SCIENCE 3/4 UNIT

In 1996 204 candidates presented for the 3 Unit paper and 525 candidates for the 4 Unit paper, making a total of 729, a slight decrease on the candidature for 1995.

As in previous years, the general standard and quality of responses were wide-ranging. The standard of drawing still leaves much to be desired, and students are again reminded that pencils, ruler and eraser should be used with care and precision. The correct use and conversion of units would help many students to improve their results, as would careful reading and analysis of each question before attempting to answer.

Students are encouraged to give concise answers, taking into account the allocation of marks, particularly in the Options paper.

Responses also suggest that more class time needs to be spent on the application of science to everyday examples.

PAPER 1 : CORE

Section I

Question	Correct Answer	Question	Correct Answer
1	D	6	D
2	A	7	B
3	B	8	C
4	A	9	B
5	B	10	C

Combined Candidature

Approximate percentage of candidates choosing each alternative. The correct answer is indicated by an asterisk.

Question	A	B	C	D
1	15	19	28	38*
2	68*	16	10	6
3	22	42*	29	6
4	57*	5	28	10
5	23	44*	29	3
6	7	10	5	78*
7	12	69*	7	12
8	3	0	96*	1
9	2	93*	2	2
10	7	6	78*	9

Section II

Question 11

(a) Almost all candidates could calculate the empirical formula of the given compound. Rounding off numbers to one significant figure was the major problem.

(b) Most candidates who correctly answered part (a) could also derive the molecular formula of the compound.

(c) Lack of care was evident in naming and drawing structural formulae. The most common errors were failure to label the location of the double bond and also failure to use the multiplying prefix *di* for the two chlorides.

Question 12

(a) Many candidates failed to make it clear that they understood the concept of the trend in bond type of the oxides of the specific elements as a progressive change rather than a number of discrete steps. Some candidates were confused about the bonding in of aluminium and silicon oxides.

(b) Most candidates could write a correct equation for the reaction of an oxide of sodium with water. A common error was failure, in the third period of the periodic table, to balance the equation correctly.

(c) Many candidates could give an acceptable formula for an oxide of chlorine. Few, however, could write an equation for the reaction of an oxide of chlorine with water.

Question 13

(a) Most candidates could calculate correctly the number of moles of CO and its concentration when 0.220g carbon dioxide is dissolved in sufficient water to produce 500.0ml of solution. Mathematical errors and use of appropriate units were a significant problem. When candidates gave equations they frequently showed a misunderstanding of the reaction, i.e. the products that were formed.

(b) A large number of candidates were aware of the importance of mole ratios but poor chemical equations resulted in incorrect ratios. The majority were aware of the formula $c = n/V$ though some could not apply the formula or substitute correctly.

Question 14

(a) Candidates found it difficult to distinguish between N_20_5, Li_20 and Kbr using the properties described. A high proportion, however, correctly identified glucose.

(b) Many explanations were not specific or candidates were incorrect in describing the origins of ions in solution or their mobile nature.

Question 15

(a) Generally candidates performed well in answering this question and in recognising and substituting into the appropriate relationships. A small number chose to use equations involving specific heat and using data which was not part of the question. Very few were distracted by the volume data.

Question 16

(a) Most candidates could correctly substitute into the equation for momentum, but a significant number failed to convert to ms^{-1} or to identify correct units.

(b) This part was generally well answered.

(c) A number of students failed to use change in kinetic energy.

Question 17

(a) Some candidates failed to interpret the circuit correctly. Those who did so performed well in parts (b) and (c).

Question 18

(a) The majority of candidates gave specific differences or similarities as being the basis on which organisms are classified as opposed to general differences or similarities.

(b) Almost all candidates could not identify common taxa and their common ancestor. Many were able to identify the obvious structures and common ancestor, but were unable to combine all sections to support the theory of evolution.

Question 19

(a) This was generally well answered, with candidates describing crustal movement such as sea-floor spreading and plate tectonics.

(b) Some candidates failed to link magnetic alignment and pole reversals.

Question 20

(a) Candidates appeared unable to define the difference between *cell division* and *differentiation*.

(b) Many failed to name a site which matched the definition given.

(c) Here many candidates confused *function* with *efficiency*.

Section III

Question 21

(a) This was generally well answered.

In (ii) a small number of candidates included a *relevant equation* as well as stating *NO REACTION*. A few candidates failed to include states with their equations.

