GCE

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Examiners' Report

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6751 Unit Test PSA1

Diagrams are often very useful to aid explanations, but they should be labelled clearly. Appropriate vocabulary, such as that used in the specification, should be introduced into written answers, for example waves reflecting rather than rebounding. Imprecise use of language can lead to ambiguity. Candidates should remember that a quantity requires a magnitude and a correct unit to gain credit in the examination. When a question seems familiar, candidates should make sure they are answering the question set and not just writing what they have learned about that topic. Candidates with lower totals scored the majority of their marks on parts of the paper which required them to state formulae, substitute values and perform calculations, such parts making up, as usual, about half the marks on the paper.

Question 1

This familiar context provided most candidates with a good start to the paper, with a large number gaining full marks. Surprisingly, the hardest part of this question was the first part, where candidates frequently referred to potential energy without applying 'gravitational' as an adjective. The great majority successfully calculated the current from the power. About half could calculate efficiency, with most candidates who decided to calculate gravitational potential energy going on to find efficiency correctly.

Question 2

The most common marks for this question were 2, 8 or 10 out of 10, these marks usually being awarded in the order in which they appear on the paper. Nearly all candidates could find the time, the most common error amongst those who could not being to use velocity ÷ distance. About a third of candidates parted company with the successful solution of the question after finding time. Most of these failed to distinguish between the perpendicular components of the ball's motion. Common errors were to apply an initial velocity of 25 m s^{-1} to the westward motion or to apply a distance of 30 m to it. A number of candidates produced the numerical answer to velocity in the section requiring displacement. Of the other candidates, the majority could recall $v = u + at$ correctly and most of these applied it correctly to find velocity. Candidates who found velocity were generally able to apply it to find the displacement. Many candidates did not appreciate the need to use a vector triangle for the last part, and a sizeable section of those who did used displacements for the northwards and westwards components or used a mixture of velocities and displacements. About a third evaluated velocity successfully. About a half of those using vector triangles found an angle, many simply omitting this, although a number failed to relate their angle clearly to North.

Question 3

While testing some basic AS concepts, this question proved the most difficult, with the majority scoring only 1 or 2 out of 5. A significant number still gained 4 out of 5 even so. A very small number of candidates could describe an energy level. Of these, many failed to specify that certain energies were allowed. Many others did not link it to energy at all but described it in terms of distance. There were a lot of references to bands and defect levels as well. Photons and the difference in energy levels were successfully described by a good majority. A number of candidates used imprecise language in the photon descriptions, such as references to bundles.

A large minority got credit for explaining the wavelengths being the same, although it wasn't always clear that they really knew it was because they had the same energy as it was buried in a large amount of writing about everything they could think of on the topic. Many candidates thought they were comparing the absorption and emission processes. Explaining the meaning of coherent was another occasion on which insufficient detail lost a number of candidates the mark. Many candidates just referred to wavelength and frequency, but those mentioning phase very often failed to extend their description to say that the phase relationship must remain constant. A significant minority had a surprising response in that they gave a description of the more everyday use of coherent in the sense of reasoned, rational or articulate. This seemed to suggest that they were not familiar with the term in a Physics context.

