RECOGNISING ACHIEVEMENT

GCE

Physics A

Advanced GCE **7883**

Advanced Subsidiary GCE **3883**

Report on the Units

January 2007

3883/7883/MS/R/07J

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REPORTS ON THE UNITS

2821: Forces and Motion (Written Examination)

General Comments

The general impression of the Examiners who marked the paper for this module was that the level of difficulty of the questions was appropriate for the candidates for whom it was intended. The paper consisted of a wide range of questions covering a large proportion of the Specification.

The candidates produced a very wide range of responses and the majority of questions provided good differentiation. There was an almost complete range of marks but very few scored less than 10 or more than 50. This suggests that the paper contained sufficient material to test the most able candidate. There were a significant number of candidates with less than 20 but the number of candidates scoring more than 50 was less than in previous years. Those candidates with less than 20 were often unable to give acceptable definitions, used inappropriate formulae in their calculations and gave low-level responses in their explanations. Basic understanding and recall was absent and suggested that these candidates had not encountered much of the content of the course. There were many scripts showing a high level of competence, especially with the numerical work. The mean mark for candidates in this session was 32.5, which was somewhat lower than the mean mark obtained in the January session in 2006 of 36.0.

All the questions provided the opportunity for the weaker candidates to score some marks, and each question had at least one part in which the more able candidates were able to show their understanding of the subject. The responses differed widely depending on the Centre. There were many centres whose candidates had clearly been very well prepared but equally there were a number of centres where the candidates had a very poor understanding of the concepts involved.

The lack of precision, poor use of English, basic errors in calculations and the failure to read the question carefully reduced the marks of many candidates of the full range of abilities. The parts of questions that required descriptive work and the precise statement of a definition were poor generally. However, the majority of candidates were able to give good answers to some parts of every question except question one. Poor answers were given to question one and the first part of question two by a wide range of candidates. The most able candidates scored highly in all the other questions on the paper. Clear explanations were seldom given in question six even by the high ability candidates. Many candidates gave no explanations whatsoever.

The length of the paper was considered to be about correct with the vast majority of the candidates finishing the paper in the required time. There were minimal examples of unfinished scripts. The standard of written communication was generally adequate with many candidates scoring at least one of the marks available for written communication. Marks were lost by a significant number of candidates who failed to spell many of the key words correctly or write in sentences.

Comments on Individual Questions

Q 1 This proved in the light of experience to have been an unfortunate question as a starter. Many of the better candidates failed to score the marks of which they were capable by not answering the question as asked. The term component did not appear to be well understood by many candidates. A misconception shown by a significant minority was that at B the ball stops because gravity balanced the upward force of the ball.

(a) Only a very small percentage answered this part correctly; most failed to realise that

vector components are required to be represented to scale and that they should also be drawn accurately both in magnitude and direction.
In (b) most scored a mark for (i) but less than 20 % gave enough detail for (ii) and zero was the most popular answer for (iii).
In (c) some of the better candidates gave a general and accurate description of the flight of the ball realising that it was falling under gravity but many simply repeated their answers to part (b). They failed to **explain** the answers given in part (b) for the description of the components of velocity at the chosen points. Another misunderstanding was not to realise that the acceleration due to gravity was the same and acted vertically downwards for the whole flight. Many candidates did not give any reason for the horizontal component remaining unchanged. Few read the question carefully and therefore failed to realise that the ball at point D had a velocity of the same magnitude as that at point A but in the opposite direction. Many described the ball as having zero velocity at D.

Q2 (a)(i) Only a very small proportion of candidates scored the first mark. The vast majority had no idea about the correct force. Comments about the braking force being a result of the frictional force from the road acting on the tyre have been stated in previous reports for this specification. Answers to (ii) were much better with only a minority forgetting to describe the car actually coming to rest.
(b) As expected this was generally well done. There were the usual careless errors like forgetting to square v in (i) or (ii). The main discrimination came in part (ii) where weaker candidates failed to calculate the acceleration correctly often assuming constant velocity instead of using the appropriate equation for constant acceleration. E grade candidates tended to score 4or 5 with A to C grade candidates achieving 7 or 8 marks.

Q3 This question produced good differentiation. The definitions though remain the stumbling blocks for both good and weak candidates. In part (a) (i) the two common omissions were *in the direction of the force* or *moved*. Part (a) (ii) was usually correct. However, there were many vague answers to part (b). There were too many *in one second* instead of *per second* and also *joules* rather than *one joule*. Part (c) was a good discriminator with part (i) and (iii) separating out the candidates who understood the Physics of the situation. The point that the tension in the cable is the weight being lifted when there is constant velocity eluded many. Calculations using constant acceleration formula were often seen. It was quite common for candidates only to score 1 mark for (iii) by calculating the P.E. but not the rate of gain of P.E. However, some did go on to calculate the power in part (iv), often by a different route. Only the better candidates realised the connection between these two parts.

Q4 (a) The comments for the definitions are as above for Q3. The lack of accurate definitions often cost candidates one or two marks here. In part (b) the application of the principle of moments was generally poorly presented with many contrived methods of obtaining the given value. The second part was well answered with weaker candidates often obtaining both marks for realising that the sum of the upward forces equalled the downward force. The discussions in (ii) were usually good enough to indicate to the examiner what the candidate intended. The confusion arose over the idea of *opposite* or *same* directions depending on whether the candidate was referring to *linear* or *rotating* forces. The responses to (iii) were on the whole good although surprisingly many used the wrong force.

Q5 (a) There were a few reversed definitions, although most then corrected themselves for part (b) (iii). The most common error was to omit *cross-sectional*.
(b) Many seemed to understand the difference between *plastic* and *elastic and could quote Hook*e's law. However, very few referred clearly to the data given in the table. A

significant number suggested that the data suggested *plastic* and that the law was not obeyed. The variation in values loading and unloading seemed to confuse candidates presumably due to their lack of practical experience. Few were able to answer (ii) fully to gain two marks. Many did not read the question and concentrated on the extension and did not include the measurement of the length. Others gave a general description of the experiment with no indication of measuring instruments, and others wrote about a vernier scale, but failed to include a fixed scale. The majority could not describe how to measure such a small extension. Most candidates scored the first mark for (iii) but often made an arithmetic error. The most common error was not to turn the extension from mm to m.

Q6 Many lost marks by not following the instructions, e.g. by writing about acceleration in (a) when the required answer was reference to velocity. In other places the car slowed down rather than decreased in velocity. Few stated on paper how the changes were related to the change in gradient. However the better and/or well-organised candidate managed to score five marks for part (a). The question did discriminate well between the candidates. The weaker ones achieved more marks in (b) than in (a) often adding omissions from (a) into their descriptions in (b) or else correcting errors in describing the motion in part (a). A common fault among even good candidates was to consider a *decreasing acceleration* to be the same as a *deceleration*. Another awkward part of the description was to consider that the car started to turn round as soon as it started to decelerate at 9 seconds, omitting to state that it came to rest at 12 s. Somehow it went into reverse without stopping or apparently so. There were the usual errors of considering the linear part of the graph to be a steady increase in velocity or constant acceleration. Very few candidates used the gradient of the graph to explain their answers. The majority were content to give a running commentary of the car's journey without any explanation.

With reference to SPAG, many candidates managed to write a complete paragraph of 10 lines without a single punctuation mark, despite they're being many complete sentences within the text. Much of the spelling and handwriting were very poor. Organisation was usually adequate to enable the examiner to realise where the candidate was in the description of the motion.

2822 - Electrons and Photons

General comments

There was a noticeable improvement in the presentation of numerical solutions but legibility remains a concern for a significant proportion of the candidates. The marks for this paper ranged from zero to sixty. It was clear that many Centres had done a good job is preparing the candidates for the complexities of this written paper. Once again, there were fewer scripts where candidates had missed entire sections of the paper. A disturbing number of candidates still struggle with rudimentary number and algebraic skills. It was very much noticeable that some Centres had not addressed the mathematical needs of the candidates. A significant number of candidates struggled with prefixes and standard form. Candidates need to be reminded that substituting numbers into wrongly recalled equations is futile. The creativity of some candidates continues to astound examiners. It was not uncommon to find expressions like: $hf = \phi \times E_{\mathrm{k}}$, $B = FIL$ and $P = V / I$.

The Quality of Written Communication (QWC) was assessed in **Q7**. The modal score for the QWC mark was two, with most candidates adequately presenting their answers. The vast majority of the candidates finished the paper in the scheduled one hour.

Comments on Individual Questions

Question One

This opening question was accessible to the majority of the candidates. A large number of candidates scored in excess of five marks.

The majority of candidates correctly stated two common properties of electromagnetic waves in **(a)**. The most popular answer stated that all '*electromagnetic could travel in a vacuum at the speed of* 3×10^{8} ms^{-1}'. Very few candidates mentioned that all electromagnetic waves consist of oscillating electric and magnetic fields.

In **(b)**, candidates identified the radio waves and the gamma rays more easily than the infrared radiation. The most common wrong answer for the wavelength of 5×10^{-6} m was visible light. A small number of candidates saw the term '*radiation*' as a trigger to write down '*alpha, beta and gamma'*.

The description of the photon in **(c)** was very much Centre-dependent. There were many good descriptions, but equally, there were many misconceptions like: '*a photon is a positive proton of light*' or *'a photon is a charged packet of light'*. The answers to **(d)** were more pleasing with many candidates identifying the gradient of the graph to be the Planck constant. Sadly, there were a variety of spelling mistakes with this name, in spite of its appearance on page 2 of the question paper.

The most common incorrect answer for the ratio in **(e)** was 2. A few candidates invented values for the wavelengths of red and blue light to determine the ratio.

Question two

Many candidates secured three marks for this question.

A significant number of candidates still have problems with prefixes and on this occasion, converting the time from hours into seconds. In **(a)**, the majority of candidates correctly recalled and applied the equation $Q = It$. A few candidates stated the ampere-hour as the unit for charge rather than the coulomb.

