calculated the maximum emf and most correctly divided their answer by 5.2; but the conversion of their answer into microamps was much more of a problem for some.

The examiners recognised that part (c)(iii) was one of the more challenging parts of the paper and therefore were lenient in accepting variables which arguably may not increase the sensitivity of the magnetometer. The use of the word 'coils' to mean 'turns' was not accepted since, with two coils present 'increasing the coils' was ambiguous. A significant number of students mentioned variables that could be changed without suggesting how they would change them (e.g., 'turns on coil C' instead of 'increase the number of turns on coils C').

Please visit AQA's Enhanced Results Analysis service. A free, online tool that gives you an instant breakdown of your GCE Physics results.

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

UMS conversion calculator www.aqa.org.uk/umsconversion.