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Examiners' Report

GCE O Level Physics (7540)

June 2006

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PHYSICS 7540, CHIEF EXAMINER'S REPORT

Paper 1

General Comments

Some very good work was seen. Calculations were again very well done although there was some scope for unit errors in questions 4 and 10. Questions involving drawing such as 6, 10 and 11 continue to cause problems because of lack of precision rather than lack of knowledge. Questions involving speed-time graphs continue to be very well answered.

Question 1
All candidates were able to calculate the force exerted by a 40 kg mass. This mass was supported by a pulley system which equally divided the 400 N weight between two strings. Explanations of why each string experienced a force of 200 N were poor, with rarely any reference to the two strings and the halving of the force.
The question asked candidates to assume that the weight of the pulleys and friction could be neglected.
When asked whether the measured force would exceed, equal or be less than 200 N many candidates felt unable to state the obvious, that there was the weight of a pulley and friction to consider.
This was supposed to be an easy question to start the paper, but for many candidates this was not the case.

Question 2
This question gave a speed-time graph. Candidates were asked to recognise in which parts of the journey a car was travelling at steady speed and decelerating. The calculation of acceleration from the slope of the graph and the calculation of distance travelled from the area under the graph was very well done by the majority of candidates, with many gaining full marks.
The easiest way to find the area was by the addition of a triangle and a trapezium. Those who attempted to add two triangles and a rectangle often got answers that were slightly out due to the estimation of some of the dimensions. Such answers could gain full marks.

Question 3
Candidates had to calculate the change in gravitational potential energy of 3.9×10^5 kg of water falling through a height of 500 m in a pumped-storage hydroelectric power station. It was pleasing to see relatively few errors in the calculation of $3.9 \times 10^5 \times 10 \times 500 = 1950000000$ J. When told that the energy transfer was 90% efficient, most candidates successfully multiplied their previous answer by 0.9 but a significant number multiplied by 90.
The last part asked why energy is lost when pumping water from the lower lake back up to the upper lake. Instead of giving the standard answer that heat is lost in some part of the process such as the pump, practically all candidates referred to work having to be done to overcome gravity.

Question 4
On a diagram of a hydraulic jack, candidates were given a value of force in N and a value of area in cm^2. Many unit errors were seen in the calculation of pressure as 12.5 N/cm^2 was frequently expressed as 12.5 Pa (Pascal). When asked to find the load that could be lifted by a piston of area 400 cm^2 , many candidates who had correctly calculated $12.5 \times 400 = 5000$ N then gave a final answer of 500 kg, thus losing a mark.

The last part required a knowledge of moments, but many candidates who had been dealing with ideas concerning pressure answered this part in terms of area rather than length.

Question 5

Candidates were shown a diagram of a gas storage tank and asked to explain in terms of molecules how the stored gas exerted a pressure on the piston.
From the mark scheme:

freely or randomly moving molecules	1
collide	1
with the piston	1

It was often the first mark that was not scored. A clear statement about movement is needed here and could be undone if it was linked to vibration.
In the Boyle's Law calculation that followed the most common error was the use of $p/V = k$.

Question 6

Candidates were shown a current-time graph for an alternating current and asked to determine the peak value and the frequency. The first answer contained some unit errors, showing A instead of mA, and the second answer was often out by a factor of 2 as a result of using $f = 1/T$ to determine 1 ÷ 0.02 instead of 1 ÷ 0.04.
Given a grid with the time axis shown, candidates were effectively asked to draw the voltage-time graph for the same signal as seen on the screen of an oscilloscope. Answers were expected that were within 1 mm of the crossing points at 0.00, 0.02, 0.04, 0.06 and 0.08 s. Furthermore, amplitudes were expected to be within 2 mm of each other. Lack of precision meant that candidates often lost marks for this part.
Candidates were than shown two traces resulting from a direct current and half wave rectification respectively, and asked to state what each represented. A range of answers was accepted as long as candidates did not undo themselves with, for example, direct current through a diode for the second example.

Question 7

Candidates were shown a circuit diagram with two resistors connected in parallel and asked to state the value of a the current in one of the resistors and confirm the value of that resistor. This was very well done. Some uncertainty followed when it was revealed that one of the resistors of known value was a wire and candidates had to state the value of the resistance of a similar wire of double the length. Follow on marks were available for finding the combined resistance of these two wires connected in series, although a small number of candidates added them in parallel.
In the last part candidates were asked to place ticks to show which of the following changed when the longer wire replaced the original wire:

- total resistance of the parallel arrangement
- potential difference across the parallel arrangement
- value of current drawn from the power supply.

It was pleasing to see that most candidates gave correct answers

Question 8

Most candidates showed a good knowledge of the magnetic field pattern associated with a straight current-carrying wire and knew the effect on the direction and strength of the field at a point when the current was increased.