The majority of candidates realised that the charge in **(b)** would be less than their previous answer, but their answers did not provide an adequate explanation. There were some superb answers in terms of the area under the graph being less than the previous case. Only a small number of candidates appreciated that the charge would be less because the average current over the period of 5 hours was less.

Question three

Most candidates correctly stated Ohm's law in **(a)** and secured two marks. A few candidates gave definition of either resistance or the ohm. The most common incorrect answer was '*resistance directly proportional to current at constant temperature*'.

Fortunately, only a small number of candidates omitted **(b)(i)**. A good number of candidates marked the end of the graph in Fig. 3.1 and labelled it as requested by the letter **M**. A small proportion of candidates placed the letter **M** close to the origin where the gradient of the graph was greatest. The answers in **(b)(ii)** were generally well presented with most candidates opting for the route $P = VI$ rather than $P = I^2R$. Most candidates struggled to show that the voltmeter reading in **(b)(iii)** was 3.4 V. Some candidates were definitely inventive and made sure that they arrived at the answer given in the stem of the question. Only those candidates who realised that that resistance of the lamp or the potential difference across the lamp had to be deduced from the graph of Fig. 3.1 stood any chance of securing some marks. Most candidates totally ignored the lamp in Fig. 3.1 when determining the internal resistance of the battery. The most common incorrect answer was 1.05 Ω. A disturbing number of candidates determined the total resistance of the circuit of 2.25 Ω and quoted this as their value for the internal resistance. It is clear that internal resistance remains an enigma for many candidates.

Question four

A small proportion of candidates did not scrutinise the question in **(a)** because they drew magnetic field pattern around the solenoid. For many candidates, this was an opportunity to secure two very accessible marks.

Very few candidates failed to secure the mark for **(b)(i)**. The majority of candidates correctly applied the equation $F = BIL$ to determine the magnetic flux density at one end of the solenoid. Inevitably, some candidates either struggled with rearranging this equation or converting the length of the wire from centimetres into metres.

Question five

Most candidates in **(a)** had no problems with completing the circuit diagram. The ammeter and the voltmeter were correctly placed in the circuit.
The majority of candidates gave good descriptions of their experiments in **(b)**. There was a noticeable improvement in the way candidates presented and organised the descriptive answers. However, the legibility of some candidates remains a cause for concern. It was clear from the

answers that most Centres had done an experiment to determine the resistivity of a material. Candidates particularly excelled at sequencing their strategies for determining the resistivity of the metal. For some candidates, the micrometer was an instrument for '*measuring the cross-sectional area of the wire*' rather than the diameter.

Question six

Some candidates made a poor start by failing to identify the light-dependent resistor in **(a)(i)**. The most common incorrect answers were the light-emitting diode and the thermistor. A significant number of candidates could not recall the variation of resistance of the LDR with intensity of light. However, the majority of candidates gave impeccable answers for **(b)(ii)**. Candidates must learn to interpret questions with care. In **(b)(iii)**, it was vital for candidates to state the factor by which the current decreased. No credit could be given for a response like '*the current in the circuit decreases'*.

Many candidates managed to secure full marks for determining the total resistance of the circuit in **(b)**. However, a disturbing number of candidates failed to recognise the structure of the circuit and simply added all the resistance values to give an answer of 8.0 kΩ. An equal number of candidates decided to have all four resistors in parallel and arrived at the incorrect answer of 0.5 kΩ. The obstacle for many candidates was recognising that the three resistors in the second branch of the circuit were in series.

The answers to **(c)** were once again dependent on the Centre. The majority of candidates opted for the potential divider equation. Their success was governed by their competence in algebra. A disturbing number of candidates totally ignored the LDR and proceeded to calculate the current in the circuit by a having a potential difference of 5.0 V across the fixed resistor. A small number of candidates cut their losses by not attempting this question.

Question seven

A significant number of candidates correctly recalled the de Broglie equation and explained the meaning of the terms in **(a)**. Some candidates tried their luck with equations linked to the photon like $E = hf$, $E = \frac{hc}{\lambda}$ and $hf = \phi + \mathrm{KE}$. Only a small number of candidates appreciated that the wavelength in the de Broglie equation was a wave characteristic, whereas mass or momentum were akin to the particle-like property of the electron. Many candidates mentioned that '*electrons can be diffracted'* in the hope of securing some extra marks.

For many candidates, photoelectric effect is very baffling. This was particularly evident in the definition for threshold frequency in **(b)(i)**. Many candidates failed to recognise that this is the minimum frequency required for the onset of photoemission. Some gave definition for work function energy. Only a small proportion of candidates appreciated that the metal surface would '*heat up*' when the electrons gained energy from the photons but were unable to escape from the metal surface. There were numerous errors made in the calculation for **(b)(ii)**. Candidates quoting a wrong equation gained no marks. Those using the Einstein photoelectric equation had several obstacles in their way. The most common error made was failure to convert the photon energy of 4.1 eV into joules. Some candidates were also defeated when rearranging the photoelectric equation or determining the wavelength using $c = f\lambda$.

2823/01 - Wave Properties

General Comments

The paper provided ample opportunity for candidates to demonstrate their knowledge and understanding of the specification and the general standard of work was similar to that of last year. There was no evidence of candidates being short of time with the vast majority of students being able to attempt every question in full.

Comments on Individual Questions

Q1. Most could correctly define *diffraction* but the majority failed to label their diagrams showing the diffraction of plane waves at a small aperture. As a result those who drew the diagram carelessly lost the mark for showing that there was no change of wavelength after passing through the gap. Simply labelling the wavelength as being the same on both sides of the gap would have guaranteed this mark. Virtually all corrected stated that a bigger gap would reduce the amount of diffraction.

Q2. As expected, most were able to define refractive index in terms of the speed of light in free space and in the medium. The ratio sin i/sin r was also accepted provided *i* and *r* were correctly identified but n = 1/sin c was not allowed. The calculations required in part (b) were successfully executed by the overwhelming majority of candidates. In part (c) most were able to correctly account for the lateral displacement of the ray but explanations for the emergent ray being parallel to the incident ray were often too vague to score full marks. Likewise many failed to give a full description of what needed to be done to determine the refractive index of the block. Many, for example, simply stated that values for *i* and r would be substituted into the formula without explaining how these values could be found.

Q3. Most candidates showed a good knowledge of *multipath dispersion* and the conditions for total internal reflection but a significant number thought that the cladding should have higher refractive index than the core. In the final part of the question, most were able to correctly calculate the critical angle as 78.5^{o} and the higher scoring candidates went on to give convincing accounts of why such a high value of *C* reduces multipath dispersion.

Q4. This was expected to be straightforward question on the graphical representation of a wave but many candidates made some elementary mistakes. The most common errors were

- failing to identify the displacement at t = 1.8ms as a negative value
- misreading the time axis scale and quoting the period as 2.62ms
- failing to convert milliseconds into seconds when determining the frequency.

The overwhelming majority of candidates scored full marks for the recall and correct use of $v=f\lambda$ in calculating the wavelength.

Q5. Most could state three phenomena applicable to all waves and virtually all gave polarisation as the phenomenon associated with transverse waves only. Explanations of how the standing wave is formed for this arrangement were again often vague and less than 50% scored full marks. Many thought the wavelength would be 1.4cm instead of the correct value of 2.8cm but most scored full marks for calculating the frequency and realised that the speed of the waves was 3×10^{8} m/s. Most candidates also showed a good knowledge of plane polarization and picked up the final marks on the paper.

2823/02 and 2826/02 - Principal Moderator's Report

As usual, for this time of year, the entry for this component was very small. Many candidates chose to carry forward their coursework marks at AS in order to improve their overall grade. Over 40% of Centres failed, however, to enter the correct code, thus causing a new entry to be recorded.

The standard of work presented was very high with the vast majority of Centres marking with care and precision, only a handful needed to suffer an adjustment to their marks.

The following points might be of interest; -

- Candidates should be encouraged to quote their references within the body of the text and make use of them in formulating their plan of action.
- There needs to be a discussion on the choice of equipment to be used in terms of the need for precision and reliability. Many candidates are simply assessing the uncertainties in measurement with the equipment they are using.
- Repeat observations are vital and if missing the award of I7b is in doubt.
- Care should be taken in awarding high Analysis marks for very simple observations. There must be some challenge in the investigation undertaken.
- The use of computers in generating graphs is increasing, but there is still a need to see the trend line of a graph and care must be taken to make the graph large enough, not to use dot-to-dot and to use proper labels. The significant figures quoted must be sensible.
- Only one investigation is needed to gain all the marks; there is little to be gained in plotting many graphs or looking at too many variables. If the candidate could be advised to aim at no more than say 10 sides of A4, all our tasks would be made much easier and the candidate could get on with further studies.
- In Evaluation, comparisons with book figures are still being used to measure "error". The uncertainties in individual measurements should be assessed for E5b and the uncertainty in the final answer will give E7b.
- Many of the improvements being offered are rather poor.

Please refer to earlier reports for detailed information on each descriptor.

2823/03 - Practical Examination 1

General Comments

The general standard of the work done by candidates was very similar to last year. Presentation of results and graphical work continues to be done reasonably well. Candidates are still experiencing difficulties with both the analysis section in question one and the evaluation section in question two.

There were no reported difficulties from Centres in obtaining the necessary apparatus.

Candidates appeared to complete the paper within the necessary time allocation and most candidates were able to complete question one and two without help from the supervisor. Candidates should be encouraged to show all the steps clearly when carrying out calculations. In addition candidates should be encouraged to include greater detail in their answers to descriptive type questions, giving reasons where necessary.

Plans are still centre specific. Centres are reminded that the planning sheet should be signed by both the candidate on page two and the teacher on the front page.