(b) This was generally well answered.

Question 22

(a) (i) Most candidates answered this well.

(ii) Here a minority of candidates failed to represent accurately the attachment of the *hydroxyl group* via the O atom.

(iii) In this part, whilst the majority of candidates were able to represent the double bond, a few failed to ensure that four bonds surrounded each carbon atom.

(b) This question was a very good discriminator.

(i) The majority of candidates failed to include *phosphorus* as one of the elements present in nucleic acids. A large number referred to *phosphate* instead of *phosphorus*.

(ii) Confusion was obvious in answers to this question as only a small number of candidates correctly used the term *nucleotide*. Many included *base* rather than the more correct term *nitrogenous base*. A number also referred incorrectly to *amino acids* in answering the question.

Question 23

(a) This was generally well answered, although a small number of candidates failed to realise that 1 tonne is equal to 10^6 gram and, therefore, failed to calculate the correct number of moles.

(b) (i) The equation was correctly written by most candidates.

(ii) A small number of candidates failed to calculate the number of moles of both H_2SO_4 and NaCl and, therefore, failed to show that NaCl was the *limiting reagent* and also failed to choose the correct number of moles to be used in the calculation.

(iii) A few candidates wrote $NaHSO_4$ as Na_2SO_4.

Question 24

(a) Most candidates were able to balance this equation correctly; a number, however, incorrectly used a 1 : 1 mole ratio in the calculation. The majority used the correct units.

(b) Many candidates experienced difficulty in trying to balance this equation; those who succeeded in doing so had some difficulty in handling the 2 : 3 mole ratio. Again, many omitted the states in the equation.

Question 25

(a) About one-third of the candidates were able to link correctly constant velocity and no net external force, concluding, therefore, that no work was done by the external forces.

(b) (i) This part was generally well done. A number of candidates were unable to use physics terminology to label all the external forces, particularly a normal force. Many included inertia as an external force.

(ii) As in (a), many candidates described a net force as acting to produce constant velocity.

(c) Many candidates appeared to manufacture a difference rather than accepting the fact that there were no differences.

Question 26

(a) This was very well answered. The most common error was failure to use vectors correctly in calculating initial momentum, i.e. $0.1u_1 + 0.3u_2$.

(b) This was very well done. The most common error was to treat *energy* as a *vector quantity*. Of those with an incorrect answer to (a) who found that the final energy was greater than the initial value, the majority simply accepted that fact and stated *energy was not conserved*.

Question 27

(a) Answers to this part were good. Most incorrect answers gave no justification for their opinion or inferred that experimental error gave rise to the curve.

(b) This was very well done.

(c) This was also very well done, since candidates were able to extrapolate from the graph. The most common error was to use the value of R from (b) to calculate 1.

(d) and (e) Answers to both these parts were very good.

Question 28

(a) This part was poorly answered, as many candidates failed to indicate the need to measure time as well as the volumes of CO_2 used or O_2 produced.

(b) Answers here were good, although some candidates failed to distinguish between *change in rate* and *net rate of photosynthesis.*

(c) Many candidates failed to link rate of photosynthesis, CO_2 concentration and increase in light intensity. The majority of candidates failed to comment on the initial section of the graph in which CO_2 concentration had no effect on the rate of photosynthesis. A common error was to attribute the increase in CO_2 concentration to the rate of increase in photosynthesis.

(d) This was quite well done, although many candidates included the factors being manipulated, e.g. CO_2 concentration and light intensity.

Section IV

Question 29

(a) (i) Students should be encouraged to make the best use of the graph space provided in their Answer Books. The majority plotted the points accurately but many used either difficult scales (e.g. 1 division = 1.5^{o}C) or a scale where the molar mass of water (18g) could not be plo1tted (indicating failure to read all parts of the question).

The line of best fit was generally well done. Many candidates, however,

- placed their line to produce an unequal distribution of points either side of it;
- incorrectly drew the line passing through the origin (0^{o}/0g mol^{-1});
- drew very rough, sketched lines rather than ruling a straight line.

(ii) Most candidates could read off the boiling point from their graph at a molar mass of 18gmol^{-1}.

(iii) A number of candidates knew that the higher than predicted boiling point of water was due to hydrogen bonding, but they failed to:

- relate it to the hydrogen bonding of alkanols (as in the table);
- recognise that more hydrogen bonds occur in water.