Question 4

In this question a number of candidates referred to the toaster heating water, suggesting that they were trying to apply the answer to a question they had practised on to a different context. Most candidates found the resistance correctly, although many did it in two stages, finding current from $P = IV$ and then resistance from $R = V/I$. Of the latter, a small number used I/V. Most stated that resistance would be expected to increase, but relatively few candidates gained credit for their explanations. The most common error was to state that molecules in the metal *started* to vibrate, or even just move, when the temperature started to rise rather than to refer to increased vibrations. The meaning of ΔE was explained by under a fifth of the cohort. This was sometimes due to lack of detail in the answer but often through not understanding the concept. There were many imprecisely described answers, such as referring to the "energy used in heating the element". As stated, this could well include the energy lost to the surroundings during the process. Although a candidate might have intended 'heating the element' to have meant increasing the internal energy of the element, the imprecision meant the meaning was not clear. Candidates would generally benefit from using the term 'heat' as an adjective only, as in 'heat energy', rather than as a verb, as in 'heating', or a noun, as in 'gained heat'. A lack of detail was evident in answers about the assumption made, where clear references to heat energy and the element as its sole destination, or at least the surroundings as a denied destination, were expected. There were a lot of references to 100 % efficiency which, for a toaster, would mean 100 % transfer of heat energy to the toast and none used to raise the temperature of the element – the opposite of the situation assumed in the calculation. The formula selection and substitution proved straightforward for the great majority and most could evaluate the temperature difference, although a few reversed the numerator and denominator when rearranging. An astonishingly large number of those completing the calculation, as many as 1 in 4, neglected to give the unit correctly by omitting the C in 39.6 °C. Most candidates could calculate a time for the temperature change from their temperature rise per second. A number of these, however, calculated it for the 700 °C final temperature rather than the 680 °C temperature change. Credit for the last part of the question was limited by insufficient detail in many answers. 'Heat lost' on its own is not sufficient – details indicating from or to are expected at the very least. About half the cohort got credit for that part, and a greater proportion got a mark for their conclusion about the effect on time taken even if the reason was insufficiently detailed for a mark.

Question 5

The great majority could use appropriate equations of motion to find the car's deceleration, although some lost a mark by not giving the required significant figures for a 'show that' question. Very few indeed failed to quote $F = ma$ and most could apply it correctly. Many who failed on this mark used g instead of the deceleration. A large minority were rewarded for explaining how the shape of the graph showed deceleration, but many were too imprecise in their descriptions and did not refer specifically to the gradient or slope decreasing, writing somewhat vaguely about the curve. While a similar large minority drew a correct tangent, a number did not draw it well enough to get the final answer within the required range and some tried to use it for a calculation of acceleration in the next part. Many candidates just used the single values of distance and time at that point in $v = s/t$. Most could state that acceleration is change in velocity divided by time, and nearly half used the formula correctly with their previous answer. A number just used the single value of velocity divided by time, others used 13 m s^{-1} as the initial velocity and some used 0 m s^{-1} as the final velocity. Some made it more complicated for themselves by using longer equations of motion such as $s = ut + 1/2\ at^2$. The final explanation was not well answered, with a number discussing the difference between the ways the deceleration were calculated and the effect on the reliability of the results. Others wrote about the time it would take for the car to come to rest in each case. Of those who did identify the deceleration as greater at the higher speed, about a third suggested a reason in sufficient detail. There were a number of imprecise references to resistive forces increasing. 'Faster' was sometimes used in reference to acceleration rather than speed.

Question 6

The descriptions of sound waves were disappointingly poor with most candidates gaining one mark at most. Descriptions of vibrating particles and of compressions and rarefactions were seen at about the same frequency, with correct references to the direction of particle oscillation appearing less than half as often and usually only by those who had mentioned either or both of the other points. Incorrect responses included those referring to the particles or the waves being compressed. A variety of terms were used instead of rarefaction, including refraction, decompression and expansion. 'Move' and 'movement' were used imprecisely so that it was not possible to distinguish between references to the direction of oscillation and the direction of wave propagation. Some candidates used diagrams to illustrate their answers, and occasionally these helped to identify more than just the compression and rarefaction. A majority defined frequency satisfactorily enough to gain credit, but many of these were lacking in precision. There were few problems with the wavespeed formula and wavelength calculation, although a small minority had problems rearranging the formula. A surprisingly large minority omitted the unit in this part, although it is not clear why they should be more likely to do so here than in the mechanics and electricity calculations.

