Version 1.0: 0810

General Certificate of Education

Physics 2450

Specification A

PHYA5/2C Applied Physics

Report on the Examination

2010 examination - June series

Further copies of this Report are available to download from the AQA Website: www.aqa.org.uk

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 A, PHYA5/2C, Section A, Nuclear and Thermal Physics

General Comments

The exam was very accessible to candidates and many good scripts were seen, some with full marks. The overall standard of writing was very good and the paper as a whole did not produce many scripts with scores in single figures. The majority of candidates had prepared well for the exam. The main difficulties for candidates were expressing their ideas clearly in the descriptive questions.

Question 1

Almost all candidates knew which equation to use in part (a) and only a small minority used the wrong temperature change.

In part (b) most candidates obtained full marks.

Part (c) turned out to be a very good discriminator. About one third of candidates were not using the heat energy released by the lead, as it cooled, in their calculation. These candidates either used their answer to (a) or (b) or the sum of the two. In addition another 10% calculated the incorrect temperature change.

Part (d) was answered well on the whole. The most common error by candidates was to not say where the heat energy might go in their answer. Candidates simply said that heat is lost.

Question 2

This question was a good discriminator. Most candidates, in part (a), knew how the core of the reactor functions. Some candidates too readily used the wording of the question as their answer. Others did not refer to neutrons even though this was asked for in the question. One example of a phrase given by candidates that did not quite answer the question but sounded reasonable was, ‘the power levels were kept constant by keeping a constant rate of fission using control rods’. This offers much of what was in the question itself and it does not refer to neutrons. The quality of the writing was generally good.

Again question (b) was a good discriminator. The majority of candidates were aware that fission products are normally unstable because they tend to be neutron rich or that they release beta and gamma rays. Less able candidates thought used fuel meant that they had undergone alpha emission.

Question 3

Less than half the candidates could explain the meaning of the decay constant. By contrast almost all candidates could find the half-life in part (b) and a majority could answer part (c). Some candidates did not gain credit because they conveniently removed 10^{12} in their calculation without showing the division. So lines like, $1.15 \times 10^{12}\,\text{Bq} = 1.15\,\text{Bq}$, were seen.

Most candidates who tackled part (d) using the exponential decay of the activity equation got full marks. Only a few candidates could not rearrange the equation. By contrast almost all candidates who tried to use the exponential decay in the number of nuclei got confused. Most had numbers of nuclei on one side of the equation but activity on the other.

Part (e) did discriminate but only between scoring zero marks or one mark. Very few candidates attempted two reasons. Most acceptable answers to this question were difficult for the candidate to express. For example, in question (d) it states that the decay rate due to carbon-14 is 0.65 Bq, indicating it is a corrected count rate. So an answer to part (e) like, 'the background can effect the result', is not acceptable. This is not the same as saying it is difficult to obtain the results for the sample activity because the background activity is high in comparison. This example is also ambiguous in that it suggests the surroundings can influence the rate of decay. Another answer that was not acceptable was, 'radioactive decay is random so it's bound to give false values'. To gain a mark following this line of thought it was necessary to refer to its effect on the statistics. The most common answers that candidates found easy to express included the following; the tree died well before the boat was made; or the boat was repaired later in its life with fresh wood; or that carbon based microbes died in the wood when the boat was rotting at the end of its useful life.

Question 4

Part (a) proved difficult for less able candidates. Some drew straight lines and others tried to force the curve to intercept the volume axis. The less able candidates sometimes marked correct points on the grid but did not draw a line. It seemed that some less able candidates followed the wrong order in tackling this part. They drew the curve before they marked points on the grid. As a result the points were just randomly placed on the curve they had drawn.

Part (b) (i) was done well by most. Candidates who used the alternative equation $PV = nRT$ often stopped when they had found the number of moles of gas. Part (b) (ii) was much more discriminating with less than 50% of candidates obtaining the correct answer. Many candidates did not have a clue whereas others could find the mean kinetic energy but then did not follow this up by finding the total kinetic energy.

Although part (c) looks like a basic question it did discriminate well. It was only the more able candidates who scored full marks. Many did not know what the question was getting at and guessed. Sometimes these candidates did score the mark associated with molecules moving in random motion. In other cases candidates did not complete their statements fully. For example, stating 'atoms travel in straight lines', rather than, 'atoms travel in straight lines between collisions'.

GCE Physics, Specification A, PHYA5/2C, Section B, Applied Physics

General Comments

Most candidates were able to attempt all the questions and they appeared to have allowed themselves enough time on this section to answer the paper in full.

A large number of candidates gave generally competent quantitative answers, particularly for the two rotational dynamics questions, but they showed less confidence when it came to writing explanations. Candidates were least well prepared for Question 3, concerning a refrigerator, a topic that did not appear on the previous specification for this option.

