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Examiners' Report June 2007

GCE

GCE Physics (7540)

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General Points and Observations

The balance of the paper with less calculation and more descriptive work meant that strong candidates did not score as well as on last summer's paper.

Question 1

(a) 90% of candidates were able to work out the weight of a bird called a red kite given its mass.

(b)(c)(i) The bird was flying at constant height and candidates were asked to add arrows to show the direction and line of action of the weight and the lift force. On average 70% of candidates scored both marks but there was great deal of uncertainty about the second mark with some showing this force as acting downwards.

(c)(i) Disappointingly only 60% thought that the lift force would be equal to the weight of the bird.

(d) Candidates were asked why large birds are able to fly at constant height with only slight wing movements. This was poorly answered with little reference to the area of the larger wings and many answers concentrated on the efforts of smaller birds. The point that the lift force had to be equal to the weight rather than greater was often missed.

Question 2

(a) Less than 60 % of candidates knew that the acceleration of an object at the start of its fall to the ground is $10 m/s^2$. The most common wrong answer was zero.

(b) In (i) nearly 90% of candidates knew that the quantity represented by the slope of a velocity-time graph was the acceleration but in (ii) the description of a such a graph in terms of acceleration was very poorly answered. The graph showed an object starting off at uniform acceleration before the acceleration reduced and became zero. Candidates often referred to the object undergoing a deceleration and reaching uniform acceleration with a velocity of zero. Others gave a correct description of events in terms of velocity only for which no marks were awarded.

(c) Nearly 90% of candidates knew that the quantity represented by the area under a velocity-time graph was the distance travelled or displacement.

(d) The graph of the motion of a lighter body of the same shape was often badly drawn where even responses which were awarded both marks, being drawn below the first line, did not show a clear levelling off.

Question 3

This question was the best-answered on the paper. It consisted of 8 marks for calculation and the average mark was above 6.

(a) Given values of mass and speed candidates, were asked to calculate the kinetic energy of crate being lifted by a forklift truck. A common error was to show the correct formula and then calculate ½ × 1200 kg × 0.20 m/s giving an answer of 120 J instead of 24 J.

(b) Candidates were asked to calculate (i) the gravitational potential energy gained by the crate in moving through a given height, (ii) the time taken and (iii) the output power of the truck. In (i) some candidates included their value of kinetic energy and they gained full marks. In (ii) many candidates based their calculation on constant acceleration rather than constant speed and showed an answer of 28 s instead of 14 s. This was usually carried forward successfully to (iii) where occasionally a mark was dropped for expressing power in joule instead of watt.

Question 4

This question was the second poorest answered on the paper.

(a) Just under 80% could correctly define centre of gravity.

(b) A young child's cup with a rounded base was shown. The cup when tilted always returned to an upright position. Candidates were asked to mark the position of the cup's centre of gravity. Most showed the geometric centre of the cup instead of a position within the base.

(c) Asked how the manufacturer could ensure that the centre of gravity was in the position previously noted only 20% of candidates suggested that the base must be heavy. The vast majority described the use of a plumbline. They misunderstood the question which asked how the centre of gravity could be positioned within the base rather than how this position could be found.

(d) A disadvantage of this cup is that it can easily topple and spill its contents but most candidates considered the main danger to be the harm to a child of lifting the cup and immediately dropping it due to its weight.

Question 5

In this question a student warms a flask, containing air, with his hands. The bottom of the flask is below the water level in a beaker and bubbles of air come out the end of the flask. Candidates were invited to identify two errors in the statement 'The air molecules in the flask expand and become less dense'.

Many stated the errors with answers such as: 'air molecules expand and become less dense'. Full marks were scored in (a) as long as candidates did not undo themselves later on. Unfortunately some did with 'because air molecules come out of the bottom of the flask they have become more dense'.

In (b) when asked to describe two changes in the behaviour of the air molecules most stated that they increased in speed or energy and that their rate of collision increased. Quite a few answers to this question were concerned with the difference in behaviour between air molecules and water molecules.

This topic is often misunderstood but it was pleasing to see that the average mark for the whole question was in line with that for the whole paper.

Question 6

(a) Candidates were asked to draw arrows along lines joining earth, an ammeter and a positively-charged high-voltage generator to show electron flow. Usually the directions of the arrows were wrong or conflicting. Although many knew that the electronic charge was negative they were mostly convinced that the electrons always go to earth and so away from the positive charge.