Question 7

While a fair majority identified reflection of the wave, some using terms like rebounding, only about half of these went on to suggest superposition of the initial and reflected waves. Very few gave sufficiently detailed descriptions of the consequences of the superposition beyond the production of the nodes and antinodes which were mentioned in the question. Most candidates labelled a node and an antinode. Somewhat fewer, but still a majority, labelled the wavelength and, of those who did not, the most frequent error was to show half a wavelength and the next most frequent was to label the curved length of the string. The explanations for the appearance of the string enabled a majority to gain one mark, often for noting that the strobe frequency was twice that of the string. About a fifth gained the second mark for extending their explanation. A minority did not employ sufficient precision in their answers, referring, for example, to the light illuminating the string twice every wavelength – a spatial reference which was probably intended to be temporal but too poorly expressed. A number of answers to the question showed an insecure understanding of standing waves in that they referred to the light illuminating the initial wave with one flash and the reflected wave with the next.

6752 Unit Test PSA2

Question 1

This question was generally well answered although a surprising number of candidates did not know the definitions of *plastic*, *tough* and *brittle*. The definition of *tough* was the least well explained with many candidates describing *durable* or *strong* properties instead. A significant minority believed plastic to be a desirable property for a trainer as this would help it mould to the shape of the athlete's foot. Most candidates could correctly calculate the stress although incorrect units were often given by weaker candidates. Many correctly identified that stress would be less with a smaller area, however it was not uncommon for candidates to gain only 1 of the 2 final marks by not giving a clear enough explanation. Some stronger candidates did give very good answers for the final section, discussing force and acceleration.

Question 2

The first two marks gave few problems. For the explanation of thermoluminescence candidates showed a good understanding of the effect. Some gained only one mark because they either focused on the electrons moving into the defect levels or on the heating and electrons moving back to the valence band. Some candidates described how radiation created the defect levels, but failed to say that the radiation gave electrons energy to move into these levels. Most knew that light should be measured, however there were also answers suggesting frequency and number of electrons. Most scored for their explanations of background radiation. The ancient source was usually a correct choice but the modern source was sometimes microwaves, radio waves, television aerials and of course, mobile phones. The description of the experiment was disappointing. Many candidates got the 'paper' mark (although a number put aluminium) but the descriptions were very poor. Very few mentioned background count, although they had been writing about it in the previous sections. Very few put that the source should be close to the counter, although a few did discuss the range of alpha particles in air.

Question 3

The first calculation proved much more difficult than a speed = distance/time problem should be. Many candidates could not recall that radio waves travel at the speed of light. A number worked backwards and a significant minority did not recall the equation. The requirement for pulses of waves was not well understood with many candidates stating that it was to enable the observer to tell the difference between the emitted and reflected waves. The interference mark was most often awarded, followed by the timing mark. The Doppler question was often answered well by candidates although many showed confusion between this technique and echo location and weaker candidates often stated that the frequency would be higher when the aircraft was close to the tower than the frequency when the aircraft was further away.

Question 4
The quality of the diagram varied greatly and it was not uncommon for candidates to draw the light rays without using a ruler. Many candidates drew a diverging lens or simply inserted a line and did not specify the lens type. Several drew lenses on the eye surface or even cutting into the front of the eyeball. The lens formula proved difficult for some. 1/f was often correct, but sometimes then substituted as 1/150 into the equation. There were some candidates who clearly wrote the equation but whose maths let them down and they could not find *u* from the correct equation. A significant minority confused *u* and *v*.

Question 5
This was a very accessible question for most candidates with many scoring highly. It was not unusual for the better candidates to gain full marks on the question. The quality of the airflow diagram again varied with weaker candidates drawing lines that were not continuous or not around the skydiver's body. The forces were usually labeled correctly although it was not uncommon to see 'gravity' rather than 'weight' and upthrust was confused with air resistance on occasions. The relationship between the forces was often described badly with many candidates stating that the forces were equal without specifying that the **total** upward forces were equal to the **total** downward force. A lot of candidates recognized that the skydiver was not spherical or had no radius but again this was not always explained well by weaker candidates. The upthrust calculation was generally well answered and the majority of candidates then realized that the upthrust was small. Surprisingly few candidates then went on to explain correctly the effect this force would have on the terminal velocity. Many candidates chose to ignore the drag force and explained that such a small upthrust would result in a much longer time taken before terminal velocity was reached.

