BOARD OF STUDIES
NEW SOUTH WALES

1999 HSC

Science 3/4 Unit

Notes from the Examination Centre

Published by
Board of Studies NSW
GPO Box 5300
Sydney NSW 2001
Australia

Tel: (02) 9367 8111

Fax: (02) 9262 6270

Internet: http://www.boardofstudies.nsw.edu.au

March 2000

ISBN 0 7313 4505 3

200063

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Science 3/4 Unit Notes from the Examination Centre

In 1999, 151 candidates presented for the 3 Unit paper and 341 candidates for the 4 Unit paper, making a total of 492, a significant decrease on the candidature of 725 for 1998.

Introduction

The examination for the 3 and 4 Unit Science courses consists of two papers; a three-hour common Core Paper (Paper 1) and an Electives Paper (Paper 2) that is of $1\frac{1}{2}$ hours duration for the 3 Unit candidates and 4 hours duration for the 4 Unit candidates. The common Core paper contains material from Biology, Chemistry, Geology and Physics. The Electives paper contains questions in each of the science disciplines, as well as some interdisciplinary studies. Candidates presenting for the 3 Unit course attempt any two Elective questions, those presenting for the 4 Unit course attempt four questions, which must be chosen from three different disciplines.

These are demanding Science courses and the syllabus incorporates qualitative and quantitative understandings in the Core and Elective topics. Candidates therefore are expected to be able to describe abstract concepts and phenomena as well as mathematical calculations in the examination. Candidates are often also examined on mandatory practical work, being asked to describe equipment required, techniques used, and concepts illustrated by experimental procedures.

The following is a copy of a Board Official Notice that should be noted by candidates.

> BOS 16/97 – Data Sheets and Units in Science.
>
> Students are advised that in Higher School Certificate examinations for which data sheets are provided or data are included in the question, the relevant values given are to be used in all questions that require calculations. Students should also take care not to round off until the completion of the calculation.
>
> In all Science work involving quantities and the naming of units, teachers should use, and encourage students to use, the International System of Units (SI). Students should be familiar with the common multiples and submultiples of SI units and be able to use them appropriately in examinations.

In addition, for questions involving mathematical calculations, candidates should show their transcription of information from the question, and state the formula being used (if applicable). All working should be clearly shown, together with statements explaining relevant reasoning. Answers involving vector quantities should always include both magnitude and direction.

Chemical equations should include states where appropriate.

Diagrams should be clear, neatly and carefully drawn, in pencil, and be well-labelled. Diagrams of scientific equipment should be drawn in such a way that the procedure being illustrated would work and the relative size of each piece of equipment is reflected in the diagram.

Diagrams of natural phenomena should also be drawn carefully. For example, volcanoes with slopes of 75^{o}, cells with membranes that cross and unjoined lines that represent pores where none

should exist may be penalised. Diagrams should be large enough to show all relevant details clearly.

The correct use and conversion of units would help many candidates improve their results, as would careful reading and analysis of each question before attempting to answer.

Candidates would be well-advised to use the spaces provided in the Answer Books for Paper 1 and the mark allocations in Paper 2 as a guide to the expected scope of the answers.

Paper 1 – Core

Section I

Section I consists of ten multiple-choice questions, each worth 1 mark.

The table provides the answer key for questions 1 – 10.

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

The 4 Unit candidature had few problems with this section of the paper, with more than 50% of the candidature correctly answering all questions except for Question 4.

The 3 Unit candidature tended to find the questions more difficult, with less than 50% of the candidates correctly answering Questions 4, 5, 6, and 7.

Section II

Section II consists of ten 3-mark questions (Questions 11 – 20).

Question 11

(a) The calculation of the empirical formula for the organic compound, given the masses of C, H, and O was well answered. The main error made by candidates was to not reduce to the simplest ratio.

(b) Most candidates were able to give the molecular formula ($C_{10}H_{20}O_2$) for the compound. Some candidates tried to write the molecular formula as half the empirical formula and ran into difficulty with $O_{1/2}$.

Question 12

(a) Candidates were required to write a balanced chemical equation to describe the reaction of nitric acid with sodium hydrogen carbonate. Although this was a fairly straight-forward question, many candidates were unable to answer correctly as they did not know the formulae for the two reactants.

(b) Many candidates were confused by the data for volumes of the solutions and interchanged the 0.100 L used in making the solution with the 0.025 L aliquot used in the titration. A few candidates neglected to convert millilitres to litres. Candidates also need to be made aware to use atomic mass data as supplied and not to round off until the final step.