Comments on Individual Questions

Plan

The plan used as a scene setter an example of recovery trucks and the importance of ensuring that the front end of the truck does not lift off the road. Candidates were required to plan an experiment to investigate how the static force exerted on a front axle varies with the vertical load applied to the rear end. To assist candidates they were given the dimensions of an appropriate block of wood.

The majority of the plans were about an appropriate length. Parts **(a)** to **(f)** on the planning sheet are designed to focus candidates' attention to relevant areas where marks will be awarded. Candidates should be encouraged to give a response to each section with reasoning. In particular part **(d)** asked for the range and precision of any instruments that would be used.

It is expected that a practical experiment should be planned.

Most candidates scored marks for drawing a labelled diagram that was supported at R and an appropriate procedure. Some candidates did not measure the correct force at F and many did not add a carried load. In addition there were some very clear diagrams and descriptions of how the block of wood was supported at F. Some weak candidates suggested wrong experiments.

Many candidates did not suggest ranges of loads that would be applied nor the range and precision of any measuring instruments used. There was one mark available for a relevant safety precaution. Again too often examiners just see a list of standard laboratory safety rules rather than an explanation as to why a safety precaution is required in this particular experiment.

There are always marks available for extra detail e.g.

- find weight of wood,
- method of determining measuring instruments range and precision
- evidence and use of preliminary investigation,
- method of reducing friction at R,

- justification of load to keep force on front axle
- method of keeping carried load in the same position.

In the notes for guidance for the plan it is stated that candidates should list clearly the sources that have been used. Two marks were available for evidence of the sources of the researched material. Detailed references should have page or chapter numbers or be internet pages. Two or more detailed references score two marks. Two or more vague references scored one mark.

Most of the more able candidates were able to score two marks for the quality of written communication which were awarded for the organisation and sentence construction of the Plan.

1 This question asked candidates to investigate how the force required to support a metre rule at a constant angle depends on the mass attached to the metre rule.

Candidates were initially asked to set up the apparatus and measure the reading on the newton-meter. Very few candidates needed help and the appropriate readings were taken.

Results tables were generally well presented. The majority of candidates labelled the columns with both a quantity and the appropriate unit; it is expected that there should be a distinguishing mark between the quantity and the unit. It is expected that all raw data should be included in a table of results. All the raw data should be given consistently. Common errors were *M* values recorded as 0.1, 0.2 etc. and *T* values having extra zeros added.

Graphical work was generally done well. Weaker candidates often used either less than half of the graph grid or awkward scales particularly in the *y*-direction. There were also a larger than usual number of candidates who did not label the axes. Points were usually plotted accurately to the nearest half square. The majority of candidates drew their line of best fit with a fair balance of points.

It is expected that the gradient should be calculated from points on their best fit line which are at least half the length of their line apart. Weaker candidates often lost marks either by using triangles that were too small or by working out $\Delta x/\Delta y$. Good candidates clearly indicate the points that they have used and show their calculation. The *y*-intercept was usually correctly read from the *y*-axis.

In part **(g)** candidates were asked to determine values for *g* and *R*. Again weak candidates do not follow the question which tells them to use their answers for determining the gradient and *y*-intercept. Failure to use these values cost candidates five marks. Good candidates equated the gradient to $3g/4$ and gave an answer for the value of *g* in ms^{-2} or Nkg^{-1} with an appropriate number of significant figures. Likewise the *y*-intercept was equated to $gR/2$.

Part **(h)(i)** asked candidates to determine the percentage difference between two values of *R*. A common error was that candidates just divided one value by the other without finding the difference. Good answers clearly demonstrated the method used to calculate the percentage difference.
Part **(h) (ii)** asked candidates to explain whether their results indicated a random error or a systematic error. Large numbers of candidates failed to refer to their

results often just describing errors which might have occurred in their practical work. Examiners expected the scatter of points on their graph would help candidates explain the random error whilst some comparison to the (percentage) differences in either *g* or *R* would be used to discuss the possibility of a systematic error. In both cases candidates were expected to give an appropriate conclusion.

2 In this question candidates were required to determine the resistance per unit length of a pencil lead and then write an evaluation of the procedure.
Most candidates were able to connect the circuit and measure the current correctly; however, weaker candidates often made errors when calculating the resistance and the resistance per unit length. Often candidates did not change milliamperes to amperes.
In part **(d) (i)** most candidates calculated the percentage uncertainty in the value of e.m.f. of the battery. Sadly few candidates then applied their knowledge to **(d) (ii)**. Very few candidates calculated the percentage uncertainty in the value of current and then added this to their earlier answer. Too often weak candidates calculated the percentage uncertainty as 0.1/resistance value x 100.
The majority of candidates gained a smaller current for a longer pencil. No further penalty was applied at this stage for calculation errors.

In part **(f)** candidates were asked whether their results supported the relationship that *R* is proportional to *L*, explaining there reasoning clearly. No marks were awarded without reasoning. Many candidates did not realise that they had already calculated a constant of proportionality. Candidates must draw an appropriate conclusion.

(g) Weak candidates are still evaluating experiments by describing the procedure they followed. Good candidates scored well by describing relevant problems and suggesting specific ways to overcome them. Vague suggestions without explanation did not gain credit. Likewise vague human error and parallax errors did not score credit.

Credit worthy problems:

difficult to attach crocodile clips,
current reading fluctuate,
physical characteristic of 'lead' not the same
heating effect of pencil
e.m.f. not 1.5 V
two readings of *R* and *L* are not enough to verify the suggestion.
credit worthy solutions:
method of improving contact with pencil
repeats readings and take an average
appropriate improvements to heating effect (take reading instantly) and physical characteristics (improvement to measure length or check cross-sectional area with a micrometer
use a voltmeter to check e.m.f.
take many readings of *R* and *L* and plot a graph of *R* v *L*.

Two marks were available for spelling, punctuation and grammar in this part.

2824 - Forces, Fields and Energy (Written Examination)

General Comments

Every question appeared to be accessible to all candidates so there were fewer unanswered questions than usual. The weakest candidates invariably found something that they recognised and could attempt. Candidates appeared to have adequate time to complete all questions. There was a good range of responses to most questions enabling differentiation to be achieved. Many middle of the range candidates scored widely different marks on different questions, showing significant knowledge of some topics and little of others. The most successfully answered questions by all candidates as expected were the (a) parts of each question and the (b) parts of questions 2 to 5. Candidates should be reminded that it is important that they must not only show their working but also explain or justify it in order to gain full marks. This is especially true in the 'show that' questions. The answer given on the examination paper is usually only approximate and is there to help any candidate attempt further parts of the question, when unable to achieve a more precise answer. Candidates should therefore be reminded to write down the answer to their calculation rather than equate an arrangement of multiplied and divided numbers directly to the answer given on the examination paper.

Comments on Individual Questions

Q1 (a) (i) All recalled the correct formula. The most common mistake was not to calculate the value of the velocity which was 1.52×10^{7} and just give the approximate value 1.5×10^{7}.

(ii) Most candidates appreciated that the two nuclei were positively charged and repelled each other. Some candidates discussed calculating the velocity using the conservation of kinetic energy instead of the conservation of momentum. Many gave too general an answer to gain the full three marks

(iii) Candidates either used the conservation of momentum obtaining the correct answer or the conservation of kinetic energy gaining no marks.

(iv) Most candidates correctly relate the force to the rate of change of momentum but then forgot to double the initial momentum of the alpha particle to find the change in momentum, gaining only one of the two marks.

(b) A few candidates gave the gravitational equation $F = Gm_1m_2/r^2$ instead of the electrostatic formula kq_1q_2/r^2. Others thought that F was proportional to1/r instead of $1/r^2$. Only a minority realised that the answers could be obtained quickly by use of ratios, although a significant number did finally reach a correct solution.

Q2 (a) The descriptions of internal energy usually included the words kinetic and potential energies but it was necessary to indicate that the kinetic energy is the random energy of thermal motion. More importantly it was necessary to indicate that the energies were those of the constituent molecules or particles of the body.

(b) Most candidates knew the formula 'pV/RT = n' but many substituted T = 15 °C instead of 288 K. Some did not notice that p = 280 kPa and substituted p = 280 instead of 280,000. Part(ii) was usually solved by using the complete formula for a second time rather than by using the ratio of p/T.

In part (iii) a large number of candidates scored no marks because they considered that the ratio of the internal energies was the ratio of the celsius rather than the absolute temperatures, despite the fact that many of these had used the kelvin scale for the earlier calculations.

Q3 (a) The most common and also incorrect expression for speed was rf rather than $2\pi rf$. Also many candidates failed to change millimetres to metres.
The discussion about why the belt slipped on the pulley with an increase in speed of the motor proved to be too demanding a question; but credit was given for any sensible and clearly explained relevant physics.

(b) Most candidates demonstrated a sufficient understanding of resonance to score full marks.

(c) Most candidates stated in some form or other that the e.m.f. was equal to the rate of change of flux linkage but about half failed to state correct times for the e.m.f. to be zero or a maximum. The next most common fault was to state that the e.m.f was 2/5 = 0.4, instead of drawing the tangent at a point where the curve crossed the x axis and finding the gradient of this; also failing to note that the time axis was in milliseconds and not seconds.

Q4 (a) This was answered well. A few candidates muddled the symbols for powers of 10 writing the answer, 60×10^{-8} C as 60 μC instead of nC. Some gave the unit as F.

(b) The time constant was usually calculated correctly as was the current but some tried to use the method for part (iii) namely using I = Q/t.
In part (iv) many candidates correctly worked out the charge which was left after one time constant but did not complete the argument by working out the charge which was lost, hence losing one of the two marks.

(c) Descriptions were poor with few stating that charge was constant and that the capacitors, being connected in parallel, were at the same voltage. Some said that the voltage was shared or constant. Only a small minority appreciated that the voltage fell to 5V. The common incorrect value for V was 5000 V.