Question 6
The calculation of area gave very few problems although several candidates still do not know the formula for the area of a circle. When completing the table a minority of candidates added x 10^6 to the calculated numbers not realising that this was included in the heading at the top of the table. It was pleasing to note that very few candidates failed to correctly plot all the points on the graph, although the line of best fit was not always accurately drawn with many candidates not drawing this through the origin. The equation linking resistance and resistivity was often correctly quoted but many candidates either used a very small triangle to calculate the gradient or missed the powers of 10 when completing the calculation. Very few candidates provided adequate reasons for the anomalies with many assuming that the readings taken had been incorrect or stating that the wire would heat up as the experiment progressed missing the fact that the anomalies were due to high resistance values on the first few results recorded.

Question 7
Although the majority of candidates drew correct diagrams there were still many seen that showed that some candidates have very little understanding of polarised light. Far fewer candidates labelled vibrations / oscillations on the correctly drawn diagrams. Many understood that a polarising filter of some sort would need to be fitted to the telescope although a minority stated that two filters were necessary to act as a crossed Polaroid. Again, far fewer explained how the filter could be used to reduce the amount of polarised moonlight detected.

6753 Coursework PSA3

The majority of centres, as in previous years, sent clearly annotated scripts, with the correct accompanying paperwork including details of internal standardisation and a report of any briefing given to candidates. Only a few centres submitted samples without any annotation: these scripts were returned to centres for annotation. Some centres persist, despite instructions to the contrary, in using plastic envelopes, rather than treasury tags, large paperclips or staples.

The best work was outstanding, written clearly and concisely, displaying high standards of physics and communication, in both the experiments and the visit.

Experimental Skills

As before, it should be noted that candidates score more highly on experiments with a clear numerical aim with a choice of apparatus and method: a good example this year was the determination of the resistivity of solder. Marks for Skill A (Planning) should only be awarded for work submitted before any implementation of proposed plans. If the proposed plan is not suitable, for safety or other reasons, centres can give candidates a more suitable plan, however, marks for Skill A would be limited for these candidates being based on the original plan. Centres should try to ensure that there is a clear indication of where the plan ends and the implementation begins. A clear plan (A6a) should say not only what will be measured but give explicit details of how results will be treated: for example stating how a diameter will be converted to an area. Marks for A6d and A6e are still being awarded by some centres with sparse evidence in the plan.

In Skill C (Observing and recording) the majority of candidates use the correct units for raw data, but not always for derived quantities. Candidates do not always record all their results, for example giving only an average for a diameter rather than the repeated raw data. Centres should not award C2a in these cases. The best candidates plot rough graphs as results are collected to enable them to identify gaps in data, turning points or anomalous data which can than be investigated further.

In Skill D (Interpreting and evaluating) the best computer drawn graphs were of a high standard, comparable with good hand-drawn graphs and including grid lines. However, for both types of graph, lines of best fit were again often drawn straight when curves would have been more appropriate. Only the best candidates can link their stated uncertainties to sensible quantitative uncertainties in their conclusion.

The visit

There were some new interesting visits this year; to a theatre, a gas distillation plant and traffic police. All of these locations allowed candidates choice in the aspects they explored. Several centres had sent candidates on individual visits. Some of these were excellent, showing a good appreciation of physics in a variety of situations.

There is increasing concern that students are not clearly identifying their sources. Centres must emphasise that quotation marks must be used for material used directly from published sources, including the internet. Advice on this is given in a Joint Council for Qualifications leaflet which should be provided for all candidates.

The best illustrations are referred to in the text rather than merely being decorative. Candidates sometimes miss opportunities for numerical arguments. These may be outside the AS specification but nevertheless within the grasp of AS students: for example during a visit to a hospital there may be an opportunity to use data concerning the energy of X-rays.