(c) A common error was the use of the number of moles of $NaHCO_3$ in 0.100 L with many candidates failing to appreciate that only 25.0 mL of the $NaHCO_3$ solution in part (b) was used in the titration.

Question 13

(a) This question was generally well answered, but some candidates had difficulty explaining clearly what the two forces were in the action/reaction pair. In particular, most candidates were able to explain the force of the adult on the boat system, but fewer were able to explain the force of the boat system on the adult.

(b) Most candidates were able to apply the Law of Conservation of momentum to the described situation. The most common error was to ignore the mass of the child.

Question 14

(a) The majority of candidates correctly substituted into the formula W=Fs. However frequent errors were made expressing the answer in scientific notation and converting joules to kilojoules.

(b) Although the majority of candidates knew the formula KE = $\frac{1}{2}$ mv^2, some attempted to find the change in energy by incorrectly using the expression KE = $\frac{1}{2}$ $m(v_2-v_1)^2$.

(c) Many candidates failed to recognise the relationship:

Work done by the horse = Gain in KE + Work done against friction, and attempted to solve the problem by using either Answer (a)/250 or Answer (b)/250. A minority of candidates calculated the acceleration of the cart and used this to find the force, without realising that this was the net force acting on the cart and NOT the force of friction exerted by the mud on the cart.

Generally there were a lot of careless mathematical errors and a tendency to round off calculations too early.

Question 15

(a) Most candidates were able to explain that the 60 W globe would have the higher resistance. Some candidates had difficulty relating the P = VI and V = IR equations, with a small number confusing resistance with power.

(b) This was well answered by most candidates. Some candidates failed to explain why the current differed when using the equation V = IR.

(c) Many candidates wrongly substituted 100 and 60 into equations for power, without realising that the current through both globes would be the same, and hence calculated incorrect values for either I or R.

Question 16

(a) The equation for the reaction of water with Na_2O was generally well answered. However, few candidates were able to write the equation for the reaction with P_4O_{10}.

(b) Poor expression marred many candidates' responses, with references to acids having higher pH values being disappointingly common. A significant number made comparisons using > and < signs incorrectly, and often contradicting written statements.

Question 17

(a) Many candidates did not state that an index fossil has a short geological time range. In their answers, many suggested that the organism rather than the species existed for a short time range.

(b) Most candidates correctly stated a possible age range for layer Z. The most common error was to give the total time range (570–440 Ma) rather than the overlapping time range.

(c) While most candidates could state the Principle of Superposition, many had difficulty applying it to answer the question.

Question 18

(a) The majority of candidates correctly identified the type of bonding in elements W and Z, though, once again, the reasons given were poorly expressed.

(b) This part was generally well answered with candidates able to explain the low melting point of the oxide of X. The most common error was to confuse intermolecular forces with intramolecular forces and how these relate to melting point.

Question 19

(a) A large number of candidates could not deduce that the third product was sodium sulfate, with many using NaO or NaOH. Some of those who gave a sulfate as the product wrote sodium sulfate as $NaSO_4$, ie using a valency of 2 for sodium.

(b) The calculations for determining which reactant was in excess were well done, although some candidates treated the sulfuric acid as if it were a gas and used the relationship $n(H_2SO_4) = 0.1/24.47$.

(c) Candidates were able to calculate the volume of gas based on their previous answers.

Question 20

(a) Most candidates were able to name the processes of (A) mitosis and (C) meiosis. Fewer were able to name stage (B) correctly as cytokinesis.

(b) Many candidates correctly identified the process that produces gametes. However, explanations for their answers tended to be poor.

Section III

Section III consists of eight 5-mark questions (Questions 21 – 28).

Question 21

(a) This part was well answered with most candidates being able to show that the magnitude of the force was 24 N. The most common error was a failure to expand correctly the algebraic expression $(M+2) \times 3$.

(b) Many candidates were aware of the relationship between work and energy though a significant number experienced difficulty in correctly calculating the value for the velocity of the trolley and mass after 0·75 seconds and substituting the value into the equation for kinetic energy.

(c) Many candidates were able to calculate correctly the change in gravitational potential energy of the 3·53 kg mass as being given by the relationship PE = mgh. The two most common errors in the calculation were the failure to recognise the relationship between the distance the trolley moved and the distance the 3·53 kg mass fell, and attempting to equate the kinetic energy of the trolley to the total gravitational potential energy, ie ignoring the kinetic energy of the 3·53 kg mass.