Some candidates incorrectly gave experimental error as a reason.

(b) (i) This part was generally well done. Frequent incorrect answers included water being given as *amphoteric* or *neutral*.

(ii) Although this was well done, incorrect answers included:

- water directly oxidises minerals
- water is dissociated into hydrogen ions and acts as an acid
- water dissolves rocks.

There often appears to be confusion between weathering and erosion.

(iii) Most candidates could find the mass of $CuSO_4$ and H_2O but many could not work out mole ratios and thus calculate a value of x for the hydrated copper sulfate, ($CuSO_4$ x H_2O).

(c) (i) This part was very well done.

(ii) Explanations here were poor. Most candidates failed to explain the role of the polar water molecule in attracting the ions from the ionic lattice. Students should be encouraged to refer specifically to the charged ends of water molecules when answering such questions.

Question 30

(a) (i) Most candidates were able to explain the role of natural selection in eliminating less suited members of a species. Many, however, did not indicate that there were *pressures* on the population, such as predators, lack of food, competition for resources, etc. This is the *struggle for existence* concept.

(ii) Many candidates were able to state one method for generating variation between individuals. A number, however, could not explain that method well, while many others could not state a second method of achieving variation.

(iii) This was very well answered. The majority of candidates indicated that pre-existing variation was essential to the survival of a species in the event of a change in environment. The most common mistake was to explain in a *Lamarckian* manner.

(b) (i) A number of candidates stated a structural region without giving a signifying letter. Those who chose regions A or F were able to explain the role of Plate Tectonics easily. Those who chose alternatives B - E were not able to answer as well.

(ii) A significant number of candidates could not recognise the fact that convection currents in the asthenosphere are the major mechanisms for plate movement. Describing mantle or asthenosphere as being *molten* was a common error.

Many candidates produced very poor diagrams, frequently drawing convection currents as small eddies around the mid-ocean ridge, without carrying through to the subduction zone. Many wrongly believe that molten rock pushes the plates apart at the MOR. The direction of plate movement was frequently either not shown or clearly stated.

PAPER 2 : ELECTIVES

Group 1 : Biology Electives

Question 1 : Flowering Plants and Animals

(a) (i) In defining transpiration many candidates presented general answers describing the movement of water within the plant rather than defining transpiration as required.

(ii) This part was generally well answered; many candidates, however, failed to discuss changes that increase transpiration, instead they listed environmental factors that could affect photosynthesis.

(b) Although plant hormones were very well known, the specifics of the hormone's action attracted broad responses and failed to address the question.

(c) (i) This part was generally well done since the naming of the tissues on the diagram presented few difficulties.

(ii) Answers here were consistent with the answers given in part (i).

(d) Many candidates drew diagrams of a reflex arc or wrote a paragraph answer rather than a flow chart to explain how a mammal responds to an environmental stimulus. Flow chart protocols were poorly understood.

(e) (i) The majority of candidates were able to list correctly two common structural similarities in leaf mesophyll and mammalian lungs; some candidates correctly identified functional similarities between both.

(ii) Most candidates were able to explain correctly how each of these features is essential for the biological function of flowering plants and mammals.

(f) (i) Many candidates failed to explain correctly why the concentration of each of the five substances differs between blood plasma and urine. A common misconception was that amino acids are absent in the filtrate because their large size prevents them from being filtered through the glomerulus.

(ii) The processes of filtration and reabsorption were well understood.

(g) The majority of candidates were aware that carbon dioxide is carried in the blood as the HCO_3^- ion but were unaware of the role of haemoglobin in dissolving CO_2.

Question 2 : Reproduction and Genetics

(a) (i) Many candidates interpreted *application* as being the way in which the process is carried out, rather than as an application of the technique.

(ii) Candidates often discussed ethical problems but failed to relate these to science.

(b) (i) This was generally well done.

(ii) Many candidates explained that a virus needs a host cell but did not compare this to reproduction in plants and animals.

(c) This question was well answered.

(d) (i) Most candidates answered correctly.

(ii) The majority could identify the process, but some failed to mention gene recombinations.

(iii) This was generally answered correctly.

(iv) Most candidates could not draw accurately the chromosomes in the gametes arising from this cell division.

(v) Candidates could recognise the fact that the genes are linked but many could not explain why the frequencies of alleles QRT and qrt would not obey Mendelian ratios and how crossing over would affect the frequencies.