Centres are reminded that marks for Skill B must come from one aspect only, and that 4 marks should only be awarded for Skill C if grammar and spelling are of a high standard.

Administrative matters

Centres are reminded to use the most up-to-date paperwork, which includes record sheets to be signed by the candidate and teacher. Centres are also referred to the Frequently Asked Questions which are updated each year and to the JCQ leaflets for candidates.

6754 Unit Test PSA4

Question 1

Almost everybody began this question well by using the formulae $V = Ed$ and $C=Q/V$. People scored on part (c) if they used the time 20 ms to estimate a current, but they generally got into difficulty if they tried to use an exponential equation. A disappointing number misused the milli prefix. The questions about the point charge model were not so well done. There were varied responses to the diagram, even from good candidates; and surprisingly few could calculate the field correctly. At (iii) almost nobody mentioned ionisation or the fact that the field would be strongest at the cloud.

Question 2

Almost everybody scored three marks on part (a). Not everyone realised that calculations were an essential element of (b); and there was some confusion between momentum and (kinetic) energy being conserved. For the speed at part (c) some people calculated angular velocity and stopped there. Most people could quote a formula for centripetal force, but the need to be disciplined about SI units often meant calculations came out wrong. In part (ii) most people realised that the weight of the sphere came into it somewhere but very few got the relationship $T = F - W$ fully sorted out.

Question 3

Most people could explain *I* and do the calculation properly - though a few sailed straight into natural-logging both sides, presumably having been drilled to do so in all situations! Most were happy with the idea of a log scale - though several got themselves tied up explaining why it is used - the phrase "large range of values" is useful here. About half saw the point of the graph - that the lines have to diverge from left to right - though some discovered that by calculation. In the last part very few committed themselves correctly as to which colour would predominate - most didn't comment on colour at all.

Question 4

Most drew the field of the magnet correctly, including arrows. Most successfully calculated the acceleration of the steel cylinder and scored three marks for part (b). The page 9 explanations proved harder - questions about E-M induction always do. Most people realised that E-M induction came in somewhere - except for the few who had been revising laminar and turbulent flow recently, and talked about air resistance. Very few explained in (d) how the upward force arises on the magnet (interaction between magnetic field and current, or between two magnetic fields); there was much appeal to the general idea of Lenz, but without applying the rule to this specific situation. In (e) people often seemed to have a sense that there would be a downward force on the tube, without saying anything with enough specific physics in it to score.

Question 5

There was a fair degree of knowledge displayed in response to this question. The main problem was that many people didn't follow the instructions, particularly in reference to "everyday matter". Thus there were a lot of "just write down everything you know" answers.

Question 6

Most good candidates could do the opening calculation well. A common error here was to use the formula for kinetic energy, with its factor of a half. In the accelerator question many people confused electric and magnetic fields; stated that the magnetic field somehow kept the electrons going straight or accelerated them along the straight parts; or confused this with the original Lawrence cyclotron. Despite that, quite a number managed to plug numbers into a formula and calculate correctly the value of the field.

6755/01 Coursework PSA5

The majority of projects showed good commitment and interest from the candidate and there was a full range of performance. The very best arose from an interest of the candidate and contained A2 level physics which the candidate had researched using a full range of sources and developed to be appropriate for their project. They had a real purpose. They chose and modified apparatus to enable them to carry out the experimental stage and analysed their results in a meaningful way.

Once again the majority of centres marked their coursework projects correctly according to the marking guidelines and dealt with the necessary administration efficiently.

Although the majority of centres annotate scripts well, the lack of annotation from a few centres continues to be a problem. Sporadic annotation in a script is as difficult to process as no annotation at all. Annotation which is helpful to the moderator is as easy as putting each mark grid reference opposite the appropriate place in the script.

Centres are required to enclose, with their sample, a brief report on how internal standardisation was organised in their centre. It was clear in some cases this year that this had not been carried out and different teachers had applied different standards. This can lead to wide variation between the moderator and the centre.