Although a statement about the string being light and inextensible and the pulley being frictionless was made in part (c), many candidates attempted to explain the energy changes in terms of friction. The vast majority of candidates did not recognise that both the moving trolley and the falling 3·53 kg mass gain kinetic energy.

Question 22

(a) This part of the question required candidates to sketch the motion of the balls before and after they collided. Many candidates did not realise that the balls were travelling in the same direction initially. Others drew sketches that showed the balls travelling in the same direction, but had Ball A ahead of Ball B. In part (a) (ii), some candidates who had answered the first part correctly failed to realise that the balls moved off together after the collision.

(b) The majority of candidates were able to calculate the value for initial and final momentum by substituting velocity values from the graphs into equations. A large proportion of the candidature, however did not realise the vector nature of momentum and therefore did not refer to direction in their answers. Others omitted or gave incorrect units for momentum.

(c) The calculation of total kinetic energy before and after the collision was generally well done, with most candidates having few problems with the question. Errors, in the main, were due to carelessness in squaring the velocity or multiplying mv^2 by $\frac{1}{2}$. Most candidates were able to compare the values obtained for initial and final kinetic energies to determine whether or not the collision was elastic. Some candidates who correctly calculated the kinetic energies as 33 J and 27 J simply stated that kinetic energy was not conserved rather than whether or not the collision was elastic.

Question 23

(a) (i) This part required candidates to calculate the rate of movement of point X *relative to* point Y in cm year^{-1}. Candidates once again experienced difficulty in converting km to cm, with many giving totally unrealistic spreading rates. There was also evidence that candidates had difficulty in interpreting the time scale for magnetic reversals. A large number of candidates attempted to calculate the half-spreading rate rather than the rate of point X relative to point Y.

(ii) This part of the question was very poorly answered. Very few candidates related the high relief at the mid-ocean ridge to the rising convection currents and the associated rocks being in expanded form. As distance from the mid-ocean ridge increases, the rocks cool and contract and ocean depth increases.

(b) The majority of candidates was able to explain the role of the asthenosphere in plate tectonic theory. However, a small proportion of the candidature still incorrectly referred to the asthenosphere as being molten or liquid, rather than a zone of plasticity that allows lateral and vertical movement of the lithosphere.

(c) Very few candidates were able to provide two types of evidence for partial melting within the asthenosphere. Many candidates confused the low velocity zone (LVZ) with the P and S wave shadow zones.

Question 24

The parts to this question were straightforward and generally were very well answered. Some candidates provided condensed structural formulae rather than the required structural formulae in their answers. It also needs to be stressed that candidates must be careful to represent functional groups and their bonding correctly, ie it should be clear that C–O–H is being represented and not C–H–O.

(a) In naming a primary alcohol with formula $C_4H_{10}O$, the most common error was to omit the prefix 1– in 1–butanol. Some candidates confused but- with prop- and pent-. Some candidates gave 2–methyl–1–propanol as a correct alternative answer.

(b) The most common incorrect answers for the final oxidation product were butanal and butanone.

(c) The question asked candidates to name a common oxidising agent and most candidates were able to provide acidified permanganate or dichromate ions as answers. Some candidates provided a formula rather than a name as required by the question.

(d) Naming and providing the structural formula for 2–butanol was well answered by the majority of candidates. Those that gave incorrect answers most commonly gave 2–methyl–1–propanol.

Question 25

(a) A significant number of candidates did not know the formula for hydrogen sulfide, with the most common error being to give H_2SO_4. Of those that gave the correct molecular formulae for all species, a significant number did not balance the equation and/or give states for all reactants and products. It was also apparent that the valencies of silver and sulfur were not well known.

(b) Candidates had little difficulty in calculating the volume of hydrogen sulfide used, and hence the number of moles.

(c) Candidates demonstrated that they could calculate the concentration of the silver nitrate solution that was consistent with the equation they wrote in part (a).

(d) Again, most candidates were able to provide an answer that was consistent with the equation given.

Question 26

(a) The majority of candidates correctly named amino acids as the building blocks of proteins and peptide bond as the bond between the amino acids.

(b) Few candidates were adequately able to relate the transcription of the genetic code, contained in DNA into mRNA, to form specific proteins. Very few included the notion of mRNA moving out of the nucleus for translation to occur.

(c) Most candidates knew that protein synthesis occurs at the ribosomes in the cytoplasm.

(d) Candidates were required to describe one function of proteins in cells. Many candidates gave a description of enzymes as a function of proteins. Some candidates however, used general terms such as growth and repair, without giving adequate descriptions.

Question 27

(a) A significant number of candidates could not draw a water molecule correctly. Some showed HO_2 while a large number showed the molecule as being linear H–O–H.