(e) (i) This was generally well answered by candidates who were able to distinguish between information provided in the question and new information about recessive and dominant characteristics which they were able to supply.

(ii) Some students failed to give a KEY for distinguishing the allele characteristics. A few failed to provide the genotype(s) of all the progeny as well as of all the parents.

(iii) A significant number of candidates failed to select the most efficient means of determining the genotype(s) of parents in Cross (IV), i.e. a back cross with a homozygous recessive partner. Similarly too many candidates failed to describe adequately the outcomes of further experiments.

(f) (i) This was handled well by the majority of candidates who answered the question with precision.

(ii) This question was poorly handled by students who failed to describe fully the medical problems they listed.

(iii) This question was difficult for some candidates who failed to convey the differences between ova, zygote and embryo. Few candidates were able to supply information about the special conditions necessary for external fertilisation or pretreatment of females in IVF.

(iv) Candidates were confused between problems arising from the use of IVF in humans and less invasive fertility treatments. Answers tended to be general rather than specific and offered moral and religious arguments rather than biological solutions to problems.

(g) (i) It was difficult for candidates to gain full marks in this section because of their inability to distinguish between the function of DNA as an inheritance agent and its function in an active, non-reproductive cell.

(ii) Candidates often failed to describe the *structural* features of DNA that enable it to carry out its function. Many confused *structure* with *function* and described a structure that did not relate to the function they outlined in part (i).

Question 3 : Micro-organisms and Disease

(a) (i) Candidates appeared to lack detailed knowledge of the structural similarities between fungi and bacteria and tended to answer the question by describing similar responses, effects and controls of these two micro-organism groups.

(ii) Responses to this section of part (a) were more confident and detailed. Many candidates, however, failed to discuss each difference in detail.

(b) (i) Almost all candidates were aware that the development of the microscope has led to the discovery of micro-organisms. Many, however, failed to describe the specific type of microscope.

(ii) Those who correctly named the type of microscope (light or electron) were also able to record the type of organism discovered.

(c) Many candidates failed to discuss the specific requirements of each section, making general observations or listing Koch's postulates. Application of knowledge to each question was poor.

(d) Many candidates failed to use the correct terminology, interchanging *antigen* with *antibody*, *helper cell* with *killer cell*, etc.

(e) (i) This was poorly done. The difference between passive and active immunity was not clear.

(ii) Problems from (i) flowed into (ii).

Question 4 : Coordination and Control

(a) Very few candidates were able to identify the part labelled *K* as the *corpus callosum*. Many incorrectly identified the medulla oblongata as being the brain stem. The functions of each of the organs were well described.

(b) (i) Most candidates were able to name the structures correctly.

(ii) Many candidates knew that neurotransmission occurred at Z, but only a few gave a good description of this process.

(c) (i) Only a small number of candidates were able to list more than one environmental stimulus that might be responsible for inducing flowering.

(ii) Very few candidates were able to design a good experiment for identifying the stimulus for flowering in chrysanthemums. A small number understood the need to work with a large sample size or to replicate an experiment before a conclusion could be drawn.

(d) Most candidates understood the characteristics of hormone behaviour and interpreted the feedback loop correctly. They were, therefore, able to indicate correctly in what respects vitamin D_3 behaves as a hormone.

(e) Most candidates succeeded in comparing and contrasting the action of hormones and nerves. Some, however, discussed only one of the two actions and ignored the other.

(f) The majority of candidates were able to name a biological process controlled by the interaction of at least two named hormones. Many confused the role that each hormone plays in this interaction with the way in which the interaction determines the overall effect of the hormone. A few candidates selected hormones that did not interact with each other in any biological process.

(g) The role of ethene in plants was very well understood. Many candidates were aware that ethene differs from other plant and animal hormones because of its gaseous nature, but were unaware of any other differences, e.g. ethene can affect plants and animals and does not require a vascular system in order to be transported.

Group 2 : Chemistry Electives

Question 5 : Energy

(a) (i) This question was generally well answered. Common errors included failure to halve the value for the nitrogen triple bond so that it can be consistent with other values or, more commonly, simply to calculate the value for the formation of 3 N-H bonds.

(ii) This question was not well answered. Many candidates gave the equation for the formation of glucose by photosynthesis from CO_2 and H_2O. Units for H_f were frequently omitted.

