A-LEVEL
PHYSICS A

PHYA1 – Particles, Quantum Phenomena and Electricity
Report on the Examination

2450
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General Comments

The overall performance of candidates in this unit was slightly weaker than last year and this was mainly due to due to poorer responses in questions requiring extended writing. A significant proportion of candidates also seemed unfamiliar with certain command words such as define. As has been the case in previous sessions, candidates found the quantitative questions more accessible. This is particularly noticeable when quantum phenomena and electricity were being examined. There was a tendency for candidates to continue their answers outside of the allotted space and in some cases it was not apparent that they had done this unless their whole script was viewed. The answer lines provided should be enough for the majority of candidates but if they do need additional space they should be encouraged to use additional answer sheets rather than write answers in blank portions of the question paper.

Question 1

This question on particles was well answered and not particularly discriminating. The majority of candidates were able to score high marks in parts (a) and (b) although less able candidates tended to lose a mark on the table, usually because they did not appreciate that a meson was a hadron.

Part (c) was less well done with only 54% of candidates identifying X correctly. The reason for their choice was also not well answered as many responses were far too vague. It was common to see statements such as ‘charge conservation’ but candidates were expected to write more of an explanation such as ‘X must be neutral so charge is conserved’. More able candidates wrote down the equation with appropriate quantum numbers and although not required, this was a sensible approach to adopt.

Question 2

Performance in this question was quite mixed.

As might be expected the first two parts of (a) on isotopes were answered well. This was not the case with part (a) (iii) however, and less than 20% of candidates were able to score both marks. A significant proportion did identify correctly the nucleus with the smallest specific charge but were not they able to explain their choice convincingly. More able candidates appreciated that the ratio of protons to nucleons was the important factor and this needed to be considered. Completing the equation in part (a)(iv) was done much better and a pleasing proportion of candidates obtained full marks for this.

Descriptions of the strong nuclear force required in part (b) tended to be little vague and less able candidates tended to mix up the strong nuclear force with the electromagnetic interaction between charges. The majority of candidates appreciated that the strong nuclear force was repulsive and then attractive but a significant proportion of candidates failed to obtain the third mark because they did not clearly state that the strong nuclear force was short range and beyond this range it had no effect. Part (b) (ii) caused more problems than expected and less than 50% of candidates scored both marks. In a significant proportion of scripts the weak interaction was referred to instead of the electromagnetic interaction. It was also quite common to see electrostatic in place of electromagnetic.

Question 3

This question was well answered and there and there were no major issues raised by it.

A significant proportion of candidates did however; lose the significant figure mark in part (b). This was usually because they gave their answers to three significant figures instead of two.

It was quite common for candidates to obtain full marks for part (c) by to using the de Broglie equation to calculate the speed of the muons rather than simply dividing the speed of the electrons by 207.

Question 4

Candidates often have problems when they are required to give extended written answers explaining aspects of quantum phenomena. This question on the fluorescent tube certainly provides evidence to support this.

While the calculations in part (b) were well done with full marks being obtained by a high proportion of candidates, this was not the case with the qualitative questions that made up parts (a) and (c). Candidates were generally able to explain the process of excitation and to apply this to the fluorescent tube. They were less confident however, when explaining why the mercury atom releases photons of characteristic frequencies. This question was often answered in general terms which explained why atoms release photons but did not explain why the frequencies of these photons where characteristic to atoms of particular elements such as mercury.

In part (c) about half the candidates realised that the coating absorbs the ultra violet photons but very few stated that the photons emitted by the coating were of lower frequency and just repeated the stem by stating that the coating emitted visible light.

Questions 5

Candidates often find circuit analysis questions challenging if the power supply in the circuit has an internal resistance. This certainly proved to be the case in this exam.

Most candidates were able to interpret the graph in part (a) but when it came to the calculations in part (b) (i), only about half of the candidates appreciated that the pd across resistor R was not 6.0 V. This led them to calculate an incorrect value for current. They were allowed consequential error however, and this meant that higher marks were seen in parts (b) (ii) and (b) (iii).

Part (c) was answered very badly with only about 6% of candidates obtaining full marks and nearly 70% getting zero. The commonest mistake was the assumption that the new graph would have the same overall shape as the one shown in figure 2. Very few candidates seemed to appreciate that with negligible internal resistance, power would be inversely proportional to resistance.

Question 6

Part (a) of this question required a definition of resistivity and many candidates did not recognise what was required by this command word. A lot of answers were vague with descriptions of what is meant by resistivity rather than a formal definition. The commonest mistake made by those who did give a definition was to refer to area rather than cross-sectional area. In part (a) (ii) a high proportion of candidates were aware that critical temperature was associated to superconductivity. Many however, lost a mark because their answers were not clear due to them making statements such as 'at the critical temperature a material becomes a superconductor' instead of 'at or below the critical temperature'.

The calculation in part (b) was done well although, as is usually the case with this type of question, it was quite common for the cross-sectional area to be calculated incorrectly. This was either because the surface area was calculated or the diameter was used as a radius. The unit for resistivity is one that is often given incorrectly with $\Omega\ m^{-1}$ being the most frequent erroneous answer.

Question 7

In the past questions requiring candidates to describe experiments have caused significant problems. This proved to be the case in this exam with only 25% of candidates getting into the top band. The main issue they had with the design of this particular experiment was the failure to explain how they would get results across the full temperature range and this was particularly true for temperatures less than room temperature. This was considered to be an important point and candidates' designs were required to be capable of producing results from 0 °C to 100 °C before the top band could be accessed. A number of responses did go beyond the allotted space and while candidates frequently used additional sheets for this, a significant proportion used blank portions of the question paper and did not always make it evident that they had done so. It is important that there is a clear indication when an answer continues elsewhere in the paper.

Part (b) caused more problems than expected. A high proportion of candidates picked up that the voltmeter reading would change in the opposite way when the thermistor was heated. Only a minority however, were able to explain why convincingly. Statements such as 'the resistor is first so it uses more voltage' were not uncommon. Some candidates were also under the misapprehension that the current was higher in the resistor than it was in the thermistor. As has been the case in previous exams qualitative questions involving electric circuits do highlight the difficulties presented by this topic.

Mark Ranges and Award of Grades

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