A number of candidates showed hydrogen bonding between water molecules without showing the charge separation on a single molecule. This may have been a result of using last year's paper in their preparation for this year's examination. Candidates should read questions carefully and answer the question set.

(b) Most candidates were able to provide an explanation of the effect of the longer alkyl chain on solubility in water.

(c) While many candidates knew that hydrogen bonding was responsible for H_2O having a higher boiling point, few were able to explain hydrogen sulfide's properties in terms of dipole-dipole intermolecular forces. A significant number stated that the intermolecular forces were dispersion forces because the molecule is non-polar.

Question 28

(a) Most candidates showed they could correctly calculate the cumulative resistance of resistors Q, R, and S, however a significant number did not recognise the globe as a resistor in parallel with Q, R, and S. Many candidates also had difficulty with simple mathematical operations.

(b) The most common errors in calculating the reading on the ammeter were ignoring the voltage drop across resistor P when using Ohm's law and using an incorrect ratio in dividing the total current for I_{globe}.

(c) Most candidates correctly recalled the equations for electrical energy and converted the time to seconds, however some candidates did not incorporate the voltage drop across P and QR in calculating a value for V to substitute into $W = V \times I \times t$.

It was noted that candidates generally gave the correct units for each of their responses.

Section IV

Section IV consists of two 10-mark questions (Questions 29 and 30).

Question 29

This question focussed on Sir Humphrey Davy's experiment to isolate sodium from the electrolysis of molten sodium hydroxide and required candidates to draw on knowledge, understanding, and skills acquired from study of a range of Core topics. It was apparent that some candidates did not appreciate the difference between molten and dissolved sodium hydroxide.

(a) Candidates generally had a good understanding of the structure of solid and molten NaOH but did not describe clearly the link between structure and conductivity.

(b) The most common error in writing the half equation for the production of sodium was to use the subscript 'aq' for Na^+. Most candidates were able to state that the sodium would be found on the surface and explain this in terms of the relative densities of Na and NaOH.

(c) Many candidates failed to make use of the data sheet to select an appropriate half-equation for the reaction at the anode, even though it was stated in part (c) (iii) that water is produced. Most, however, were able to describe the process occurring at the anode as oxidation and to explain it as involving a loss of electrons. Most were also able to explain what would happen to the water formed at the anode.

(d) Although this question was reasonably straight forward, this part was not well answered, with many candidates demonstrating little understanding of how to approach the problem. Surprisingly, while many candidates had correctly converted time to seconds in Question 28, in this question they substituted time in hours into $Q = I \times t$. Candidates should also be encouraged to make use of the data sheet for values such as the Faraday constant and elementary charge.

Question 30

(a) This question required candidates to use interpretive and analytic skills.

In part (i) candidates were expected to use information from the stem of the question as well as diagram X to explain which isotopes would be most suitable for age dating the complete stratigraphic sequence. Most candidates understood the significance of radioactive dating but were unable to match the isotope pairs to the rock ages. The very long break in the stratigraphic sequence was often ignored and the inappropriateness of ^{87}Rb with its very long half-life was often not recognised.

Part (ii) was poorly answered with many candidates appearing not to understand the term 'geological environment'.

In part (iii) candidates were required to explain how a major break in the fossil record could occur. Most candidates were able to provide an explanation of how an unconformity could occur.

(b) Candidates were required to identify two apparent evolutionary changes in the graptolites shown. This was generally well answered although it was evident that some candidates were not aware that fossil B4 was older than B1.

(c) In this part candidates were asked to explain, using any example, the mechanism that Charles Darwin had proposed for the process that brought about the diversity of species that he had observed on the Galapagos Islands. Most candidates used this cue to refer to examples from

the Galapagos in their answers. While the steps required for diversity were well known, few candidates completed the explanation to show the development of the new species.

(d) Many candidates were able to give an excellent description of a theory that has been proposed for the origin of life on Earth and incorporated into their answers the scientific evidence that supports the theory. Some candidates confused the origin of life on Earth with the evolutionary sequence from single cell organisms to mammals.

Paper 2 – Electives

In this Paper, 3 unit candidates attempt any two elective questions, and 4 Unit candidates attempt four elective questions chosen from three different groups.

The table shows the approximate percentage of the combined 3 and 4 Unit candidature that attempted each elective.