(b) (i) Parts 1 and 2 were generally well done. More mistakes were made with balancing part 2 for the combustion of liquid ethanol.

(ii) 1. This was well answered.

2. Very few candidates mentioned the fact that liquid ethanol containing oxygen in the molecule is already partially oxidised. Some related the short carbon chain to the fact that complete combustion is usual; many candidates gave quite irrelevant answers.

(iii) This part was generally well done, although many answers did not include any calculations and appeared to comprise a general discussion based directly on values from the table without any processing of given data. In answers where calculations were done, a comparison between the two values was often omitted.

(c) This was reasonably well answered. Various methods were used to calculate the factor of 75% of the heat generated. The most common error was incorrect values for the powers of 10 associated with kL, J or kJ, etc.

(d) (i) This was generally well answered. Some candidates, however, did not halve their calculations to give a <u>standard</u> enthalpy change <u>per molecule</u>.

(ii) A common error was to use the incorrect energy value.

(iii) Answers here were not good since the enthalpy value was often ambiguously stated. Some candidates were obviously not clear about the meaning of *fusion*.

(e) (i) This was generally well done. The following labels were frequently missing:
(*aq*) for the ions in the electrolyte solution,
$e^{\text{å}}$ in the external circuit.

(ii) and (iii) Both of these parts were handled well.

(iv) Answers to this part were poor.

(v) This part was well done by those who could answer (iv).

(f) (i) 1, 2 and 3 were, on the whole, well done. The most common error was to use H_f for $H_2O_{(g)}$ instead of H_f for $H_2O_{(l)}$.

(ii) This question was not well understood and only a few candidates made any connection between parts (i) and (ii).

Question 6 : Atomic Structure and the Periodic Table

(a) (i) Candidates gave a good account of the *plum pudding* model of the atom but few could give any details of the experiments which led to the determination of the e/m ratio for the electron. Much extraneous information about Crookes' experiment was given.

(ii) This part was answered well.

(iii) Knowledge of the details of Chadwick's experiment was poor.

(b) (i) and (ii) Both parts were handled well.

(iii) Many candidates failed to relate this question to electron energy levels.

(iv) Very few candidates gave the answer required, failing to identify the 4f sub-shell.

(c) (i) The trend in melting points was well understood, although explanations in terms of intermolecular (dispersion) forces was not.

(ii) Few candidates could adequately relate similarities in chemical reactivity. Only a small number could give more than one similarity. In both questions a large number of candidates failed to distinguish between *physical* and *chemical* properties.

(d) (i) 1 and 2 Answers to both these parts were excellent

(ii) 1. Most candidates correctly compared the atomic radii of sodium and francium but failed to relate them clearly to the number of electron energy levels.

2. Common errors or omissions were:

- failure to specify states of reactants and products
- giving $Fr_2O_{(aq)}$, H^+ and O_2 as products.

3. Although the formula for francium chloride and prediction of the type of bonding were handled very well, explanations of bonding were often trivial. The explanation should refer to the difference in electronegativity between francium and chlorine.

4. Many candidates failed to read the question carefully and wrote about conductivity of francium **not** its compounds. Reference to the mobility of ions in solution was a necessary part of the answer.

(e) (i) The best candidates showed their knowledge of the Heisenberg Uncertainty Principle and the Pauli Exclusion Principle. There was, however, considerable confusion in some cases between orbitals and orbits.

(ii) The general idea of the shapes of these orbitals was well understood, but the quality of the drawings left much to be desired. Many drew *electrons* on the perimeters of these shapes, suggesting that they considered such shapes to be electron paths.

(f) This was very poorly answered. Candidates failed to analyse the question and to give a clear account of covalent bonding in NCI_3 and PCl_3. A large number referred to the bonding as being *ionic*. Only the best candidates gave an account of the promotion of the third sub-shell in PCl_5. Several attempted explanations of bonding in terms of allotropy.

Question 7 : Carbon Chemistry

General Comment: Structural formulae should be used where appropriate.

(a) (i) On the whole this was well done, although there was some inaccuracy in the placement of bonds towards the -O of the -OH group and many candidates failed to name the compounds.

(ii) Most students answered this well.

(iii) 1. In naming the reagents, many omitted to include the acid, e.g. acidified potassium permanganate.

2. The majority of candidates did not indicate the structural formula of a tertiary alkanol.

(iv) Many students did not clearly understand the nature of the bonds formed between water and alkanols, and the polarity associated with alkanol molecules.