Units were given on the answer lines to all calculations apart from Question 2 (a) (i) where candidates were instructed to give an appropriate unit. The unit mark was an independent mark, and was awarded even if the numerical answer was incorrect. Similarly an independent mark was awarded in Question 1 (a) (i) for writing an answer to the correct number of significant figures.

Question 1

Question 1 was set in the context of a rotating playground roundabout and (a) (i) was answered correctly by a majority of candidates. Most correctly applied $I = \sum mr^2$ to the children but some then forgot to add the moment of inertia of the roundabout itself. A few candidates did not square the radii. The data in the question were given to two significant figures and a mark was awarded for giving the final answer to two significant figures. Many candidates failed to gain credit by not doing this.

In (a) (ii) most were able to convert 35 revolutions per minute to rad s^{-1} and then go on successfully to calculate the rotational kinetic energy.

Candidates who were confident about the conservation of angular momentum wrote correct and concise answers to (b) (i). However, many candidates answered in terms of conservation of rotational kinetic energy, which cannot be applied here. It was very surprising to see the conservation of angular momentum applied perfectly correctly in the calculation for (b) (ii) even though (b) (i) had been incorrectly answered.

Part (b) (iii) was usually correctly answered.

In part (c) relatively few candidates realised that the increase in kinetic energy came from the work done by the children in moving to the centre. The best answers from candidates also included reference to centripetal force.

Question 2

This question was generally answered correctly and confidently. In (a) (i) a common error was the use of T = *force* × *diameter* instead of *force* × *radius.* The majority of candidates stated the unit (N m) correctly. The unit kg m^2 s^{-2} was not accepted as 'appropriate'. Most candidates were able to apply $P = T\omega$ in (a) (ii).

In part (b), $\theta = \frac{1}{2}(\omega_1 + \omega_2)t$ was usually applied correctly to find the angular displacement in radians, though some found the angular deceleration and substituted in $\theta = \omega_1 t + \frac{1}{2}\alpha t^2$ to reach the same answer by a longer route. It is worth pointing out that a small but significant number of candidates then wrote (correctly) number of rotations = 370/2π but misused their calculators; they divided 370 by 2 and then multiplied the answer by π.

Question 3

Part (a) was intended to test whether candidates had a basic understanding of the formula for the coefficient of performance of a refrigerator quoted in the question (and also given in the *Data and Formulae Booklet*). It was clear that many candidates were totally unprepared for this. Unfortunately, if they did not understand the meaning of Q_{out}, Q_{in} and W applied to a reversed heat engine they were hardly able to score in (a) or (b). There were far too many answers along the lines of: Q_{in} is the energy into the refrigerator and Q_{out} is the energy out. The examiners were looking for a clear understanding that Q_{in} is the energy given to the surroundings of the refrigerator and Q_{out} is the energy removed from inside the refrigerator (or from the contents, or food).

It was possible to score one mark in (b) (i) for calculating either the rate at which energy had to be removed from the ice, or the work (rather than power) input. In (b) (ii), all that was needed was to add the power input to the rate at which energy was removed from the ice, but relatively few candidates were able to make any sense of this at all.

Question 4

Part (a) was well answered by the majority of candidates. The usual method was to count squares, either 150 'small' squares or 6 large (1 cm × 1 cm) squares, and convert to joules using a factor calculated from the axes scales. A small tolerance (± 10 J) was allowed. Other methods were acceptable provided there was a similar degree of precision. Some candidates failed to read the question carefully and calculated the area under the curve to zero pressure, but if they did this correctly they were awarded two marks out of the three. Some candidates joined the ends of the curve with a straight line and calculated the area of the triangle thus formed, but this was considered too crude a method.

Generally candidates were much less successful in part (b). Many correctly stated that the curve for an isothermal expansion would be less steep, but then went on to say that this would give a *smaller* area under the curve, hence less work done. Some candidates ignored the instruction to refer to the graph.

Question 5

In part (a), candidates were asked to write an extended descriptive answer on the ideal petrol engine (Otto) cycle, and they were told that the quality of their written answers would be assessed. There were some extremely well written, concise and correct answers which even included application of the first law of thermodynamics to each process, but these were very few and far between. The best answers were those that concentrated on the processes and not on the workings of an engine. In an *ideal* cycle a fixed mass of air is taken through the four processes irrespective of any kind of mechanism, or any particular method of providing the heating. Common errors were thinking that the compression and/or expansion were isothermal, that work is done during a constant volume process, that the 'spark occurs at point C', and that the four processes represented the four strokes of the engine. Most candidates seemed to appreciate that they were expected to express their ideas in sentences rather than a series of terse notes.

In part (b) there were some well-drawn diagrams showing a good knowledge of what a real indicator diagram looks like, but many candidates concentrated only on drawing a loop with rounded corners, not realising that in the real engine the area of the loop would be less than the area of the ideal cycle. Many candidates completely missed out a line or narrow loop for the induction and exhaust strokes, and some drew a cycle for an engine of considerably different maximum and minimum volumes than the ideal.

Mark Ranges and Award of Grades

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