Q	Group	Elective	Approx %
1	Biology	Flowering Plants and Mammals	22·6
2	Biology	Reproduction and Genetics	59·6
3	Biology	Micro-organisms and Disease	16·5
4	Biology	Coordination and Control	3·7
5	Chemistry	Energy	16·1
6	Chemistry	Atomic Structure and the Periodic Table	29·7
7	Chemistry	Carbon Chemistry	76·0
8	Geology	Regional Geology	1·4
9	Geology	Mountains	32·1
10	Physics	Electromagnetism	10·6
11	Physics	Oscillations and Waves	24·8
12	Physics	Light	18·3
13	Interdisc'y	Biochemistry	16·7
14	Interdisc'y	Photography	6·3
15	Interdisc'y	Physics in Medicine	1·4
16	Interdisc'y	Space Science	3·0

Question 1 – Flowering Plants and Mammals

(a) (i) Nearly all candidates were able to identify structure T correctly. However part (ii), in which candidates were required to describe the function of structure T, was surprisingly poorly answered by many candidates. The main deficiency was that candidates did not explain that both oxygen and carbon dioxide move both in and out through the stoma. Most understood the concept of water moving out by transpiration.

(iii) Many candidates were able to explain the changes in the rate of oxygen release shown in the graph by linking the production of oxygen to photosynthesis and to the closing of the stomata in the heat of the day to prevent water loss.

(b) (i) The majority of candidates correctly named the root hairs or zone of differentiation as the location where the uptake of most water and minerals occurs.

(ii) The better candidates included a comparison of the energy required for the active uptake of ions from the soil and the movement of water by osmosis.

(iii) Most candidates named the specialised type of tissue as xylem, with the majority using a diagram to assist their description of its structure. Better candidates included lignified or thickened walls, perforated or absent end walls, pits in the side of the walls, and the concept of a lumen in their descriptions.

(c) (i) Most candidates correctly identified substance A as oxygen and B as carbon dioxide.

(ii) This part was also well answered with candidates demonstrating a good understanding of the effect of differences in oxygen concentrations between alveoli and capillaries.

(iii) The most common error in this part was to simply mention attachment to haemoglobin rather than naming oxyhaemoglobin.

(iv) Most candidates described carbon dioxide as being transported in the blood as bicarbonate ions dissolved in plasma.

(d) (i) Responses to this part of the question tended to be very poorly structured. Many candidates could have improved their responses by using a table to contrast the components of the filtrate solutions at X and Y. In many cases, components at X were mentioned with no reference to Y.

(ii) Homeostasis was a concept that was well understood by most candidates, although a small number did not relate the regulation of the internal balance to both reabsorption of water and elimination of urea.

(iii) Explanations of why the functioning kidney generates large amounts of heat were poor. While many understood the functioning of a sodium pump requires energy, few linked this to cell respiration as the process that provides the energy and ultimately releases heat.

(e) (i) Most candidates identified water and gravity as the environmental stimuli being investigated. Some candidates gave the terms geotropism and hydrotropism, rather than answering the question.

(ii) Explanations of an advantage of the plants' response to one of these stimuli tended to be poor.

(f) (i) The quality of the labelled diagrams tended to be very poor. Candidates need to be encouraged to take more care when answering questions that require a diagram.

(ii) This part of the question was well answered.

Question 2 – Reproduction and Genetics

When answering questions in this Elective, candidates should be aware that in general, completing a punnet square, without further explanation, is an inadequate answer. Similarly, punnet squares that lack keys are unlikely to score full marks.

(a) (i) Most candidates correctly identified the dominant alleles as inflated pod shape and yellow seed colour. However, few candidates related the concept of dominance to the ratios in the table of results given in the question.

(ii) Again, while the majority of candidates were able to identify the parent plants as heterozygous for genes controlling seed colour and pod shape, few were able to explain their answer, either using adequately labelled and keyed punnet squares or in terms of the ratio of 9:3:3:1 as it related to the results table.

(b) (i) A large proportion of the candidature was able to show the results of the cross between a red-eyed male and a white-eyed female using a punnet square, although many candidates did not give a key for the letters used to show dominant and recessive, nor XX and XY. Many candidates did not explain how the punnet square answered the question.

(ii) Most candidates were able to determine the chances of heterozygous parents producing a red-eyed male offspring.

(c) While many candidates could name three ways sexual reproduction contributes to phenotypic variation, fewer were able to provide adequate descriptions of these ways.

(d) (i) Poor expression tended to mar many candidates' explanations of the term 'recombinant DNA technology'.

(ii) Descriptions of how a plasmid may be used to produce hGH in bacteria tended to be quite good. Common omissions in answers were using the *same* restriction enzyme to cut the foreign gene and the plasmid to produce complementary 'sticky ends'; and using ligase to stabilise the annealing process.