(b) (i) Although this was generally well done, many omitted H_2O as a product.

(ii) Answers here were good.

(c) Candidates should use the type of formula indicated in the question.

(d) Reaction (1) Few candidates understood this.

Reaction (2) Answers here were good.

Reaction (3) Many candidates gave an equation for an addition rather than a substitution reaction.

Reaction (4) There was a lack of understanding of the relationship between the product of equation (3) and reaction (4). A structural formula should be used so that responses are unambiguous.

(e) The trend in boiling points of straight-chain saturated hydrocarbons was well understood. The explanations were generally good. Any misunderstandings were due to failure to recognise the difference between inter-molecular forces and chemical bonds.

(f) The products of fermentation were not well known.

(g) (i) This was generally well done, although many omitted H_2O as a reactant.

(ii) The majority of candidates had a very poor knowledge of the process of saponification.

(h) (i) and (ii) These parts were generally well done. Care should be taken with using accepted conventions.

Group 3 : Geology Electives

Question 8 : Regional Geology

(a) (i), (ii) (iii) and (iv) These parts were well answered. Many candidates did not know the age of the oldest rock in their chosen region (v).

(b) (i) Many candidates could not name an igneous rock in the region, some named basement rock or rock in another region.

(ii) Many were not sure of the age of the igneous rock they had described.

(iii) Boundary relationships between the specific igneous rock and surrounding sedimentary or metamorphic rocks were not well known.

(iv) Answers to this part were average.

(c) (i) Many confused a *structural* feature with *erosional* features, e.g. the Three Sisters in the Sydney Basin.

(ii) This part was well done if (i) were correct.

(iii) The historical geological events associated with the structure named were poorly understood.

(iv) Some diagrams here were excellent.

(d) All parts were well done.

Question 9 : Mountains

(a) This question was generally well answered.

(i) Some candidates made poor choices for the two volcanoes - attempting to describe subtle differences, e.g. Fuji and Mount St Helen's. Students should select carefully in order to maximise the opportunities to provide relevant but not repetitive information. The question intended students to select volcanoes related to very different plate movements.

(ii) Candidates found it difficult to explain how heat is generated to form magma. Some failed to give rock types or to describe composition in terms of silica content.

(b) Some candidates had problems with the instruction to *compare and contrast*, while those who chose similar ranges encountered problems, while the majority were able to describe the type of plate interaction involved, those who had problems chose unsuitable ranges. Most candidates could describe folding or buckling in the Himalayan setting, but few could describe the crustal underplating involved.

The better candidates easily described the two processes of crustal shortening and injection of magma involved in Andean type ranges. Those choosing the Mid-Atlantic ridge type could describe the upwelling of magma, but the majority could not describe the expansion of the hot magma which contributes to the height of the ridge. Most candidates successfully described at least two structures in their chosen areas. Naming of relevant rock types was generally well done, although some failed to give specific rock names.

Group 4 : Physics Electives

Question 10 : Electromagnetism

General Comment: Simple data transcription errors were common. It is advisable to construct a data table for each question.

(a) (i) Most candidates were familiar with a solenoid and its field, but many failed to show the current direction correctly. The next most common error was failure to draw complete lines of force through and around the solenoid. It is emphasised that drawn diagrams must be sufficiently large to clarify details.

(ii) The formula for finding flux density at the centre of a solenoid was known by most candidates, but many interpreted n as being the total number of turns. Failure to describe a unit to μ_o was a common error, although the unit appears on the Data Sheet.

(b) This was generally well answered. A small number of candidates failed to use the proton charge, while others used cos 30^o.

(c) Answers here were good, with most frequent errors being due to neglect of the number of turns and/or conversion of the lengths to metre^2.

(d) This question posed little difficulty for the majority of candidates.

(e) Difficulty was experienced in discerning and describing force direction rather than in identifying P, Q and R as giving rise to forces. Emphasis must be placed on stating direction in the context of the question.

(f) (i) This was well answered, with a small number misinterpreting the angle, perhaps through overlooking the diagram provided.

(ii) A number of candidates calculated a non-zero e.m.f. despite clear information that no field lines were being cut by the plane.

(g) Almost all candidates gave a correct value of the magnetic flux density at P, but some failed to give an acceptable explanation in terms of opposing fields. A small number thought that the two fields would reinforce each other, while a few candidates confused static charges with magnetic poles.