Treasury tags or tied loops of string through a punched hole are still the best way to present a candidate's script. Staples are unsuitable if the wad of paper is too thick to allow a staple to close properly. Plastic wallets mean that the pages are not connected together when removed from the wallet for reading.

Choice of Projects

A large number of reports were genuinely interesting. Sometimes this was because the topic itself was novel e.g. "the materials that are used for sutures and the method of tying", but more often because the candidate had personalised the topic in some way. It was disappointing to see some centres using a limited range of project titles and apparatus.

Several projects started with a promising title but become standard experiments with meaningless or vague conclusions, a minority even being at GCSE level. This year there were several on the general topic of heating which have many good practical applications and with due consideration of cooling effects or continuous flow techniques can lead to high level physics but most of which just became a practical exercise with little physics theory.

Interesting titles this year included

- Attenuation of light through Ribena
- Variation of resistance with pressure of quantum tunnelling composite
- Mass and torque of a dancer's turn
- Diving boards and the depth reached under water
- Physics of the yo-yo

The most popular topic was eddy current braking. Too often this led to a dull report using standard apparatus and with a superficial conclusion.

Research and rational

Rationale is still an area of confusion with several centres giving the highest marks for a simple statement of physics theory. Rationale is not physics theory. It should reflect the interest the candidate has in the project and include a well-constructed argument for wanting to carry out the investigation.

This seems to be the year of wikipedia. It was quoted in almost all bibliographies but rarely was its reliability commented upon. For the highest marks for research the candidates should have consulted a wide range of sources and have shown where they have used the information gathered. There were some excellent examples where candidates had put references in the main body of the text or had annotated the bibliography to show what had been gathered from a source and where it had been used.

A growing concern is the amount of examples where candidates have copied and pasted information with no acknowledgment of source. This is plagiarism and needs to be annotated by the teacher with marks being deducted accordingly.

For the highest marks, physics theory needs to be developed so that it is appropriate and meaningful for the project proposed. From it should lead the variables to be measured and some idea for analysing results. On many occasions centres awarded the highest marks for an equation which had just been quoted.

Planning

In most cases variables were considered within a coherent plan and apparatus was chosen well. Often a lack of structure in the report resulted in a lack of clarity. A clear method cannot be awarded simply for a time plan. The time element is for the candidate to show that they are planning work which will take two weeks of lab time. This should be one part of a clear plan which should also include a proposed analysis of results. The pilot should be completed before the lab time thus allowing candidates to develop their investigation across a two week period.

It was pleasing to see more use of risk assessments for the projects.

Some centres provided their own proforma to attach to the front of the report in which to fill in title, aim, rationale, what needs to be researched. While not wanting to limit the students to this it might help to focus minds in the initial stages.

Observing

Tables of results were almost universally presented well with headings and units.
Most students reported the existence of anomalous results bur few investigated them. Where a graph had a turning point, such as the stalling angle for an aerofoil, candidates should ensure that they take enough readings around this point to identify it correctly.

Analysis

Computer graphs continue to be the norm and can be an excellent way of analysing the results. However candidates need guidance to make their graphs an adequate size with vertical and horizontal gridlines and labelled axes. Error bars should be a norm at A level. Hand drawing is still often the best and easiest way of dealing with graphs.

Excel was often used to produce a final equation which often bore little relevance to the original aims of the project but was considered by the candidate to be a good conclusion.
Best-fit straight lines are still being drawn through points which are obviously a curve. Many candidates still seem to think that all curves are exponential.

It is still disappointing to see so few attempts at relevant error analysis. Few candidates used best and worst fit lines to estimate uncertainties in conclusions.

Communication

As in previous years the vast majority of reports were well planned and readable. Diagrams and photographs added to the clarity especially when considering the experimental set-up. The best reports had clear sections and I would advocate subheadings especially in the planning section which contains so many different aspects of the project to be considered.