Q5 (a) Many candidates did not score both marks for the field lines by not drawing them spaced equally; in most cases because the line which should have been drawn on or close to the beam line was missing. The direction of the arrows on the lines was usually correct.
Very few candidates appeared to know that the energy of the electrons is given by eV which is to be equated to $\frac{1}{2} mv^2$. The common approach in the few cases where part (ii) was not left unanswered was to try to use E = V/d with various interpretations of the meanings of the symbols.

(b) About half of the candidates gave the force direction correctly, with almost all determining the direction of the magnetic field, whether correct or not, using Fleming's left hand rule.
Many candidates scored full marks for part (iii). A regular, though not too frequent, error was to confuse V with v in F = BQv.

(c) Most candidates were able to say something sensible about adjusting the position of the electron beam to score one mark, with the better candidates giving enough detail to gain both.

Q6 (a) The nuclear equations were usually completed correctly.

(b) Candidates do not seem to grasp the need to give the details to make an experiment work or to enable a conclusion to be found. Some of the better candidates lost a mark because there was no mention of background count. For weaker candidates, several steps in the experimental verification were often missing; descriptions being often incomplete or lacking substance.

(c) Most candidates knew that $A = \lambda N$ but many were unable to work out N from the mass, nucleon number and Avogadro's number.
Also most candidates evaluated $\ln 2/\lambda$ correctly to find the half life but then many failed to plot the graph correctly.

Q7 (a) This question was accessible to all and many weak candidates gave a good account of the processes often scoring well over half marks. However, there was also a great tendency to pad out the answer.
Some candidates referred to particles, atoms and substances instead of nuclei when describing fission or fusion. Other common errors in fission descriptions included the nucleus splitting into a new nucleus with an α or β particle or into many nuclei instead of two; failing to mention the role of neutrons in triggering a fission reaction or being given out as part of the process.
In fusion descriptions candidates failed to note that the temperature must be very or extremely high but some scored the mark by saying fusion occurred in stars or in the Sun. Some candidates thought hydrogen/helium nuclei were unstable by referring to less stable nuclei becoming more stable in the fusion process. Very few candidates mentioned the effect of Coulomb repulsion in either fusion or fission.

(b) There were some good reasoned arguments but many candidates did not answer the question, only repeating it at great length. It was necessary to make some use of the data before a mark could be awarded.
Many candidates identified the important factors without giving a full analysis. The most common error was to forget the factor of 4 required to convert hydrogen to helium. It was also not clear with some weaker candidates when they mentioned 'particles' whether they were referring to the neutrons and protons in the nucleus or atoms in 1 kg. Some candidates successfully compared the energy produced per hydrogen nucleus in fusion with the energy per nucleon in a uranium nucleus in fission. To complete the argument it was then necessary to state that there was approximately the same number of nucleons in one kilogramme of each element.

QWC The presentation and layout of the answers to this question have continued to be of a better standard. However too many candidates do not stop to think and plan a short succinct answer to the question; but ramble on writing many sentences which do not gain them further marks.

2825/01 - Cosmology

General Comments

The number of candidates was significantly higher than for the January 2006 paper and their performance produced a full range of marks.
Many candidates displayed a good depth of knowledge throughout the paper, performed calculations clearly and expressed themselves well. Graph work was generally excellent, but since the relation was non-linear, those who used a pen to sketch the curve often encountered problems. Candidates should be aware that they can often gain marks by showing their reasoning and in particular, questions which contain the instruction 'show that' will usually require working to be evident in answers in order to gain full credit.

Comments on Individual Questions

1. (a)(i) This question was answered well. Most candidates quoted Galileo's observations of mountains or craters on the Moon and stated that Jupiter had moons in orbit.
   (a)(ii) The relevance of these was also well known although some stated that the Moon's orbit around the Earth disproved the geocentric theory. Candidates who gave a full explanation of retrograde motion received credit as this follows on from a heliocentric model of the Solar System.
   (b) Perturbations in the orbit of Uranus were often explained well. Candidates knew their cause and what was discovered as a result, although many confused Pluto with Neptune.
   (c) This question was answered correctly by less than half of all candidates. It is clearly an area where candidates can improve their knowledge. In place of galaxy, answers of Milky Way or black hole were allowed. The most common incorrect answers for the most massive object were red giant and neutron star, the latter perhaps displaying some confusion between mass and density

2. (a)(i) Many candidates knew the correct expression for the centripetal force but it had to be equated with Newton's Universal law of gravitation to gain credit.
   (a)(ii) The simple relationship between period and velocity was shown by most candidates and the majority of these went on to use the previous result to obtain the correct expression. Where candidates failed to gain full marks the most common errors were those of algebra such as cancelling down r or forgetting to square the period.
   (b) This question produced more errors than expected and some candidates would benefit from using more care. A small but significant number of candidates used a value of 9.81 for G, despite its value being stated at the front of the question paper. The time also caused problems. Examples were seen where values in days, hours or minutes were used. Many candidates who correctly converted the time to seconds then forgot to square the value. Another common error was to take the square root rather than the cube root. Candidates who showed their working could be given marks for each step in the calculation and thus were potentially at an advantage.
   (c)(i) This was answered well. Most candidates could give at least one reason for the difference and many gave a second. Answers in terms of velocities and gravitational field strength were sufficient. Some candidates attempted to bring in the principle of equivalence and discussed acceleration, but in doing so it was not unusual to have statements that acceleration in orbit or on the Earth's surface was zero.
   (c)(ii) A good number of candidates realised that the orbits must be elliptical, thereby causing the satellites to experience a change in height and speed. In general, candidates are well advised to say what something is, rather than what it is not, and descriptions of the satellites' orbits as 'non-circular' were not accepted. In this case, answers using speed or velocity gained equal credit.

3. (a) Nearly all candidates knew the Doppler Effect or could explain it by quoting an example using sound or light waves. ‘Shift in wavelength’ was accepted, but ‘red shift’ did not gain credit unless accompanied by a reference to wavelength.
(b) There were many examples of full answers to this part of the question and the mark scheme contained a good number of possible points so most candidates scored at least 3 marks out of the 6 allocated. Many answers referred to the red shift, expansion of the universe and Hubble’s law. It was not unusual for candidates to refer exclusively to stars or planets and one mark was reserved for reference to galaxies. The method of calculation of the recessional speed was described well but very few candidates stated how distances to galaxies were determined. More surprising was the small number of candidates who showed how the age of the universe could be estimated from knowledge of Hubble’s constant.

4. (a) Hydrogen burning was given as a characteristic of a main sequence star by many candidates but other reasons such as it being the most long-lived or most stable part of the star’s cycle were not given so frequently. Answers which stated that radiation pressure was in equilibrium with gravitational compression were accepted but references to HR diagrams did not usually address the question.
(b)(i) Few candidates referred to the inverse-square relationship for intensity of light and distance, but a good number knew that absolute magnitude compared stars at equal distances of 10pc.
(b)(ii) Most candidates quoted the relation $m – M = 5\log(r/10)$ correctly and could proceed to substitute the data. Relatively few candidates demonstrated problems using logarithms and the most common error by far was to convert the star’s distance into metres whilst leaving the 10pc term unchanged. This casts some doubt on candidates’ understanding of the formula, despite their answers to the previous question.
(c)(i) The plotting of points was performed well with just a small proportion of candidates making simple errors. A quick check for correct +/- sign is worthwhile.
(c)(ii) The curve was not simple to draw and perhaps more difficult to get right than a straight line. An accuracy of half a square was expected together with a smooth, curved peak. As already mentioned at the start of this report, those candidates who used pen to plot points and draw the curve found it difficult to recover successfully from elementary errors.
(c)(ii)i. This was done well and only a very small minority made errors reading from the scale or gave the time for maximum brightness, instead of the apparent magnitude, as requested.
(c)(i)v. A supernova event was correctly identified by most candidates, of whom about a third went on to explain why. The most popular answer, perhaps triggered by the first part of this question, was that the star had become a red giant. These candidates clearly did not understand the timescale for the formation of a red giant or appreciate by how many orders of magnitude the luminosity had increased.

5. (a) This was not answered so well as other parts of the paper, but nevertheless there was a full range of answers, some of which showed a knowledge which went beyond the immediate demands of the syllabus.
In the context of this question, the term ‘hot’ was not accepted as a substitute for ‘temperature’ and candidates were expected to understand that temperatures were *very* high during the first moments after the big bang. Many candidates could discuss the formation of leptons and hadrons, the separation of forces and the annihilation of matter and antimatter. The role played by the cooling of the universe was generally well explained but the proportion of hydrogen to helium, formation of hydrogen atoms and the consequent transparency of the universe to gamma radiation were less frequently seen in answers.

A very small number of candidates ignored the thrust of the question and explained stellar formation.

(b) Many candidates knew that the cosmic microwave background radiation is isotropic, but fewer explained its origin from 'decoupling' of nuclei and electrons. Some candidates gave its corresponding black body of 2.7K but rarely stated that this was predicted by the big bang model.

(c)(i) The relation E = hf was quoted by many candidates and the majority of these went on to complete the calculation successfully by substituting the wavelength and speed of light.

(c)(ii). Most candidates knew Einstein's equation for the rest mass energy and used it to get the correct value. Weaker candidates either left this blank or used the formula for kinetic energy.

(c)(ii)i. This question expected straight forward substitution of data and most candidates had little difficulty. There were, however, a minority of answers which did not contain the factor of 10^9 or made an arithmetic error using this factor. Again, a quick check of data and numerical methods can be advantageous.

(c)(i)v. About half of all candidates realised that the photon energy would be higher when the Universe was younger, thus reducing the overall ratio. Other candidates failed to understand that the number of photons being considered is constant or thought the rest mass energy of a proton or neutron would change significantly.