Fewer candidates were confident about predicting the resulting magnetic field half way between two parallel wires carrying similar currents in the same direction. Stronger candidates knew that the strength of the field would be zero but many candidates thought that the field would be stronger as a result of the second wire.

Question 9

Candidates were asked to explain why Pb-210 and Po-210 could not be isotopes. This reversal of the usual question was handled well by most candidates. A surprising number of candidates were not able to recognise alpha and beta radiation from a diagram showing absorption by cardboard and aluminium sheet. A few labelled one of the radiations as gamma. Relatively few candidates were aware that alpha radiation is more harmful within the human body due to greater ionisation. Many candidates are unsure about this topic and would benefit from a better understanding of the nature of these radiations.

Question 10

Candidates were shown plane water waves travelling towards a barrier and one reflected wavefront. They were asked to draw one more reflected wavefront, and most did this correctly.
A calculation to determine the speed of waves with a frequency of 2 Hz and a wavelength of 3 cm contained a surprising number of power-of-ten errors where candidates tried to convert cm/s to m/s.
The next part asked how the speed of the water waves could be decreased. Answers that suggested placing a block of glass (or anything else) as a way of making the water shallower were awarded full marks, but such answers were often undone by the candidates going on to write that the waves slowed down when going **through** the glass. Some candidates confused this effect with diffraction and wrote about barriers with gaps in.
The last part asked for the name of the phenomenon during which wave speed was changed. Answers here of 'diffraction' rather than 'refraction' confirmed earlier confusion.

Question 11

A question asking candidates to draw rays to show the formation of an image using a **diverging** lens resulted in most candidates producing a ray diagram for a **converging** lens. It was still possible to score one out of two marks for a straight line going from the top of the object undeviated through the centre of the lens. The mark scheme was adapted to give candidates as many marks as possible, awarding follow through marks for those who had produced real images. Even so, many of the ray diagrams were so inconclusive that it not possible to award many further marks. This question was very poorly answered.

Paper 2

General Comments

The majority of candidates were able to attempt all parts of the paper in the time allocated. Many wrote extensive answers to questions requiring explanations of physical principles but some of it was irrelevant, incorrect and contradictory. Some of the calculations were answered well although units were still being missed off or written incorrectly.

Many candidates ignored the instruction to start each question on a fresh page and many are still crowding their answers together. This problem should be solved in future as the layout of the paper will change in January 2007, when Paper 2 will be set out as a question and answer booklet in a similar way to Paper 1.

Question 1

Well prepared candidates scored well on this question but it was clear that some had not experienced the experiments involved.

(a) Most candidates knew that the water should be stirred since a stirrer was provided. Those that had seen the experiment performed knew that before taking the readings the heat source should be removed and time allowed for the air in the flask to reach the same temperature as the water. The sketch graph was often well drawn but many failed to label the axes correctly or to mark –273 ^{0}C at the point where pressure became zero. Some candidates ignored the instruction to draw the sketch graph in their answer book and instead were issued with graph paper. A majority were able to recall the name 'absolute zero' but vague answers of absolute temperature did not score. Most knew the correct equation for the pressure law but about half failed to convert the Celsius temperature to Kelvin, but were only penalised one mark. Incorrect rounding and missed units were often seen.

(b) Candidates who had seen this procedure scored well. Many started by removing the air, weighing the flask and then letting the air in and reweighing. Marks were lost if they subtracted the mass of the flask with air from the mass of the empty flask, or if they omitted details such as letting the air back in or using the tap which was labelled in the diagram. Use of a balloon instead of the flask, a different flask or weighing the vacuum pump were given no credit. The method expected for measurement of the volume of air involved filling the flask with water and then measuring the volume of water with a measuring cylinder. Correct use of a displacement can was allowed, and candidates who measured the dimensions of the spherical and the cylindrical parts of the cylinder and then used these measurements to calculate the volume were allowed one mark. Pumping the air into a gas syringe or other container was given no credit.
When saying how to use the measurements to calculate the density, too many candidates simply wrote the bald equation without saying they would use the mass of air divided by the volume of air. Many had difficulty with the last part, forgetting that it related to the experiment they had just described. Some said that the density remained constant as the flask was sealed, forgetting that they had just let air into the flask; some guessed that the density would increase, and neither gained any credit for their answers. Good candidates realised that the air would have expanded and that as a result the mass in the flask would be less.

Question 2
Responses to the calculations in this question were disappointing.

(a) The calculation proved rather difficult with many candidates unable to handle the 20% efficiency correctly. Many applied the 20% to 2750 W rather than to 1400 W/m^2 but the best candidates had no problem with it. Too many focussed on the term 'equator' and gave silly answers about the solar panels receiving too much energy and melting. Most ignored the information given in the question about how the energy received was used, thinking it was used to propel the satellite. Only a small minority realised that it would pass into the shadow of the Earth and hence receive no light for half the time. The energy changes were also often poorly done, especially as one of the required changes (light to electrical) was given in the introduction. Too many talked about solar energy, losing that mark. In answers to energy questions candidates are expected to name the accepted types of energy to gain credit.