(iii) This part was well answered.

(e) Most candidates could provide an application of their chosen technology. In part (ii), weaker candidates tended to give very general answers and described non-technical aspects of the process. This was especially true for those candidates who chose to answer in relation to tissue culture.

(f) (i) Descriptions of a difference in the structure of male gametes produced by mammals and those of flowering plants were good. Explanations of why this structural difference might have arisen tended to be much weaker.

(ii) Quite a few candidates answered this question well, although there are many who still use the concept of an entire virus entering the cell, prior to replication, rather than the virus injecting its DNA/RNA.

(g) Some candidates were able to provide good explanations of the switching on and off of genes, depending on the chemical environment etc. Most candidates were unable to use a satisfactory example of undifferentiated cells and the differentiated cells resulting from the process.

Question 3 – Micro-organisms and Disease

(a) (i) Most candidates were able to describe how to isolate the contaminating bacteria as a pure culture for further examination but few mentioned the use of a selective medium. Most candidates did not refer to the selection of an isolated bacterial colony although most knew how to streak for isolated colonies. Some candidates used the terms colony and culture interchangeably. Many candidates confused this question with Koch's postulates.

(ii) Few candidates understood the importance of biochemical tests and many described the structure of the bacterial colony but referred to it as the structure of the bacteria.

(iii) Common answers to this question included nucleus, mitochondria and vacuoles.

(b) In answering this question, some candidates confused bacterial diseases with fungal diseases. Some candidates who chose to answer in point form did not adequately describe the full process of transmission of the disease.

(c) (i) The main error in answering this question was confusing the lymphatic system with the lymphocytes.

(ii) Most candidates were able to describe a role of *B*-cells and a role of *T*-cells in the immunological response.

(iii) This question was well answered.

(d) (i) Many candidates could only describe one difference in the two antibody responses and did not include the role of memory *B*-cells in their explanation.

(ii) Most candidates had a good understanding of the difference between active and passive immunisation, although some confused these with naturally and artificially induced immunisation.

(e) Many candidates had difficulty naming a specific organism of industrial importance, and giving details of the micro-organism's role in an industrial or economic process.

(f) Most candidates understood the effect of antibiotics on bacteria. Many candidates thought that a virus would mutate in response to an antibiotic.

(g) Some candidates stated that bacteria became immune rather than resistant to antibiotics.

(h) Few candidates gave a specific example of goods that may be subject to quarantine.

Question 4 – Coordination and Control

(a) A minority of candidates could correctly name all six structures. Some candidates attempted to name only 1 or 2 structures, others used generalities such as F = axons or dendrites.

(b) (i) In answering this question candidates needed to show clearly the resting potential that exists between the outside and inside of the neurone, the movement of sodium and potassium ions, the zone of depolarisation and the subsequent repolarisation of the neurone. Answers ranged from very thorough to very poor.

(ii) Those candidates that answered part (b) (i) well provided similarly comprehensive answers to this part. These candidates were able to describe the mechanism used to transmit the impulse between adjacent neurones.

(c) (i) This part was well answered.

(ii) The main weakness in answering this part was lack of detail. Some candidates did not include a description of how the nervous system was involved in the response.

(d)(i)-(iv) While it was clear that candidates had studied an animal hormone, many had difficulty explaining how the hormone acts on the target cells and their response. Part (iv) was also poorly answered.

(e) Candidates had a poor understanding of the difference between short-term and long-term responses. The descriptions of the mechanisms also tended to be poor. Those candidates who chose phototropism as their response demonstrated a very good understanding of the role of auxins.

(f) Candidates had little difficulty discussing pollination and recognised that timing was important so that pollinators would be present and that flowers are all open at the same time. The two most common environmental factors stated were day-length and temperature.

(g) Most candidates were able to describe that roots will grow downwards and shoots will grow up in response to gravity, regardless of the inversion that has taken place. However, few used their knowledge of plant cell responses to explain that the gravity response was ‘programmed’ into the stem and that inverting it did not reverse this message so the original top still produced shoots and the original bottom produced roots.

Question 5 – Energy

(a) (i) Most candidates defined the term 'ignition temperature' well. A small number confused ignition temperature with flash point and wrote about sparks starting combustion.

(ii) This part was well answered, with most candidates mentioning storage considerations.

(iii) It was apparent that some candidates did not understand the meaning of the term oxidiser.

(iv) There were few problems in writing the equations. The most common error was confusing ethyne with ethene. Similarly, in other parts of the question, it was apparent that some candidates did not know the formula for octane.