6. (a) This was answered well by the majority of candidates. The constancy of the speed of light was well understood and many correctly discussed the equivalence of all inertial frames of reference. With regard to the latter, answers in terms of Newton's First Law applying to *all* such frames were accepted. Answers which merely explained the meaning of an inertial frame fell short of addressing the question.

(b) This question produced a range of performances. Many candidates gave very full accounts, showing a good understanding of the origin of muons, the measurements necessary and the effect upon half-life due to the high velocity. A space was left for a diagram to be included, but these could only gain credit if labelled. Experiments which measured the muon intensity from mountains, aeroplanes or particle accelerators were equally acceptable, but it was difficult to give credit to answers which described thought experiments showing time dilation.

(c)(i). The meaning of a light-year was well-known, but reference to it being a *distance* was required.

(c)(ii). 1. Many candidates converted a light-year to metres and used a time in seconds for this calculation. This tended to increase the number of errors and frequently a time calculated in seconds was given the unit of years which appeared in the answer line.

2. This calculation proved difficult for many and only about one third of candidates gained full marks. Those who calculated the Lorentz factor correctly were given credit, but very often velocities were not squared or, most commonly, the times were transposed. It was not uncommon in this part to see the use of speed = distance /time.

2825/02 – Health Physics

General Comments: Generally it was felt that candidates were well prepared for this paper. Question three was sometimes poorly done by top physics candidates showing that they had not given due consideration to this part of the syllabus. Many candidates produced ray sketches without the use of a ruler and offered lines that were not straight and that appeared to lack care. A number of responses to questions requiring explanations were vague and often offered phrases rather than sentences, some of which were ambiguous.

Comments on Individual Questions:

1 **(a)(i)(ii)** The 'work' and 'power' calculations were mostly (but by no means always) done well. Common errors included use of *g* as $10\ m\ s^{-2}$ and the conversion of 250 mm to m. A number of candidates multiplied the mass by the distance to calculate the work done.

(a)(iii) It was expected that a discussion of the efficiency of the muscles and subsequent generation of thermal energy in the muscles might be offered. Instead many candidates submitted the words ' heat' or 'some is lost as heat' without reference to where the heat is generated. Some answers did go further and instead of describing the muscles that were performing the work, referred to the extra energy required to keep the body warm and to maintain metabolic functions.

(b) A number of candidates described the wall pushing on the person. To gain both of the marks it was necessary to apply the physics of *moments* to the situation, making reference to either the movement of the centre of gravity of the person to the right of the pivot / feet or the net clockwise moment which could not be counterbalanced.

(c) Almost all candidates knew that it was important to lift by bending the knees and keeping the back as vertical as possible. Very few responses gained all 5 marks by making reference to the reduction the perpendicular distance of the line of action of the load / centre of gravity to the pivot, and hence reduction of the moment.

2 **(a)(i)** Many candidates successfully identified the eye defect. But for those who didn't, it was still possible to gain ecf marks for the rest of the question.

(ii) It was expected that candidates offer both the reason for the defect as well as the effect on the sufferer. Many responses only focused on what a sufferer would experience.

(iii) Many diagrams were drawn without the use of a ruler and care. The majority of responses were correct.

(b)(i) Common errors include the conversion of mm to m prior to the calculation using the lens formula.

(ii) A number of candidates used a recalled value of 0.020m for the cornea-retina distance.

(iii) The most common error was to get the subtraction the wrong way round ending up with a negative lens power.

3 Responses varied dependent on whether candidates had studied this or not. Where candidates had not studied this it was common to see attempts at showing what they knew about cones and their responses to light of differing intensity and frequency. Some marks were made available where this line of approach was adopted.

4 Nearly all responses made reference to ‘bloodless’ surgery. Many responses were too vague to gain credit, e.g. ‘the surgery is clean….’. It was not clear whether this meant ‘sterile’ or ‘not messy’ ?

5 **(a)** A common mistake was to say that *frequencies* below this value could not be detected. Many candidates were unable to score marks here.

(b) Only about half of the candidates were able to solve this equation.

(c)(i) Only a few candidates were able to find the constant of proportionality. Some attempted to reason the answer. Very few were successful.

(ii) Most candidates were able to gain both marks here carrying forward their errors.

(iii) Many candidates were unable to interpret the graph and the significance of the position of their answer on the graph. Most were able to guess what problems the sound engineer might encounter.

6 (a) Most candidates were able to get the thermal energy box correct. Less were able to identify where the energy was kinetic with even fewer getting the initial energy of the electrons.

(b) This proved straight forward for many although a few went straight to the equation *power = V x I.*

(c) This was not very well answered. About half of the responses identified that heat was generated. Most of these went on to successfully identify a feature in the design of an X-ray tube.

(d) This calculation proved difficult for many. A common error was to use 10^{-12} for I_o.

(e) Most candidates were able to get some marks here.

7 Not many were able to convey the difference between *direct* and *indirect*. It was common for candidates to pick up marks for ‘damage to DNA’ and in the case of *indirect effect,* the ‘formation of free radicals’.

8 **(a)** For many candidates, this proved difficult. In general candidates either got full marks or one (for the unit).

(b) It was common to find responses that said ‘the absorbed dose decreased with decreasing photon energy’ which did not make reference to the graph.

9 **(a)** Many candidates worked out the average *time* for the three tests and then considered this value to be the mean *speed*.

(b)(i) It was possible to gain credit here by following either the mathematical path (the horizontal and vertical components being the same for an angle of 45^o) or the physics path (by discussing the constant horizontal component). Many candidates were unable to express clearly what they wanted to say and failed to be convincing.

(ii) Where an equation of motion was quoted, the reasoning that followed was generally correct.

(iii) Once again, it followed that candidates who were successful in (ii) had no problem in using s = u x t to find the horizontal distance travelled.

(iv) It was quite common for candidates to start with the equation for kinetic energy and then upon realising the required answer was twice that which they had obtained, some crossed out the ½ in their original equation so 'fixing' the answer while others simply doubled the answer without giving any reason.

(c)(i) This was poorly answered with only about a quarter discussing the centripetal force or centripetal acceleration.

(ii) Most candidates were able to successfully score full marks for this.

(iii) While most candidates scored full marks here, there was frequently no comment to accompany the two slightly different answers.

(iv) This part differentiated well as candidates had to reason what would happen in the absence of a centripetal force. There were some very good attempts at describing the path of the cyclist. Some reasoned well but lacked the detail (e.g. 'vertically' upwards, or 'at a tangent' to the semi-circle at A).

2825/03 - Materials

Due to the low entry for this unit no Report for Centres has been written.

2825/04 - Nuclear an Particles Physics

General Comments

There were a few excellent scripts which scored well-deserved marks close to the maximum and many candidates who acquitted themselves well, but once again there was a surprisingly large number of candidates who seemed inadequately prepared for this A2 paper and who therefore failed to engage properly with large parts of it. On the other hand, weaknesses highlighted in earlier reports such as poor use of terms like nucleus, nucleon, neutron, nuclide etc. were much less evident. Candidates were also less prone to confuse 'atom' with 'nucleus' than in earlier years. A continuing weakness however is the use of the incorrect and confusing term 'fussion'. The examiner usually has to interpret this from the context in which it is used in order to decide whether the candidate means 'fission' or 'fusion'. Poor presentation, particularly of numerical answers continues to blight the work of some candidates and increases the chance of credit-worthy work being inadequately rewarded. Candidates were however more consistent in their use of standard form for their answers.
Candidates often did not make adequate distinction between questions which asked them to 'calculate..' a value and those which required them to 'show that..' a certain answer could be achieved. In the latter case they must take particular care to set out their answer clearly with some verbal explanation because there is no mark for arriving at an answer which has already been given.
A minority of candidates did not leave themselves enough time to make a proper attempt at the last question and left much of this section blank.

Comments on Individual Questions

1 *(a)(i)* Candidates were expected to know the standard force-separation graph for the strong force between two neutrons. Most were able to do this but many failed to show that the strong force at larger separations actually becomes zero; instead they showed the force approaching the separation axis asymptotically, or simply stopped the graph line before they had made clear whether the line met the axis or not. A few candidates failed to show any turning point, or showed *two* turning points, in the style of a wave.

(ii) Most were able correctly to show the regions in which the force was attractive and those where it is repulsive. A few had curves which differed so much from the correct shape that it was impossible to give credit for the attraction / repulsion regions.

(iii) Most candidates correctly showed the equilibrium separation **X** at the point where the graph crossed the separation axis. A minority, however, showed it either as the turning point of the graph or as a point at which the strong force of attraction is balanced by a repulsive electrostatic force, forgetting that the question concerned two *neutrons* which have no charge.

(b) Candidates were expected to state that if a neutron is displaced slightly to the left (decreasing the separation) then the strong force would become repulsive; displacement to the right causes attraction. Therefore the strong force, around the equilibrium position acts as a restoring force and at the equilibrium position itself the strong force is zero. Many candidates were able to score full credit for the statement of this. A few, thinking that charge was involved, described how the electrostatic force balances the strong force at the equilibrium point. Others stated that the attractive and repulsive parts of the strong force itself are balanced at the equilibrium position. Whilst not seriously wrong, this approach is probably unhelpful

to candidates who would be better to regard the variation of force with separation as simply a description of the strong force itself.

(c) Candidates were expected to realise that the short-range aspect of the strong force means that it acts only on its nearest neighbour and not on nucleons further away. This means that the inter-nucleon separation is not affected by how many other nucleons are present in the nucleus and therefore the density of the nucleus is independent of its size. This part was not well done; many candidates wrote at some length without addressing the question properly at all. Others made statements such as ' the strong force is short range, so smaller nuclei are more dense than large ones'. Others again thought that the density would be greater at the centre of a large nucleus than at the edge.