(b) The calculations to determine charge flowing and energy transferred given values of voltage, current and time were very well done with the occasional power of ten and unit error.

Question 7

(a) Nearly 90% of candidates were able to identify the symbol for a diode.

(b) Over 75% of candidates were able to label the positive and negative terminals on a power supply in a series circuit such that the diode would be positively biased.

(c)(d) Most candidates were able to calculate and explain the distribution of voltage across two resistors with a resistance ratio of 2:1. Many showed a calculation based on the same current in each resistor.

(e) In (i) most candidates were able to calculate the combined resistance of two similar resistors in parallel but in (ii) most were uncertain about the effect this had on the voltages across the components in this new circuit.

(f) While most candidates were able to draw a voltmeter connected across the parallel combination, relatively few were able to state why the addition of the voltmeter did not affect the potential difference across the combination. Frequent references to negligible resistance were seen and this is an area of misunderstanding for many candidates.

Question 8

This question was by far the worst-answered on the paper with an average mark of about 1 out of 4.

(a) In (i) about 20% of candidates were able to find the direction of the magnetic field in which a positively-charged particle was travelling. Many did not appreciate that it was a question testing the Left Hand Rule and that the rule can be applied to moving charged particles. In (ii) less than 35% were able to state the property of a particle that would cause it travel undeviated in the field.

(b) Nearly 60% were able to state a direction in which the magnetic field could act so that the particles are undeviated.

(c) About 5% of candidates were able to explain why a particle following a curved path would spiral inwards. The mark scheme allowed for slowing down, losing energy, acquiring charge, losing mass or entering a stronger field. Some candidates who were on the right track often gave incomplete answers such as 'it is going slowly' or 'the field is strong'. Answers often attributed the forces due to the other particles.

Question 9

This question was well answered with candidates showing a sound knowledge of radioactivity.

(a) Candidates were asked to explain the terms (i)'stable' and (ii)'isotope' in the statement 'Tin has several stable isotopes'. The descriptions seen in (i) were often based on a knowledge of chemistry with reference to electron shells but the explanation in (ii) was very well known.

(b) In (i) candidates were asked to insert mass numbers and atomic numbers in an equation showing beta-minus decay of tin-121. A common error was to give the atomic number of the product antimony as 49 instead of 51. In (ii) a pleasing number of candidates recognised that the decay equation in this context was not dependent on half-life.

Question 10

(a) About 60% of candidates recognised the wave type as longitudinal, which was shown travelling a metal spring. The wrong answer was usually 'transverse' or occasionally 'sound'.

(b) The calculation of wavelength given values of frequency and sound was very well done with occasional unit errors.

(c) In (ii) the explanation of resonance, when a vibrating tuning fork is brought near to a wire of the same natural frequency causing a small piece of paper to be dislodged from its centre, often missed key words or phrases.
Complete answers were often as follows : 'the wire vibrates at its natural frequency', 'the tuning fork is at its natural frequency' and 'the tuning fork matches the natural frequency of the paper'. The latter response was very common and most answers neglected the increased amplitude of

vibration of the wire. In (ii) most candidates knew of one adjustment that would stop the paper jumping off. Change of tension was the most common although it was often carelessly stated as, for example, 'release the spring'. Some suggested the use of glue and most candidates neglected to say that this would result in a change of natural frequency.

Question 11

This question on lenses was well answered with candidates showing a sound knowledge of the topic.

(a) Candidates were able to recognise from ray diagrams the size and nature of the images formed by converging and diverging lenses respectively. The correct which involved circling certain terms was often arrived at after much crossing out.

(b) In (i) over 60% of candidates continued to show an understanding of the nature of the image formed by a converging lens as it changed from virtual to real with the doubling of the object distance. In (ii) even more candidates recognised the effect of a similar change for a diverging lens.

7540/02

General Points and Observations

This paper featured a layout to enable the use of online marking which was introduced in the January 2007 examination. Candidates were required to answer questions on the spaces provided on the question paper. In general this has resulted in more concise answers with more candidates addressing the question being asked. A number of candidates repeated parts of the question before starting their answers and then found it difficult to fit their answers in the remaining space. A significant number of candidates extended their answers beyond the space provided or continued their answers on one of the blank pages; centres should stress the need to complete answers within the space provided wherever possible and to indicate clearly within the space provided that the answer continues elsewhere. The majority of candidates were able to attempt all parts of the paper in the time allocated. Many wrote good answers to questions requiring explanations of physical principles but some of it was irrelevant, incorrect and could be contradictory. Calculations were answered well although units were still being missed off or written incorrectly.

