Examiners' Report/
Principal Examiner Feedback

Summer 2013

GCE Physics (6PH05)
Paper 01R: Physics–Creation/Collapse

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6PH05 / 01R Summer 2013

The assessment structure of 6PH05 mirrors that of other units in the specification, consisting of 10 multiple choice questions, a number of short answer questions and some longer, less structured questions. As an A2 assessment unit, synoptic elements are incorporated into this paper. There is overlap with circular motion and exponential variation in Unit 4, but also overlap with some of the AS content such as electricity and waves from Unit 2.

This paper gave candidates the opportunity to demonstrate their understanding of a wide range of topics from this unit, with all of the questions eliciting responses across the range of marks. However marks for questions 12(c), 13, 14(b), 14(c), 15(a), 16(b)(i), 16(c), 16(d), 17(d) and 18(a) tended to be clustered at the lower end of the scale.

In general, calculation and 'show that' questions gave candidates an opportunity to demonstrate their problem solving skills to good effect. Some very good responses were seen for such questions, with solutions which were well crafted, clearly set out and accurate. Occasionally in calculation questions the final mark was lost due to a missing unit. Most candidates understood the convention that in the "show that" questions it was necessary to give the final answer to at least one more significant figure than the value quoted in the question.

Once again there were examples of candidates disadvantaging themselves by not actually answering the question, or by not expressing themselves using suitably precise language. This was particularly the case in extended answer questions such as 14(b) & (c), 15(c), and 18(a) where candidates sometimes had knowledge of the topic, but could not express it accurately and succinctly. Candidates could most improve by ensuring they describe all aspects in sufficient detail and always use appropriate specialist terminology when giving descriptive answers.

Scientific terminology was used imprecisely and incorrectly in a number of responses seen on this paper. Once again there was confusion demonstrated between atoms, molecules, nuclei and particles. At A2 level it is to be expected that, where candidates use such terms, they do so with accuracy.

The space allowed for responses was usually sufficient. However, candidates need to remember that the space provided does not have to be filled. Candidates should be encouraged to consider the number of marks available for a question, and to use this to inform their response.

If candidates either need more space or want to replace an answer with a different one, they should indicate clearly where that response is to be found.
The response to the multiple choice questions was generally good with 6 of the questions having 70 % or more correct answers and only one with less than 50% correct answers.

In order of highest percentage correct they were, Q7 (93%), Q10 (90%), Q3 (83%), Q1 (87%), Q6 & Q8 (72%), Q9 (66%), Q5 (65%), Q2 (58%) and Q4 (43%).

Question 11

Many candidates told us that it was a Doppler or red shift and then reiterated what is in the stem of the question. Some became tangled up in trying to describe how to use red shift and/or Hubble's law without making it clear that the further away the galaxy is, the greater its recessional velocity.

Quite a few candidates seemed to think that it was evidence that that galaxies are expanding.

Question 12a

This was generally well answered, although many candidates wrote their answer as a traditional rather than a spread sheet equation. Some even calculated a value for the cell. Although this was not required, it did demonstrate how the value would be calculated. The most common error was not to rearrange their equation to make T or B2 the subject.

Question 12b

Most candidates could manage the calculation, although a significant minority worked backwards and used $A = 4\pi r^2$. Factors of ten were an issue for some candidates, in particular the 10^{18} or 10^{19} that their calculation gave worried some weaker candidates who then manipulated their answer to get the 0.2 indicated in the stem.

Question 12c

This is a well-known part of the specification, and many candidates were able to score full marks here. Common reasons not to score full marks included:

- not specifying that the flux should be measured and that distance determined
- not rearranging the flux equation to show how the luminosity is calculated.
- not mentioning that that to use the HR diagram it is necessary to know the type of star

Question 13a

Many candidates failed to correctly calculate reasonable values for the logarithmic scale, although most realised the temperature axis was reversed. Attempts at logarithmic scales on the temperature axis were very weak, often being neither logarithmic nor linear. The most common responses were 9000, 6000, and 3000. Most candidates had little idea how much variation in luminosity exists for stars and it was common to see 0, 1, and 2 as values on the vertical axis.

Candidates responses seen on this paper would suggest that centres could spend more time teaching the HR diagram.

Question 13b

Although this question part was intended to be reasonably straightforward answers seen were often too simplistic. The circle to identify the most massive stars was sometimes in wrong place entirely. Hydrogen fusion was mentioned, but without a reference to helium and gravitational forces were rarely mentioned. On a technical note, all visible stars have high luminosity and temperature and so it was a requirement that candidates stated the most massive stars have the highest temperature.

Whereas most candidates identified high(er) temperatures and/or luminosities, they frequently contradicted themselves (high luminosity and low temperature). Rate of fusion and gravitational forces were rarely discussed but even those who did often lost the third mark through lack of comparatives or absolutes.

Question 14a

This was well answered with the vast majority of candidates scoring full marks. Clearly, this is the kind of calculation that has been practised and mastered. Nearly all scored mp1 and mp2 and most attempted mp3. It was at this point that they often made mistakes, sometimes forgetting to square omega. Most went down the $m\omega^2r$ route rather than using mv^2/r.

Question 14bc

Candidates often had the correct ideas for this question but had problems expressing themselves concisely with appropriate terminology. Where candidates had the idea of geostationary they were sometimes unable to express themselves clearly enough to score marks, and ideas of geosynchronous were even more badly described. Many appreciated that the GPS satellite had a lower orbit, but the idea of the communication satellite orbiting around the equator was rarely seen.