(h) A number of candidates showed difficulty in interpreting this question. Many were unable to calculate the flux for a given coil angle.

(i) This part was answered correctly by most candidates. Some confused the formula for the *field* with that for *force*, while others were unable to convert force per unit length to the force on a stated length.

(j) (i) Most candidates were familiar with magnetic braking, whilst a few thought the disc would oscillate, accelerate or levitate.

(ii) Many failed to give a complete explanation for their observations, relying on a statement of Lenz's Law without explaining the interactions in this situation.

Question 11 : Oscillations and Waves

General comment: Candidates substituted reasonably well into formulae, but were unable to calculate a correct answer reliably. Units were carelessly handled, diagrams often lacked precision.

(a) (i) 1. Answers here were poor since candidates did not appear to understand what the question was asking.

2. In this part candidates knew the correct formula, but often neglected to convert days to seconds.

3. Candidates were able to substitute the value from the previous question but were careless in determining which radius to use.

4. Many candidates calculated acceleration, not force, and failed to convert *km* to *m* when calculating answers in *N*.

(ii) Candidates misunderstood the question, consequently answers were poor.

(b) This part was reasonable well done, although many candidates felt compelled to include a torsional wave as it appeared in the stem of the question.

(c) (i) 1. Candidates had difficulty in counting wavelengths and converting minutes to seconds. Many inadvertently calculated f instead of T.

2. Most recognised the inverse relationship between f and T.

3. Wave equation was well known, but many candidates overlooked the units.

4. This question was generally well answered.

(d) (i) Answers here were good.

(ii) Many candidates' comparisons of motions were poor and failed to distinguish clearly between the two pendulums.

(iii) A number of candidates included unnecessary detail in their responses and contradicted a correct answer.

(e) (i) Most candidates knew that the type of motion was SHM, but failed to give adequate reasons.

(ii) and (iii) These parts were generally well answered.

(f) (i) and (ii) Answers here were also good.

(iii) This part was reasonably well answered. Some candidates identified a wavefront but not constructive interference of the water surfaces.

(iv) This was poorly answered. Candidates failed to consider the number of antinodes between the two prongs or the fact that the prongs themselves formed antinodes. Diagrams were poor and did not show the proportions of the waves.

(g) Candidates recognised that frequency was unchanged across the boundary, but failed to explain the reason clearly.

Question 12 : Light

(a) This section was well done, with most candidates reaching the correct answer, although a significant number showed poor mathematical skills in manipulating formulae.

(b) (i) This part was well answered, but a number of candidates were unable to give clear responses to (ii) and (iii), many believing that *no* patterns would be observed under the specific conditions. A significant number confused interference effects with dispersion in (iii).

(c) Explanations of the term *plane polarised* often did not show a clear understanding of its meaning and the idea of waves travelling in one direction was confused with that of a field vector's vibrating in one plane.

(d) Only a very few candidates described correctly how this diffraction pattern occurred.

(e) A disappointingly high proportion of candidates were unable to draw accurate ray diagrams with the necessary degree of care and precision, despite the emphasis on this skill in the Syllabus. A small number confused the terms *concave* and *convex* and *mirror* and *lens*.

(i) Here many candidates, with the object at 50 cm, knew where the image was located but did not show the paths of two reflected rays to form this image.

(f) A straightforward question, this was generally well answered.

(g), (h), (i) and (j) These parts were knowledged-based and were well answered by most candidates, reflecting a good level of understanding

(k) Many candidates did not answer in terms of *observations* made by Young and simply gave a general account of his theory.

Group 5 : Interdisciplinary Electives

Question 13 : Biochemistry

(a) (i) Many candidates, although conversant with the tests used, failed to give a specific example of a carbohydrate in their answers.

It was a matter of concern that some schools were still using Millon's reagent to test for protein.

(ii) This was well understood by most candidates, although some still omitted to state which tests required heat to give a positive result.

(b) This part was generally well answered by the majority of candidates. The diagrams were generally well drawn.

(c) (i) Answers here were good.

(ii) Many candidates succeeded in designing an experiment, although the concept of constants and variables was poorly understood.

(d) (i) Most candidates were able to name a carbohydrate that exhibits stereoisomerism.

(ii) The distinguishing test for stereoisomers was understood by only a few candidates.

(e) (i) This part was generally well answered.