Clarity was also improved with the use of abstracts, page numbering and the use of appendices

A good bibliography should include a range of sources from standard textbooks, other books, magazines and journals, expert and websites. Editions and page numbers should be given and the date on which web sites were accessed.

Some reports were overlong. This was often because a huge mass of data had been accumulated and many graphs drawn. However the final conclusion depended on only a few graphs and consideration should have been given to the most appropriate presentation of this information.

6755/02 Unit Test PSA5ii

Question 1

This was a very accessible question and most candidates were able to score at least half marks. In the first part of the question, most candidates correctly identified the P.E. and K.E. at X and Y, but many did not discuss the interchange of energy taking place as the string moves between the two points. In describing the acceleration of the string, many candidates were able to identify maximum acceleration at X and **zero** acceleration at Y. However, there was confusion between acceleration and velocity, so a significant number of candidates thought that the acceleration at X must be zero as the string was not moving. The vast majority of candidates were able to explain the meaning of resonate in the given context. A small number of candidates omitted to mention the large amplitude occurring at resonance, and some referred to the *resonant frequency* rather than the natural frequency of the violin body. The effect of a large amplitude on the loudness of the sound produced was stated by most, but not all candidates. Instead some answers referred to the quality or timbre of the sound. The "show that" question was generally well done, with only a handful of candidates failing to gain full credit. In contrast the calculation of the lowest frequency at which the violin body would resonate often gained only one out of the two marks available. The vast majority of candidates were able to recall the wave equation $c=f\lambda$, but only a minority remembered that the wavelength was twice the length of the violin body. In the final part of the question most candidates said that the intensity increased, but only a minority quoted a numerical factor. For those candidates who attempted to use $I \propto A^2$, a few arrived at a factor of $\sqrt{5}$ rather than 25.

Question 2

Most candidates were able to complete the table correctly and name fission as the process that produced Sr and Cs. A small number of candidates left the empty cells blank, and a surprisingly large minority got one or both proton numbers wrong. Very few candidates were able to suggest how plutonium was formed in the reactor. Unfortunately, those candidates who did refer to an interaction between neutrons and ^{238}U often mentioned other particles (such as protons), or used the word "fusion" or "bonding" for neutron absorption. The calculation for ^{137}Cs was generally well done, although some candidates wasted time by converting all times to seconds rather than leaving them in years. A small number of candidates thought that 30 years had elapsed since June 1986, and so they just halved the initial emission rate to obtain their answer. Some candidates read the half-life for $\mathbf{^{134}}$Cs from the table, and so their final answer was incorrect. Many candidates were able to give a good assumption, although a relatively common answer was either than the decay rate was exponential, or that it was constant. Iodine was identified by the vast majority of candidates as no longer being of concern today. A large proportion also identified ^{134}Cs. Most candidates stated that this was due to the very short half lives of these two isotopes, but didn't always make it clear that "very short" was *in comparison to the 20 year period of time that has elapsed* since Chernobyl. Similarly, in answering the last part of the question candidates were often vague about the isotopes which would still be dangerous, referring to "many of the isotopes" rather than naming the isotopes which still posed a threat and giving some supporting evidence. e.g. Pu will continue to be a danger for *thousands of years,* ^{137}Cs *still* has a high emission rate. Some candidates used the final part of the question to make a political comment, although supporting physics was necessary for marks to be awarded.