Some key points noticed from answers seen to part (c):

- Most candidates were content with discussions about the different periodic times and velocities.
- Some candidates managed to deduce that the radius of a GPS satellite would be smaller.
- A few candidates knew that communications satellites orbit above the equator.
- Some candidates tried to use the diagram to say that a GPS satellite has an elliptical orbit.

Question 15a

This question required recall of AS knowledge and, as a result, few candidates mentioned the lack of balance between upthrust and weight. There was a general lack of synoptic thinking seen in the answers to this question part. Even those who realised that the density of the air would decrease, failed to link this to the upthrust produced and then to the fact that if the balloon is to rise the upthrust must be greater than the weight.

Question 15b

This was very well answered, with the vast majority of students gaining full marks. Where marks were lost it was most often for a mistake in finding the temperature difference correctly but sometimes for a wrong rearrangement of the mass = density x volume equation.

Question 15ci

This part of the question was well done, with very few failing to score at all, with not many candidates forgetting to convert Celsius to Kelvin. Candidates seemed to be more likely to get the right answer if they started with $p_2/p_1 = T_2/T_1$

Question 15cii.

Although not penalised, there were several references to air instead of hydrogen. Most students scored 1 or 2 of the first two marking points. Constant volume was a common non-scoring answer. Hardly any mentioned the idea of temperature the same inside and out.

Question 15ciii

It was common to see that kinetic energy of the molecules decreases but very rare to be able to give the mark because average missing from the KE references. By and large mp2 was awarded most often. The rate of change of momentum with the walls was mostly poorly explained, if at all.

Question 16a
This was relatively straightforward and most candidates obtained the correct answer. Some candidates confused this with object of measurable luminosity or confused luminosity for radiant flux/brightness/intensity.

Question 16aii
This was mostly well answered. The main error was talking about luminosity and not saying that we must measure flux. The apparent magnitude equation (which is not on the specification) was rarely used, but credited were seen.

Question 16bi
Some good responses were seen, with a lot of candidates either getting one part or the other i.e. long wavelength OR galaxy moving away but not together. Some confusion with blue shift or not saying WHAT has happened to wavelength/frequency.

Question 16bii
Many candidates had no problems with this one, but some candidates were squaring the speed of light (and hence losing marks) or introducing errors when trying to combine and use both equations in one.

Question 16c
A number of candidates were able to describe how observations of galaxies could lead to estimation of masses that differ from the mass required to gravitational forces necessary. Some were able to capitalise on this, relating it to the existence of mass that does not emit em-radiation. Making a statement that dark matter has mass was often overlooked. Many gave good descriptions of the possible fate of the universe but failed to relate how dark matter would influence this. Many realised that the universe is more likely to be closed but few mentioned the evidence for the existence of dark matter.

Some confused dark matter with dark energy. In some answers mp1 was lost because candidates were too vague about what dark matter didn't emit ("you can't see it", "it gives off undetectable radiation", "it absorbs all radiation"). Perhaps several were attempting to describe black body radiators. Students attempting to get mp2 often described the rate of expansion of the universe or stars expanding. Many had it the wrong way round ("The universe is expanding faster than it should").

Question 16d
Candidates often failed to understand what is meant by the observable universe, and those who did, struggled to put their ideas across in a way that would score marks. Many repeated ideas from part (c), mentioning that a closed universe was more likely. Many candidates thought that the most distant parts of the universe were receding faster than the speed of light, which was why we couldn't see them. Of those scoring marks, it was most often for ideas about only being able to see as far as light has had time to travel.

Question 17a
Many inadequate answers were seen. There were frequent references to unstable atoms instead of nuclei, and general statements about emission of radiation.

Question 17b
Many candidates failed to realise the significance of the e^+.

Question 17c

Answers seen were mostly good. Errors included using c^2, missing out 106 for mega, and carrying out the wrong mass calculation. However, there are still those who find the mass unit, MeV/c^2 very hard to deal with. Most were able to score 2 marks.

Question 17d

References to a short half-life were given most of the time. References to low ionising power were either not given or generally muddled with reference to alpha or gamma. Many candidates appreciated that the short half life was relevant but failed to follow this by explaining that this would mean that radioactivity would only be released for a short time inside the body. The 2nd mp was not awarded as often, as many candidates were under the impression that gamma rays were emitted. References to boron were usually insufficient to score.

Question 17e

There were many good, logical solutions showing that they were able to handle an exponential calculation. Insufficient care in reading the question meant that some failed to realise that they were being asked to calculate A_o not A.

Question 18a

The candidates who were most likely to score were the ones who explained the conditions for shm and gave a correct definition of Hooke's law. A missing reference to extension most common error including stating Hookes law as F=kx

Question 18b

The vast majority of candidates had very few problems in doing this calculation

Question 18c

There were muddles about the meaning of critical damping and references to heavy damping and overdamping. Almost all candidates could identify resonance in ciii and calculate the frequency.

Question 18d

The majority scored at least one mark here for higher frequency, but usually failed to score both marks for not making it clear whether they were talking about the bouncer's frequency or the frequency at which the baby needed to kick. There were quite a lot of candidates who seemed to think that the mass was the amplitude and so said that amplitude didn't affect frequency. Sloppy answers lost marks because of missing out the idea that it is the natural frequency of the system that increase and then failing to explicitly say what the baby would have to do.

It is to be expected that, as part of their A-level, most candidates would have done some experiments with mass spring systems and investigated the effect of changing the mass. It is surprising therefore that so many thought that the frequency was not going to change.

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