(b) This demanding graph was usually well drawn, with few candidates drawing the axes the wrong way round or failing to label the axes with correct names and units. Most candidates were able to use a suitable scale and to plot the points within the accepted tolerance. The curve was usually well drawn but some candidates joined some or all of the plots with a ruler and lost the curve mark. A majority marked the graph to show how they would obtain the solar power at 5.2 AU. Candidates should be advised to draw a line across and down in order to be sure to score. They should also be advised that in designing graphs it is assumed that candidates will draw their axes 2 cm from the left and bottom of the grid and use that space to write their labels and numbers. The most appropriate scale will then be one which uses most of the remaining area; it should not be possible to double the selected scale whilst still fitting all the points within the grid area as points outside the grid will lose plotting marks.

(c) Those who had problems with the calculation in part (a) had the same problem here. Too many focussed on the gravitational pull of Jupiter, or the cost, when thinking of disadvantages. Good candidates used the information to obtain the mass of the panels needed and realised that this mass would be very large, that the area would also be very large and would create problems when launching from the Earth.

Question 3

Candidates made a good attempt at this unfamiliar application of physics.

(a) This was usually well attempted except for those who used musical terms such as sharp or shrill instead of frequency, pitch, amplitude and loudness. A few misunderstood the idea of amplitude, thinking that when the needle moved up the amplitude was large and that when it moved down it would be small. Most realised that the disc would wear or scratch but only a tiny minority realised that the hard diamond needle would not wear. A few also focussed on the musical definition of 'quality' and tried to answer this in terms of overtones.

(b) This section scored fairly well. Most candidates realised that the tip needed to be repelled and so the surface should be negative as like charges repel. As usual a few wrote ‘like poles repel’ and lost marks. In (b)(ii) many candidates quoted Hooke's law without applying it to the question. Some candidates mistakenly believed that ‘elastic’ meant ‘ability to stretch’, although many correctly knew it referred to the ability to regain its original shape. But most of those candidates omitted to add a statement which meant ‘when the load is removed’. Most realised that the flat surface was needed for accurate reflection of light to the detector but some wrote about charges gathering at points. Although many realised that in this case there would be little or no wear, few added that there was no contact or friction.

(c) This part usually scored all four marks although it was sometimes clear that candidates were not familiar with a GL electroscope. Some candidates did not know that polythene gains a negative charge when rubbed and hedged their bets, giving both possibilities, and so failed to show that they knew the leaf would deflect more and that the rod was negative.

Question 4
Many candidates scored well on this question, especially in the calculation.

(a) This was usually well answered but some candidates failed to state that they recorded the current or deflection and lost a mark.

(b) (i) Even when candidates had the correct forms of energy, hardly any stated where these energies were located. Too many talked about ‘magnetic energy’.

(ii) and (iii) Only a few candidates recognised that aluminium is non-magnetic and yet an electrical conductor. Although many used the idea of magnetic lines being cut they usually repeated the term ‘induced current’, which was given in the question, rather than ‘induced emf’.

(iv) Most were able to give at least one way of increasing the induced current.

(c) Many scored the first two marks but some wrote about the speed of magnetisation rather than ease of magnetisation, or temporary and permanent which was the answer to part (ii).

(d) The calculation scored very well with most candidates scoring all five marks.

Question 5
This question often scored very well for those who laid out their answers in a logical fashion using the subdivisions from the question. Where they ignored the headings it proved difficult to award all the marks they might deserve. The change in layout will make this much clearer in future examinations.

(a) It was clear that candidates do not know that the resistance of an LDR decreases with increasing light intensity. Many thought that an LDR increased in resistance in light (often they thought that it was because it was heated).

(b) Most candidates could correctly state one of the two laws of reflection.

(c) This often scored well. Most candidates used the headings provided to structure their answers and could think of at least two factors needed to be constant and two appropriate additional items of equipment. Many could give a good account of the procedure needed. Some very successful answers were given as bullet points or as a numbered list, which seemed to focus the candidate's mind on the steps needed.

(d) (i) The correct response was related to the answer to 5a(i) and most candidates could choose the correct one.

(ii) Candidates were seldom able to recognise that the fact that one curve was always above the other meant that, for this metal, the current was always larger no matter what the distance, and that to score they had to compare currents at the same distance. Even fewer gained the second mark as they just stated that more light was reflected (given in the question) rather than that more light fell on the LDR.

PHYSICS 7540, GRADE BOUNDARIES

Grade	A	B	C	D	E
Lowest mark for award of grade	70	59	49	44	26

Note: Grade boundaries may vary from year to year and from subject to subject, depending on the demands of the question paper.