(v) A surprising number of candidates stated the molar mass of hydrogen was 1 g.

(vi)-(vii) These parts of the question were answered well.

(viii) This question posed few problems to candidates.

(b) The main weaknesses in the diagrams were labelling or Fe^{3+}as the cathode electrode and the ion movement in the salt bridge going in one direction. In calculating the cell voltage some candidates multiplied the E^o values by the number of electrons,
eg. $Fe^{2+} + e^- \_ Fe^{3+}$ $E^o = 2 \times 0{\cdot}77$ V. In part (iv), many candidates assumed the anode and cathode were the same as in the electrochemical cell.

(c) This part was not well answered with relatively few candidates able to obtain the correct value for the C–C bond energy. Many candidates failed to realise that heats of combustion are given at 25^o C and so the water formed is in the liquid state or that bond energies involve molecules in the gaseous state. Consequently many did not apply Hess's Law appropriately. It would be expected that the inclusion of $\Delta_{rap}H^o$ ($H_2O(l)$) would suggest that it should be used, but many candidates did not. There was also some confusion about the correct method of calculating the average bond energy with some candidates trying to use heats of formation although the relevant data were not available. Other candidates failed to use the correct bond energies for carbon dioxide, incorrectly using the 358 kJ mol^{-1} value given for the C–O bond . Candidates did not have a good understanding of why average bond energies were quoted with some stating that isotopic values were involved.

Question 6 – Atomic Structure and the Periodic Table

(a) Most candidates gave the correct name with the most common error being 'halides'. Most candidates were able to give correct answers to parts (ii) and (iii). Poorer candidates referred to trends in group 7 rather than comparing the two elements.

(b) (i) This part was very well answered.

(ii) Most candidates answered correctly although a few gave 'f block' as the incorrect answer.

(iii) This part was well answered. The most common error was placing beryllium in period 1 and phosphorus in period 2.

(iv) This was generally well answered with candidates displaying a good understanding of subshells. Some, however, showed phosphorus as a positive ion.

(c) (i) Most candidates were able to name Crookes' tubes correctly.

(ii) Most candidates gave the answer JJ Thompson, although some attributed this to Crookes or Rutherford. In part (II) many wrote about electrons in magnetic fields and ascribed to magnets and/or their associated fields, positive and negative poles. Very few candidates could describe Thomson's experiment to determine the charge to mass ratio. There was little or no mention of measurement nor of the deflections caused by magnetic and electric fields on the cathode rays.

(d) The Geiger-Marsden experiment was fairly well understood. However, few candidates were able to link the observations with Rutherford's inferences. Many wrote of the alpha particles colliding with the nucleus and rebounding to position 3. Some wrote of the electrons interfering with the path of the alpha particles to produce the deflection at 2. There was some confusion about the different inferences that could be made from the deflections at 2 and 3.

Question 7 – Carbon Chemistry

(a) Both parts of this question were well answered with few candidates having problems determining the molecular formula C_3H_6. The most common error was to name the compound 1–propene.

(b) (i) The IUPAC naming of the eight compounds was generally done well. The most frequent error was naming compound *G* 2–propanone.

(ii) Candidates had little difficulty providing a necessary safety procedure.

(iii) The standard of diagrams was better than in recent years, but the drawing of a condenser still caused difficulties. Condensers were frequently drawn without a cooling jacket or the top of the jacket unsealed. Even though labels were required the 'condenser' was often omitted.

The need for using the reflux apparatus for the reaction of compounds *D* and *F* was generally well understood.

In part 3, some candidates used a separating funnel only, confusing its use in extracting excess acid by shaking with sodium carbonate solution, with the intention of obtaining the pure form of compound *I*.

(c) There were very few difficulties with parts (i) and (ii).

(iii) Many candidates had difficulty giving the formula for sodium stearate.

(iv) Many candidates stated that sodium stearate is added to soaps and did not realise that sodium stearate is a soap.

(v) Many had difficulty in describing the action of soap, often incorrectly stating that the positive sodium ion played a part.

(vi)-(vii) These parts were generally well answered.

Question 8 – Regional Geology

(a) The small number of candidates who attempted this elective all based their answers on the Sydney Basin. Candidates must be prepared to illustrate answers for this elective with carefully drawn diagrams with adequate labelling.

(b) Some of the maps drawn were of very poor quality and were not a full page as required by the question. Most candidates could name two adjoining regions.

(c) Again diagrams were poor and lacking in detail.