Question 1

Well prepared candidates scored well on this question.

(a) (a) Most candidates were able to say that the runway would be raised to compensate for friction but very few really understood that it was necessary so that there were no resultant forces acting on the trolleys. Most said that it was so that the trolleys would move at constant velocity which was a consequence of the adjustment not the reason for it. This aspect was tested in part (ii) and was not credited here; candidates should read the whole question before answering it. A majority of candidates stated that the adjustment had been made and could usually say that this was because the equal spacing showed that it was travelling at constant speed. Some candidates simply said that the diagram showed the runway horizontal and hence the adjustment had not been made; others thought that if it had been made that the tape would show acceleration.

(b) Many candidates found part (i) difficult. A majority of these assumed that the smaller spacing represented the motion before the collision showing that they had probably not carried out this exercise themselves. Too many counted the dots rather than the spaces between them when calculating the time. Some measured either just one dot space or the whole of both parts of the tape and so obtained an incorrect value for the speed. Part (ii) was usually well answered as the candidates gained full marks for correct answers based on their answer from part (i) although some failed to provide a correct unit. Many answered part (iii) well although some failed to use the combined mass of both trolleys or used the momentum obtained in (ii) rather than the value given in the question. Part (iv) was disappointing as those who obtained an incorrect value in (ii) failed to state that momentum should be conserved. A number of candidates who obtained an answer in (ii) which was close to 0.384 kgm/s (eg 0.385 kgm/s) stated that they were different rather than very similar and so did not score.

(c) This part was usually answered very well with many candidates scoring the full five marks available. Marks were lost for not giving the correct unit in part (i). Some stated that the energy calculated was less than 0.16 J when they had correctly obtained 0.64 J in part (i). Many gave heat and sound energy in part (iii). A few gave gravitational potential energy, presumably because of the downward slope but failed to appreciate that this would have increased the amount of energy rather than decrease it.

Question 2

Candidates often scored well on this question.

(a) (i) Most candidates could explain why radiation was the only way energy from the Sun was transferred. However it was worrying to see answers to the effect that it was too far away for conduction or convection, that it could not be convection because the Earth is next to the Sun rather than above it or that it was due to evaporation.

(ii) Many candidates stated that black was a good absorber; those giving vague answers such as black absorbed more heat only gained one mark. A few undid any marks by adding that black was a good conductor or heat.

(iii) Most students assumed that air in contact with the warm wall would be heated by convection instead of conduction.

(iv) Most stated that warm air was less dense and would rise, fewer said that the air would expand or that the process was convection. Marks were lost by those who thought that molecules expand and become less dense. Very few referred to heat rising but a smaller number thought that warm air was denser. The question asked about how heated air is transferred but some described the behaviour of colder air.

(iv) Good candidates focussed on the trapped air and could say it was an insulator. Too many said that it prevented rather than reduced heat energy being lost and did not say where it was lost to. No credit was given here for responses based on the greenhouse effect which would apply equally to a single glazed window.

(b) (i) to (iii) Many candidates scored full marks here but some only calculated the energy absorbed for one square metre or forgot to convert the time to seconds. Incorrect units for energy or mass lost marks. Candidates were given full credit for a temperature rise correctly calculated from their values of energy and mass even when this gave rise to very small or very large changes.

(iv) A majority of candidates gave heat lost to the surroundings with only the better candidates giving a second reason such as heat transferred to other objects in the room or to the walls or ceilings.

(v) Most candidates could give at least one acceptable advantage or disadvantage but many gave vague responses such as environmentally friendly or cheaper which did not score.

Question 3

Many candidates found this question very demanding.

(a) (i) This was usually well answered.

(ii) Good candidates could state that the field at X was uniform.

(iii) Even good candidates found it difficult to make a correct comparison of the field strengths at X and Y.

(iv) Good candidates made reference to the diagrams to answer this question gaining one mark by considering the effect on the field and then the effect on the clips. Weaker candidates gave vague answers often attempting to use an electromagnetic induction explanation which would not score.

(b) (i) The field pattern for a flat circular coil was not well known. The diagrams drawn by those who did know were often ambiguous making it impossible to award the mark for the correct direction of field lines. The diagrams were rarely labelled making it difficult to tell which lines represented current and which the field lines. Weaker candidates drew the field for a solenoid or a long straight wire, but again the diagrams were rarely unambiguous. A few candidates simply redrew the diagram given and added random lines to it.