2 *(a)* Candidates were expected to write two nuclear equations, each of which included a product beta-particle and an antineutrino. Many were able to score full credit for this. Marks were sometimes lost, however by omission of the antineutrino or failure to represent correctly the negative beta-particles. Inclusion of a neutrino rather than an antineutrino was not penalised.

(b) This was, in effect, a data analysis question. Candidates were expected to visualise what would happen in the event of a constant rate of production of neptunium-239 which itself was decaying to a very long-life plutonium nuclide. It was expected that candidates would realise that the number of neptunium nuclei produced would increase in proportion to time and that as the number increased, the rate of decay would also increase because the rate of decay is proportional to the number of neptunium nuclei present. This means that eventually the number of neptunium nuclei present would stabilise when the rate of production was balanced by the rate of decay. Thus the graph of nuclei produced against time is a straight line through the origin. Many candidates were able to score this mark, even if they did not realise the later implications.

(c)(i) Although many candidates were able to state that the rate of decay of the neptunium would increase because the number present is increasing, many others failed to score here because they had incorrectly inferred that the initial amount of neptunium was constant. This led them to deduce that the number of nuclei is decreasing in an exponential manner, and that the rate of decay would decrease in the same way.

(ii) It was pleasing to note that many, even some who had scored poorly on *(i)*, did realise that the number of nuclei had stabilised because the rate of decay had become equal to the rate of production. Some, however, attributed the constant number of neptunium nuclei to the exhaustion of the uranium nuclei which were producing them. This arose from two misconceptions, namely that the rate of production of neptunium (contrary to what is stated in the question) is not in fact constant, and that the neptunium is not itself decaying.

(iii) Candidates who had understood the situation were able to apply the equation $A = \lambda N$. Having calculated the value of λ they were able to calculate N, the constant number of neptunium nuclei in the dynamic equilibrium. This part was not well done. Most achieved partial credit for evaluating λ but many lost further credit by attempting to apply the equation $N = N_0 e^{-\lambda t}$.

(iv) Candidates were expected to sketch a graph, roughly exponential in shape, rising from zero and approaching a value equal to the number of nuclei calculated in *(iii)*.

Those who had not arrived at a sensible answer to *(iii)* were unable to attempt this so only a small minority of candidates were able to score this mark.

(d)(i) Most were able to remember the half-life of plutonium-239 in years and to convert this to seconds.

(ii) A few who had succeeded so far were able to realise that the number of plutonium nuclei was the difference between the number of neptunium nuclei produced (and shown in the graph of *(b)*) and the number of neptunium nuclei present at any given time (as in the graph of *(c)(iv)*). This meant the graph labelled **Z** should have started from zero at zero time and increased at an increasing rate until this rate was the same as the original rate of production i.e. this graph should eventually have approached a straight line parallel with the graph in *(b)*. Again, candidates who had failed to understand what was going on were unable to make a sensible attempt at this part.

3 *(a)(i)* Candidates were expected to realise that the initial momentum of the deuterium-tritium system was not zero because the masses of the particles were different. If they both came to rest simultaneously the system would then have zero momentum which would be contrary to the principle of conservation of momentum; so this outcome is not possible. Surprisingly this part was not well done. This was probably less to do with the candidates' failure to understand the question and more to do with their failure to answer the question as asked. Thus, many candidates made statements along the lines of ‘the tritium nucleus is heavier than the deuterium nucleus so it will decelerate more slowly and so the deuterium nucleus will come to rest before the tritium nucleus'. Whilst this was true, it failed to consider the conservation of momentum, as asked for in the question. Others stated that the momentum of the tritium nucleus is greater than that of the deuterium nucleus - not strictly true because they were in opposite directions and therefore have opposite signs.

(ii) Candidates were expected to equate the initial momentum of the system, expressed in terms of masses and initial velocities, to the final momentum and so deduce that the final velocity of both nuclei must be equal to u/5. Again candidates probably underachieved here, this time often because they failed to set out their answer unambiguously and *explain* (in words) what they were doing. This is particularly important in a 'show that..' question where the answer is already given.

(b)(i) Candidates' responses to this straightforward question were particularly disappointing. They were expected to write a word equation relating the initial (kinetic) energy to the final (potential *and* kinetic) energy. Most candidates simply equated initial kinetic energy to final potential energy, failing to appreciate that the nuclei, at closest approach were still both moving, as given in *(a)(ii)*. Attributing energy loss to 'heat' was also a common error.

(ii) It was pleasing that most candidates were able to deduce the combined kinetic energy of the two nuclei in terms of *u*. Successful candidates used the mass of the proton and neutron (presumed to be the same as the proton mass) given in Data and were able to arrive at the given expression. Few failed to score these marks.

(iii) Candidates were expected to calculate the potential energy of the two nuclei at their closest separation and to equate this to the difference between the initial and the final kinetic energies. In view of the comments of *(b)(i)* it was not surprising that most candidates omitted the expression for the kinetic energy of the two nuclei when at their closest separation. They lost some credit for this but most candidates

were able still to score most of the available marks. A few lost credit by assuming that the charge on a hydrogen nucleus is simply 1.00, i.e. they failed calculate the charge in coulomb.

4 *(a)* Candidates were asked to give a brief account of the principles of operation of the JET fusion experiment, given some bullet points to focus their attention towards particular aspects. This was generally well done. It was expected that candidates would either quote the nuclear reaction for the deuterium-tritium reaction or, having stated the reactants, give some reason for choosing them. Most candidates were able to score on this; of those who did not, some had confused JET with CERN and wrote about the need to accelerate particles and/or collide them. Most realised that magnetic confinement of the plasma is used in the JET reactor though many failed to give detail such as how the magnetic field is created or why such a field does in fact confine a plasma. A significant proportion of candidates quoted inertial confinement which was not relevant to a description of a tokamak-based reactor. A few wasted time by pointing out that gravitational confinement acts inside the Sun. Many candidates were able to describe two methods of supplying energy to the plasma. The commonest was ohmic heating by passing a current through the plasma. Others were heating by applying electromagnetic waves at RF frequencies and the injection of high-energy particles. Only a few mentioned the self-heating by energetic alpha-particles which are one of the products of the fusion reaction. Many realised that the reason why the reactants must be raised to a high temperature is that it gives the reacting nuclei enough kinetic energy to overcome the coulomb barrier caused by the repulsion between the positively charged nuclei. A significant minority thought that the reason for the high temperature is to separate the electrons from their nucleus i.e. changing the gas into a plasma. Others seemed to make no distinction at all between a gas and a plasma. As in many other questions on this paper, it was important to refer to processes on the *particulate* level. Thus, comments that the high temperature is needed to give the *plasma* more energy fell short of the mark.

(b) In explaining the advantages of the fusion process compared with fission, most candidates were aware that the production of damaging waste in the fission process makes it less suitable. However many candidates failed to mention that this is *radioactive* waste, not just 'nuclear' waste. Likewise, while many candidates realised that fusion is capable of generating more energy, they failed to mention that this is only meaningful if referred to as greater energy per unit mass, or per nucleon. In passing, it is worth mentioning that the fusion reaction does not produce more energy *per reaction*. Many stated that the fusion reaction is better because the reactants are *easier* to obtain. The more important point was that the raw materials for the fusion reaction are more *abundant*. Many were aware that the fusion reactor cannot go into meltdown, but fewer were able to state that this is because there is such a minute quantity of fuel at any time inside the reactor and that the reaction ceases very quickly. A few gave the absence of greenhouse gas emission as an advantage of the fusion process, forgetting that the fission process also emits no greenhouse gases.

5 *(a)* Candidates were asked to calculate the final speed of protons inside a cyclotron, given several numerical parameters. It was expected that they would deduce this speed from the final energy of the protons in the usual way. Those who attempted to do this usually scored well. Those who failed to do so had usually not approached the problem in the right way, often attempting to deduce the speed from an application of the physics of circular motion. This was bound to be fruitless because candidates had no knowledge of the magnetic field strength.

(b) The question asked candidates to show that the time spent inside each dee of the cyclotron is about 1.0×10^{-7} s. Most candidates who had successfully calculated the speed of the protons were able to do this. This meant finding the time for a proton to traverse *half* a circle. This could be done by using the half-circumference or by finding the time period for a full revolution and halving it. Some, choosing the latter course left the examiner wondering why a division by 2 had suddenly appeared without explanation. However there was usually no penalty for this.

(c) Many candidates were able to find the number of times a proton crosses the gap between the dees by dividing the total energy of an emerging proton by the energy gained in each crossing, namely 15 keV.

(d) Candidates were given an energy-time grid and asked to show how the energy of a proton varied with time. This graph consists of a 'flight of stairs' because the proton gains energy only as it crosses the gaps and whilst inside the dees its energy is constant. Only a minority of candidates was able to do this satisfactorily. A few were aware that the graph would be 'stepped' without knowing the time inside each dee or the energy gain between the dees and so gained only partial credit. A commoner error was to draw a *straight* line.

(e) Here candidates were asked to describe in words how the graph would have differed if the candidate had been asked to plot speed rather than energy. Candidates needed to realise that since speed is proportional to the square root of kinetic energy, the intervals between the 'steps' on the speed graph would decrease as the energy increased. This proved a challenging question for most candidates and was usually answered in terms of the effect of speeds near to the speed of light on a particle's mass. However, by merely choosing to plot a different variable one does not change the situation itself. There were no appreciable relativistic effects in the energy graph and therefore there are none if speed is plotted instead.

6 *(a)* Candidates were usually able to write a correct nuclear equation for the specified fission of uranium-236, although a few showed a neutron being absorbed and in effect showed the fission of uranium-237. A few others lost this mark by representing the 5 product neutrons as ${}^{5}_{0}\mathrm{n}$.

(b)(i) Most candidates stated that a beta minus emission results in no change to the nucleon number but an increase of one in the proton number.

(ii) Of those who succeeded in *(i)* most were able to deduce the nucleon and proton number after four decays. The commonest error here was to fail to notice that there were three *more* beta decays, not three altogether. This resulted in a proton number one short of the correct value.