Question 3

Most candidates were able to describe correctly the changes in pitch heard as an ambulance passes. A small number of descriptions referred to the frequency getting "higher and higher" and then "lower and lower" indicating that the candidates had not fully understood the Doppler effect. Some weaker candidates omitted any reference to frequency changes, and instead referred to the sound getting louder and then quieter. The "Doppler Wobble" was answered well by some candidates, although some answers indicated that candidates thought that the wobble could be seen directly. Equally, some candidates tried to reference the effect to something that they had heard about before, so answers which described intensity variations (as in eclipsing binary stars) or radar techniques (with radiation, or even sound, being sent out from the Earth and bouncing off the planet) were not uncommon. The best answers often scored full marks from their diagram alone. The determination of orbital time from the astronomers' observations was rarely described clearly enough for a mark to be awarded. Some candidates just referred to the "wobble" without saying what was being measured. Some answers implied that the light went from constant red shift to constant blue shift. A good way to communicate the method used was to draw a graph of frequency shift against time and indicate the six-year period. The final part of the question required a carefully formulated argument. Too many answers included a variety of equations and little structured linkage of ideas. A surprising number of answers implied that the candidate thought that the new planet might be orbiting our own sun. The best answers used one gravitation equation (Newton's Law), identified what would be too small to observe (the Doppler shift, not the "wobble") and why.

Question 4

This was a challenging question for most candidates. Unfortunately some candidates misread the question and so compared electric and magnetic fields. For those comparing the correct fields, answers were often simply a list of things that candidates knew about the two fields with little attempt made to link similarities and differences. It was rare for full marks to be scored on this question, and a large minority failed to gain any marks at all. The best answers showed evidence of planning before putting pen to paper, and used a table or bulleted list.

6756 Unit Test PSA6

Candidates' responses suggested that each of the four questions contained a similar level of challenge. Many candidates produced some excellent answers to some searching questions reflecting some very good Physics.

Question 1

The first part was answered well by many candidates showing confident use of the UVAST equations and the ability to change units as required. The calculation of the height of the space station proved very difficult with many candidates attempting to use an equation containing the gravitational field strength rather than connecting circular motion with gravitational force. Many candidates added a centripetal force to both weight and tension revealing a basic misunderstanding of this area of Physics. Without a correct version of the force diagram explanations were then often confused. Remaining parts proved very accessible to most candidates with some very thorough answers to electromagnetic induction.

Question 2

This data analysis proved as demanding as any of the questions. Most candidates scored well on the first part. The straight line graph proved to be very discriminating. Approximately half the candidates identified the correct axes but many found the large numbers difficult to handle and made basic calculator errors. The explanation of the inverse square law for the propulsion force was usually muddled with many candidates ignoring d in their arguments.

Question 3

The first two parts proved very accessible with good answers to the doppler shift explanation. Many candidates made a very good attempt at the calculation and a reasonable proportion were able to construct a fully correct solution. The most common error was to divide the wavenumber by 100 to change to "metres". Most candidates gave confident answers to the final part.

Question 4

This question was well attempted by most candidates. A high proportion gained credit for the use of momentum conservation and many went on to give a good full answer for kinetic energy and its origin. A common error was to assume the speed of the recoiling nucleus and alpha particle were the same. The kinetic energy ratio then gives the reciprocal of the given answer but this was ignored.

Grade boundaries

The raw mark obtained in each module is converted into a standardised mark on a uniform mark scale, and the uniform marks are then aggregated into a total for the subject.

The table below shows the boundaries at which the raw marks are converted into uniform marks. Raw marks within each grade are scaled appropriately within the equivalent range of uniform marks.

Units converted to 100 uniform marks

Unit	Maximum mark	Grade				
		A	B	C	D	E
	Uniform marks 100	80	70	60	50	40
	Raw marks					
PSA1	60	43	38	33	28	24
PSA2	60	45	40	36	32	28
PSA3	60	50	45	40	36	32

Units converted to 90 uniform marks

Unit	Maximum mark	Grade				
		A	B	C	D	E
	Uniform marks 90	72	63	54	45	36
	Raw marks					
PSA4	60	43	39	35	31	28
PSA6	60	38	34	30	27	24

Unit converted to 120 uniform marks

Unit	Maximum mark	Grade				
		A	B	C	D	E
	Uniform marks 120	96	84	72	60	48
	Raw marks					
PSA5	80	57	52	47	43	39

Raw marks are obtained for PSA5 by adding the component mark for Paper 1 to the mark for Paper 2. Grade boundaries for the individual papers are not available.

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