(ii) Many vague answers were seen. Some tried to explain in terms of attraction between the two coils while others stated that it was so that the *receiver* coil would not induce a current in the *transmitter* coil.

(iii) Many candidates could give a correct answer in terms of the direction of the current but too many also thought that ac is a varying current whilst dc is constant; an explanation including this was ignored as were those in terms of polarity.

(iv) Many candidates found it difficult to answer this question. The introduction to the question told them that an alternating current produced an alternating magnetic field which induced an alternating current in the object. Those who addressed these points scored well.

(c) Most scored well on this graph with a majority choosing a suitable scale. However a significant number either failed to draw lines on the graph to show how they read off the depth at 2 mA or misread the reading as 25.6 cm rather than 28 cm.

Question 4

Throughout the question there was a strong tendency for candidates to write in terms of density rather than refractive index or speed of light in different mediums. It is clear that many candidates confuse this term with physical density.

(a) (i) This was often well attempted. Some candidates failed to label the order of colours on the screen. A number thought that all the dispersion occurs at

the second face. Marks were also lost by candidates who showed incorrect deviation for any of the rays shown.

(b) It was unfortunate that an erratum was not issued to centres as had been requested. The angle labelled Critical angle should have been labelled Incident angle. The mark scheme was adjusted to cope with this omission and there was no evidence that candidates were disadvantaged by this minor error.

(i) Most candidates gained at least one mark by describing what was shown in the diagram, that the ray of light was refracted towards the normal. Many did not gain the second mark by using the ideas of density rather than refractive index or correct change of speed.

(ii) Many candidates scored both marks by saying that the angle of incidence was equal to or larger than the critical angle and so the light was totally or partially internally reflected. The first mark could also be scored by saying that the angle of incidence was equal to the angle of reflection.

(iii) This part of the question involved higher level skills and was a good discriminator. The best candidates could readily gain five marks by addressing each part of the path of the blue light. It was pleasing to see how many candidates reasoned that the red light would bend less than the blue as it's change of speed would be smaller. The scheme allowed candidates to propose three different situations for what might happen at point B depending on how they thought the angle of incidence here would relate to the critical angle. Candidates who wrote their answers as a list of bullet points often produced more structured responses which would score highly.

(c) (i) Most candidates knew the correct relationship for calculating the angle of refraction but unfortunately some used the refractive index of glass rather than that of water.

(ii) This part was fairly demanding and often scored poorly as candidates were expected to refer to the refractive indices of the three materials involved to explain what was happening. Again many referred to the density of the materials and scored poorly.

(iii) As in (i) a number of candidates did not use the refractive index for water to calculate the critical angle. Those that did usually scrored both marks.

Question 5

This question often scored very well for those read the question carefully before answering it. Some candidates simply described an experiment to test for alpha, beta and gamma while a very small number wrote about how they would determine the half-value thickness for Aluminium.

(a) (i) Most candidates could give an acceptable method for determining the corrected count rate. A few lost a mark by subtracting the count rate for the source from the background count.

(ii) Most candidates gave a suitable value for the half-value thickness.

(iii) Most candidates could give an acceptable reason for the source needing to have a long half-life.

(iv) Many candidates just stated that readings should be repeated for accuracy and failed to score. They needed to support their arguments by either stating that radioactivity was random or that they needed to obtain the average count rate.

(b) (i) Most candidates could correctly give three of the four required items of apparatus although few stated which one might be for safety. Simply saying goggles or protective clothing was insufficient.

(ii) Candidates often described how they would take the measurements rather than writing a list as instructed.

(iii) There were a lot of very good, well described answers for the method to be used but many candidates repeated information that had been quoted in previous answers and then ran out of space before beginning to answer the question.

(iv) Many gained both marks here although some gave a list of measurements again without drawing a table**.** Of those who drew a table, too many did not include the units they would use in the headings.

(c) Although the question stated that a graph of half-value thickness against density was needed a worrying number of candidates drew graphs with differently labelled axes and so would lose both marks. Most of those who used the correct variables on their axes scored both marks by adding a downward line or curve.

Statistics

Overall Subject Grade Boundaries

Grade	Max. Mark	A	B	C	D	E
Overall subject grade boundaries	100	71	60	50	45	28

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