(iii) For most candidates it was a straightforward matter to show the neutron and proton numbers on the graph grid together with the arrows showing the direction of the changes. Those who plotted the incorrectly deduced value in *(ii)* lost no credit here, having already being penalised for the earlier mistake. A few plotted points all at the same neutron number, perhaps confusing neutrons with nucleons.

(iv) Here candidates were asked to sketch the line of stability on the same graph grid. This should have passed through, or near the final, stable nuclide and have a gradient a bit greater than one and/ or be curved correctly. About half of candidates who had plotted the points were able to proceed to a correct representation here. Some failed to score because they plotted (a bit of) the line representing (number of neutrons) = (number of protons).

(c)(i) Most candidates succeeded in finding the mass defect, though a few failed to use the mass of the electron.

(ii) Here candidates were expected to convert the mass defect to kg and apply the equation $E = m c^2$ in order to find the energy in joule. This was generally well done though some failed to change the mass unit correctly.

(iii) Better candidates were able to identify the discrepancy between the energy released and the energy given to the beta-particle as due to the creation of a neutrino and the fact that this particle will carry away some kinetic energy. A few gained partial credit for stating that the recoiling niobium nucleus will have some energy (not much, in fact). Some candidates attributed the loss to 'heat', forgetting that energy due to random motion of molecules is totally irrelevant in the context of a nuclear reaction.

7 *(a)* Candidates were asked to find the mean value of the cyclist's speed over a measured distance. They were expected to find the mean time and divide this into the distance in order to find the speed. This seemingly straightforward task was less successfully achieved than might have been expected. A significant minority of candidates, upon arriving at a mean time of 15.9 s, jumped to the conclusion that this must be the speed of 'about 15 m s^{-1}' and gave it as the answer in units of m s^{-1}. Others calculated three speeds using the three times and found the average of these three speeds. Although not identical with the expected answer, candidates were given full credit for this.

(b)(i) Candidates were expected to realise that, for the cyclist to arrive at the ramp correctly, i.e. travelling at an angle of 45° to the horizontal, his vertical component of velocity must equal his horizontal velocity. which in the absence of air resistance will remain constant at 15 m s^{-1}. Most were able to state this.

(ii) Here candidates had a choice of method. Most chose to use the equation $v^2 = u^2 + 2 a s$. Alternatively they were able to find the time of fall by applying $v = u + a t$ to the vertical motion and then to use this time to calculate the vertical fall with the help of the equation $s = u t + ½ a t^2$. A few lost all credit by noting that 15 cos 45 is approximately 11 and presuming that this was a valid deduction of the required answer.

(iii) Most candidates, knowing the horizontal velocity and the time were able to calculate the horizontal distance travelled, showing that it is close to 23 m. Some, having not needed to calculate the time in *(ii)*, had to do so here.

(iv) There were several ways for candidates to proceed here. Some calculated the resultant speed of the cyclist as he hits the ramp as 21.2 m s^{-1} and then calculated his kinetic energy in the usual way. Others, equally correctly calculated the kinetic energies due to the horizontal and vertical components of velocity and added them to find the total kinetic energy Others again found the kinetic energy due to the horizontal velocity and added the loss of potential energy. Of those who failed to

score full credit, the commonest weakness was to give as their answer the kinetic energy due to the horizontal velocity only.

(c)(i) Again there were several valid approaches; candidates who took the hint given in the stem, used the dynamics of circular motion to find the speed at the top of the loop which required a centripetal acceleration of just $9.81\ m\ s^{-1}$. Alternatively, candidates were able to use the principle of conservation of energy to deduce the speed at the top of the loop. Both methods were used, but many candidates were unable to succeed with either approach. Radius/diameter confusion also caused some to lose credit.

(ii) Nearly all candidates who had sufficient time were able to calculate correctly the kinetic energy and potential energy of the cyclist at the top of the loop.

(iii) This part was also well done. Candidates were usually able to calculate the kinetic energy at the point of entry and to equate it successfully to the sum of the answers to *(ii)*. Few failed to score fully here.

(iv) It was pleasing to see that many candidates, faced with this novel question were able correctly to deduce that removal of the top half of the loop would also remove any centripetal force and would therefore make it impossible for the cyclist to perform circular motion. Instead, he would simply travel vertically upwards (and fall painfully back to his take-off point!).

2825/05 - Telecommunications

Due to the low entry for this unit no Report for Centres has been written.

2826/01 - Unifying Concepts in Physics Paper

General Comments

This paper produced marks in the range 11 - 54, with only 6.3% of the 270 candidates being unable to score 20 marks. There were however two aspects of candidates responses which were very disappointing. They will be dealt with in more detail in the section on individual questions but basically they were, first of all, that a very large proportion of candidates do not understand several key principles of physics, Newton's laws in particular, and secondly, that far too many candidates, including some of the more able ones, lose far too many marks through careless and sloppy working. If only candidates would use units more in their working they would see when things have gone wrong. The number of candidates who had the kinetic energy of the cylinder of air as 7.8 mJ had to be seen to be believed. There is such a difference between these two answers:

$$\boldsymbol{m} = \frac{\boldsymbol{d}}{\boldsymbol{V}} = \frac{\mathbf{1.3}}{\mathbf{18800}} = \mathbf{6.915 \times 10^{-5}} = \tfrac{1}{2} \times \mathbf{6.915 \times 10^{-5} \times 15^2} = \mathbf{7.8\,mJ}$$ that was seen far too often

and

$$\boldsymbol{m} = \boldsymbol{d} \times \boldsymbol{V} = \mathbf{1.3}\,\frac{\mathbf{kg}}{\mathbf{m^3}} \times \mathbf{18800\ m^3} = \mathbf{24500\ kg}$$

$$\mathbf{k.e.} = \tfrac{1}{2}\boldsymbol{mV}^2 = \tfrac{1}{2} \times \mathbf{24500\ kg} \times \mathbf{15^2\ m^2 s^{-2}} = \mathbf{2.76 \times 10^6\ J}$$

The second method takes very little extra time to put in the units but it has a two built in checks. The first, that the only the correct manipulation of the density formula can give an answer in kilograms and the second that all equations now do mean something so you cannot get an incorrect unit at the end of the line. It is a mystery how anyone getting an answer for this question that has such a small value of energy does not notice immediately that something has gone wrong. It is a matter of regret that many candidates simply think of physics as a process of stuffing numbers into formulae and using a calculator to produce and answer which therefore must be right. Long strings of numbers with no explanation in words are a recipe for disaster in many cases. Sloppiness of working extended into the handwriting of some candidates. There were many occasions when not only did their lack of clarity make it difficult or impossible for the examiner to discern their meaning but also occasions when they confused themselves and consequently lost marks. Virtually all the candidates completed the paper in the allotted time.

Comments on Individual Questions

1. Very few candidates had any difficulty with the principles of this question but careless mistakes abounded. The number of candidates who reached (b)(ii) with 2000 wind turbines must have been considerably less than half. It was a common mistake to get the volume of a cylinder incorrect. Many of the suggested formulae could not have been a volume at all. The final number was anything between far less than 1 to many millions. Part (c) was answered correctly in most cases but few candidates related the output required from wind turbines being unable to match up with varying demand, either here or in part (d)(iii). Answers to (d)(i) tended to be too trivial. 'More energy is wasted' or 'friction reduces the efficiency' do not answer the question as reduced efficiency could still result in increased output power. It was hoped that candidates would deal with the question on a more detailed basis and write about the greater amount of air kinetic energy that does not get transferred into electrical energy as a result of greater turbulence. Answers to (d)(iii) were similarly sketchy. Few answers referred to base load or to the problems associated with the need for the turbines to be in windy places, which are a long way from centres of population where the demand is. Nevertheless, it was not too difficult, thanks to error carried forward rules, for most candidates to score at least 12 marks on this question.

2. Candidates who could do electricity questions had no difficulty in scoring 12/13 marks here. Unfortunately there are too many candidates who fall at the first hurdle and even error carried forward does not enable them to gain more than the odd mark. Someone who starts with $Q = V \times t$ is not going to get very far. There were the usual mistakes such as 4 hours = 240 seconds but it was also very common to see $E = ½QV$. The other common mistake was to assume that during discharge of the battery the current was the same as when on charge. Few candidates noticed that the part of the calculation which reduces the reliability to only 1 sig. fig. accuracy is the subtraction 4.5 V - 4.0 V = 0.5 V. A surprising number of candidates thought that 4.0 V is only 1 sig. fig. presumably because it rounds up to a whole number.

3. This was the question that really tested candidates. It showed that there are many pupils studying physics in schools who, even at the end of their A-level course, have very little insight to some of the subject's fundamental principles. Here there was a large percentage of the entry who could not score more than 5/14, and many who scored zero. Quite frequently candidates implied that the statements themselves were incorrect, despite being told that they were correct. Common misconceptions for each part were as follows.

   (a) This question is about force. Too many candidates spent all their time writing about 'grip'. They had forces all over the place and had diagrams with arrows showing rotation, or torque, or motion, or friction back or friction forward, and seldom with clarity about what the force was acting on. What was required was a diagram or a statement that, in the horizontal direction, the car tyre exerted a backward (frictional) force on the road and that therefore, using Newton's third law, the road exerted an equal and opposite forward force on the car.

   (b) Far too many candidates get this completely wrong. They state or imply that Newton's third law only applies to bodies in equilibrium. Statements such as 'when a pen rests on a desk it has an equal and opposite reaction to its weight to support it but if you drop it there is no equal and opposite force so it accelerates' were manifold. Candidates' use of 'reaction' is so often wrong. Even with the more modern statement of the law they still do not realise that the forces being considered act on two different bodies. The candidates that were most successful in answering this question were those who dealt with an explosive situation, the larger mass having the smaller acceleration. Even here there were too many who stated that acceleration is proportional to mass, when they meant 'inversely proportional'.