(ii) Many candidates could not explain in biochemical terms the reduction in muscle efficiency as the result of the accumulation of lactic acid.

(f) (i) and (ii) Most candidates could define the term *zwitterion*, although many could not explain what important property of amino acids arises from their behaviour as zwitterions.

(g) (i) This was generally well answered.

(ii) Some candidates found difficulty in expressing biologically the significance of the carbon fixation stage of photosynthesis.

Question 14 : Photography

(a) (i) Candidates were confused by the wording of the question. The words *conventional diagram* suggested a ray diagram, yet the words *simple camera* suggested drawing a camera with all its parts. As a result the question was not well answered.

(ii) This was not answered as well as it might have been since all that was required was the standard answer: real, inverted, diminished.

(iii) Candidates did not recognise the given lens as being a standard lens, consequently the question was not well answered.

(b) (i) Answers here were generally good, although only a few candidates realised that a microscope has a small aperture.

(ii) and (iii) These parts were well answered.

(iv) and (v) On the whole answers here were good. Many candidates did not understand the problem of getting an acceptable depth of field with a microscope.

(c) (i) Answers here were poor. Most candidates tried to explain how the light metre *works* rather than how it is *used*.

(ii) This part was well answered.

(d) (i) and (ii) Answers to both these parts were good.

(iii) This was badly answered since few candidates could describe the main steps in the process of toning.

(e) (i) and (ii) These parts were generally well answered.

Question 15 : Physics in Medicine

(a) (i) This was well answered, although many responses were not clearly expressed.

(ii) Most answers to this part were good; a few candidates gave excellent descriptions of NMR.

(b) (i) The majority of candidates failed to explain the Doppler frequency shift fully..

(ii) This was quite well answered by most candidates.

(c) (i) The majority of candidates answered this part well.

(ii) and (iii) Although two techniques were named, descriptions were often inadequate.

(d) (i) Answers here were poor.

(ii) Candidates had a good general idea of how a radiation film badge records information but often could not explain the principles adequately.

(iii) A large number of candidates failed to explain why exposure to radiation is dangerous.

(e) (i) Many candidates gave inadequate definitions of the term *half-lif*e.

(ii) and (iii) These parts were generally well answered, although, again, responses often lacked detail.

(f) Most candidates obviously possessed a good understanding of ultrasound and its applications.

Question 16 : Space Science

(a) The majority of candidates had difficulty in identifying three problems unique to the Space Shuttle; many gave only general problems of space flight.

(b) Most candidates were familiar with the principle features of the Space Shuttle. Often, however, they failed to give specific descriptions of its design, although these were relevant to the question.

(i) The majority of candidates gave an adequate explanation (based on Newton's Third Law or momentum principles) of how a rocket operates.

(ii) The role of chemical propellants in providing energy for lift-off was described adequately, but few candidates could give examples of propellants. Many ignored the oxidiser as being an essential constituent of most propellants.

(c) (i) This was a straightforward substitution, yet many candidates failed to convert units from Earth's radius.

(ii) Most candidates cited air resistance as the difference between escape velocity and actual velocity, but many did not complete the explanation.

(iii) Here responses were similar to those in part (i), with about 50% failing to add the Earth's radius to the satellite altitude.

(d) Most candidates gave a description of the Impact Theory to account for the origin of the Moon. As in many other descriptive answers, many failed to cover all descriptive elements of the theory, e.g. accretion of debris and entry into Earth's orbit.

(e) Many candidates did not recognise the requirements of prolonged self-sufficiency as specified and, therefore, gave inappropriate answers such as *dependence on food supply from Earth* and *removal of wastes from the system.*

(i) The majority cited growth of plants for food but not the key role of sunlight which is needed for adequate growth.

(ii) Too many gave general answers such as air-conditioning, rather than specific solutions for controlling heat transfer externally and internally.

(iii) Most cited solar energy as the primary source of power, but often without describing a means of capturing such energy. Rechargeable batteries, nuclear power and fuel cells were given by some candidates as secondary sources.

(iv) This was generally answered well, although a surprising number of responses employed satellites to relay signals for communication.

(v) The majority suggested recycling of refuse to provide water and nutrients for plant growth. Many would propel their wastes back to Earth for disposal!

(vi) A large number of candidates linked atmosphere control with plant growth but only a small number mentioned specifically oxygen/carbon dioxide recycling.