   (c) In this question the mistake most frequently made was to answer that longitudinal waves produced transverse waves when they entered the tube. Lots of answers were also received where the candidate wrote about waves bouncing off the side of the tube - were they thinking of optical fibres? Good sketches showing particles in compression and rarefactions were also given - even if it is difficult to show on one diagram that this is a stationary wave.

   (d) Answers here often dealt with only one of the two situations required. VI being zero on open circuit when I is zero and being zero when shorted with V zero. It was clear that some candidates did not know the terms 'open' and 'shorted'. It is admitted that these are not in the specification but the setting committee did assume that at this level at least candidates would have come across the term 'short circuit'.

   (e) Only the better candidates could relate this to free fall. Wrong answers were often bizarre. The majority of answers implied or stated that a reduction in force of 10% was enough to make the astronaut (frequently spelt astronaught) feel weightless. Many thought that 90% was the reduction in weight. Answers varied from 'at that height he would be pulled up by the Moon' or 'he is out in space and where there is no air there is no gravity' or 'the force of gravity of the space station itself is pulling him in all directions, not just downwards' to Einstein's theory of relativity enables a thought experiment to be done which gives no weight'. The link between a vacuum and lack of gravity is very strong in many people's mind. Those candidates who did mention free fall did not always add that since the space station itself is also in free fall there is no contact force between the space station and the astronaut. Many candidates who dealt with centripetal force wrote about the weight of the astronaut being equal and opposite to the centripetal force. It is preferable not to use the term 'centripetal force'. The weight of the astronaut is the force that causes his centripetal acceleration, $F = m \times v^2/r$.

4. This question produced good discrimination. It was an application that was new to all candidates. Many were able to work it right through and weak candidates were able to do several parts. It was disappointing in (b)(i) to see so few candidates writing λ = 0.123 m / 3 = 0.041 m. An answer to 2 sig. figs. was expected here so candidates who could not be bothered to measure accurately and wrote 0.04 did not score the mark. Note: disabled candidates using oversize papers were marked according to the size of paper they used. Again with (b)(ii) there were too many candidates getting the formula the wrong way round. Answers such as $f = 1.4 \times 10^{-8}$ Hz were not uncommon - even on some occasions being called X-rays. Almost everyone could answer (c)(i) and (ii) correctly and the amplitude being given as either the same as at R or doubled was accepted. It was a pity that too many candidates could not accurately add up the distances in (iii) but of those who correctly got 18 cm and 80 cm far too many gave the phase difference as 80/18. Those who got 20 waves - 4½ waves = 15½ waves sometimes gave the phase difference as 2 cm or $\pi/2$, even when they knew that the two waves were in antiphase. Part (v) was a demanding test, with many good candidates realising that the weak signals from R arrive at the receiver in phase along the two routes and can be detected because it is not swamped by the strong signal from T. (In practice these signals arrive at different times but the circuit is used so that the transmitter does not damage the receiver and so that any ringing from the transmitter after it has in theory been switched off, does not mask reflected signals.)

2826/03 - Physics Practical

The examination at this time of year is taken by less than two hundred candidates, and the standard was fairly good with very few weak scripts, and perhaps fewer really strong scripts.
There were no difficulties reported from centres with regard to apparatus, and no candidates appeared to be short of time.

Question 1

The behaviour of rubber bands under load was investigated. The bands were at first stretched with a load consisting of a 100 g mass holder, and the reading on the metre rule next to the mass holder was considered as the zero of extension. After that, masses were added and the further extensions read off. A log graph of added mass against extension was then plotted to give a straight line graph.

A large number of candidates used actual mass rather than added mass and were not penalised, but some of these were in trouble later when attempting to plot log x (extension) when x was zero, and lost marks here. Usually tables of results were well presented and organised, with units correctly expressed and with consistent raw readings. However, in this case, a lot of candidates lost credit by omitting the raw readings taken from the rule (y), and just put the extension x in the table.

Very few had trouble with logarithms, but it was noticeable how many were unaware that the significant figures of a logarithm involve only those figures after the decimal point (the mantissa). E.g. log 15 (2 s.f) should be expressed as 1.18 and not 1.2. They were not penalised for this, but it often led to a scattering of points on the graph, thus losing quality marks.

The graphs were generally well drawn, covering a good area of the page, with gradients successfully found. However, there are still candidates who lose credit by squashing the graphs up into a corner of the sheet, in order to get the origin on to the sheet. Most knew that n (from $m = kx^n$) was the gradient of the log graph, but the weaker candidates could not explain why. Not many candidates used the micrometer screw gauge correctly to measure the dimensions of the rubber band. Most readings were far too low indicating that the rubber had been considerably squashed by the micrometer. Cross-sectional areas were well calculated but weaker candidates failed to correctly convert mm^2 to m^2.

Most gave 0.01 mm as the uncertainty in the width b. Although a micrometer can be read to 0.01 mm, in this case it is likely that the rubber has been slightly squashed or is not perfectly uniform, so 0.05 mm or 0.1 mm is more realistic.

The final calculation was generally done well; the common error was a failure to convert 100 grams to newtons correctly. The assumption expected was that the cross-sectional area remained unchanged during loading.

Question 2

This is a difficult experiment to do well without a lot of practice, and the difficulties provide plenty of material for the evaluation. In trials Newton's law of cooling (rate of cooling is proportional to excess temperature) was found to be approximately followed, and candidates were credited with concluding that it either was or was not obeyed (depending on their figures), as long as the explanations were clear. These had to include calculations and a comparison of the two constants of proportionality k. It is the percentage difference between the two values which is important, not the actual difference. If the two values of k are 0.01 and 0.02, you can not say, as some did, that since the difference is only 0.01 the proportionality holds true, since in this example the difference is 100%.

In the evaluation there was still too much concentration on “magical” solutions using digital thermometers, data-loggers, computers etc. Candidates should not describe a different experiment. A digital temperature probe attached to the thermometer bulb was however accepted as a valid improvement. The mark scheme lists all the accepted problems and their solutions, but some points need to be made. Repeat readings on their own are not enough; they must be averaged. Just plotting a graph with extra sets of readings is not enough; the quantities to be plotted must be given. “Human error” is not enough; more details are needed.

Many questioned the accuracy and constancy of the given room temperature with all the heat sources on in the laboratory. In comparison with the inaccuracy of the thermometer and stopwatch readings, this would be unimportant.

Planning Exercise

Most plans, with useful diagrams, and of the correct length, were done well. The plastic shopping bag investigation is a familiar one, often used in coursework, and with plenty of available resources in books and on the internet, and for this reason the mark scheme was fairly tight.

In the experimental set-up, shown in a diagram, marks were specifically given for sensible clamping of the plastic specimen, and for effective measurement of the extension. Some extensions seemed to be measured from about a third the way along the specimen rather than from the end.

Credit was given for the use of a micrometer to measure thickness, and further credit for using several sheets of plastic to do this, but many candidates omitted to show how the cross-sectional area was to be calculated.

The stress/strain (or load/extension) graphs for plastic came in all shapes and sizes, as they do in the textbooks. Most were accepted, but not those with a discontinuity at the yield point, which happens with some metals. The Young modulus had to be calculated from the initial gradient of the graph.

The ideal combination of properties looked for by manufacturers was not generally done well. “Strong”, “light”, and “inexpensive” were properties already itemised in the question so were not credited. Good answers said the material should be tough, i.e. have a large plastic range and be resistant to tearing, and have a high Young modulus so that it didn’t stretch too much, and have a large ultimate tensile stress.

References were usually good but some candidates are still leaving out page or chapter numbers. The quality of written communication marks were nearly always earned.

Advanced GCE Physics A 3883/7883

January 2007 Assessment Series

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
2821	Raw	90	43	38	33	28	24	0
	UMS	90	72	63	54	45	36	0
2822	Raw	90	49	44	39	34	29	0
	UMS	90	72	63	54	45	36	0
2823A	Raw	120	96	85	74	64	54	0
	UMS	120	96	84	72	60	48	0
2823B	Raw	120	96	85	74	64	54	0
	UMS	120	96	84	72	60	48	0
2823C	Raw	120	93	84	75	66	57	0
	UMS	120	96	84	72	60	48	0
2824	Raw	90	62	55	48	41	35	0
	UMS	90	72	63	54	45	36	0
2825A	Raw	90	66	59	52	46	40	0
	UMS	90	72	63	54	45	36	0
2825B	Raw	90	66	59	52	46	40	0
	UMS	90	72	63	54	45	36	0
2825C	Raw	90	65	58	51	45	39	0
	UMS	90	72	63	54	45	36	0
2825D	Raw	90	64	56	48	41	34	0
	UMS	90	72	63	54	45	36	0
2825E	Raw	90	64	57	50	44	38	0
	UMS	90	72	63	54	45	36	0
2826A	Raw	120	89	80	71	62	53	0
	UMS	120	96	84	72	60	48	0
2826B	Raw	120	89	80	71	62	53	0
	UMS	120	96	84	72	60	48	0
2826C	Raw	120	86	79	72	65	59	0
	UMS	120	96	84	72	60	48	0

Specification Aggregation Results

Overall threshold marks in UMS (i.e. after conversion of raw marks to uniform marks)

	Maximum Mark	A	B	C	D	E	U
3883	300	240	210	180	150	120	0
7883	600	480	420	360	300	240	0

The cumulative percentage of candidates awarded each grade was as follows:

	A	B	C	D	E	U	Total Number of Candidates
3883	18.9	36.6	58.1	77.0	94.0	100.0	278
7883	21.7	45.7	69.6	87.0	95.7	100.0	54

For a description of how UMS marks are calculated see;
http://www.ocr.org.uk/exam_system/understand_ums.html

Statistics are correct at the time of publication

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