(d) Most candidates were able to name two different types of fossils found in the Sydney Basin and provide details about these fossils.

(e) There appeared to be some confusion about the term 'igneous rock unit'.

(f) While candidates were able to draw a simplified stratigraphic column, their presentation of names of major formations, major lithologies and palaeoenvironment of formation tended to be unclear and confusing.

(g) This question based on a major economic deposit was answered well.

(h) Once again, diagrams were poor and labelling inadequate.

Question 9 – Mountains

(a) (i) Most candidates could describe the differences in the processes leading to volcanic activity at points *P* and *Q*. Some candidates had difficulty describing a process that leads to the development of hot spots.

(ii) This part was also answered well.

(iii) This part was not well answered. A significant number of candidates could not link the 'step like changes' with transform faults off-setting the mid-ocean ridge.

(iv) This part was generally well answered. Some candidates neglected to mention the Benioff zone at site *Q* – an inclined zone of seismic activity.

(v) Most candidates recognised the recycled nature of the oceanic crust, but did not adequately explain the tectonic stability of continental land masses.

(vi) Most candidates could predict the likely locations of future continent-continent collisions.

(b) (i) This question was generally answered well, although many candidates failed to recognise section 2 as a site of ocean-ocean collision, but identified it as an ocean-continent plate boundary.

(ii) Many candidates did not discriminate between the two sections in terms of compressive forces and style of folding and faulting.

(c) (i) Most candidates correctly identified and described a source of volcanic hazard and suggested a logical and practical way of mitigating the hazard.

(ii) This was generally answered well although some candidates did not relate the effects to the 'high relief, frequent seismic activity, and occasional heavy rainfall'.

Question 10 – Electromagnetism

(a) (i) Most candidates were able to visualise this situation and correctly indicated the directions of the associated magnetic fields. However, most did not demonstrate the relative intensities produced by the currents and due to distance from the conductor.

(ii) Most candidates were able to calculate the magnetic field due to each wire and the magnitude of the resultant vector addition. Many candidates did not give the direction for the resultant magnetic field strength.

(b) (i) While many candidates could explain why the magnet moves down, others could not determine the polarity of the coil correctly. A few candidates described the magnet as causing induced currents in the coil.

(ii) This was generally well answered by the majority of candidates. Acceptable answers included more loops in the coil, more current or voltage in the circuit, or using a stronger magnet.

(c) The majority of candidates was able to recognise the question as an induction problem that could be solved by the equation emf = $Blv\sin\theta$. Some candidates attempted to use $F = BIl\sin\theta$.

(d) (i) Only about half the candidates were able to apply their knowledge of Faraday's Law and induction effects to explain what happens when the motor is first switched on. Many candidates did not use the stimulus information provided in the question, but attempted to give answers based on the simple dc motor.

(ii) Again only about half the candidates were able to explain that the induced current carrying coil in the magnetic field will experience a torque.

(iii) This part was poorly answered with only a few candidates recognising that the relative speed of the stator field to the rotor is much smaller than it was at start up and so the induced emf is smaller and the currents are limited.

(iv) Most candidates recognised the torque as determining the steady speed at which the motor operates. Some candidates had trouble determining the change in speed with a change in load. Very few candidates were able to give explanations of why the motor speed was related to load.

(v) The majority of candidates was able to calculate the force exerted by one bar on the other.

Question 11 – Oscillations and Waves

(a) (i) Some difficulty was experienced by candidates when calculating the frequency of the puck's motion. Incorrect answers included counting the images as though they were time intervals, ie in 180^o turn there are 7 images which incorrectly gives $7 \times 0{\cdot}1 = 0{\cdot}\ 7$ s.

(ii) Many candidates were able to calculate the velocity of the puck, realising that the length of the string is equal to the radius.

(iii) Most candidates were able to calculate the tension in the line using $T=mv^2/r$.

(b) (i) The concept of longitudinal waves and the relationship between particle motion and wave energy movement was well understood.

(ii) Most candidates were able to calculate the extra distance travelled by the reflected wave as 4 metres and consequently gave an answer of 8 wavelengths.

(iii) The concept of constructive interference was well understood by the majority of candidates, who used it to explain the reduced sound intensity at O.

(c) (i) Most candidates were able to identify system A as exhibiting simple harmonic motion. Amplitude and period values also posed few problems.

(ii) The majority of candidates recognised that the regular decrease in amplitude in system B was due to dampening.

(iii) The majority of candidates recognised system C as the answer and were able to give valid reasons including; constant speed between collisions, no loss of speed, kinetic energy conserved in successive collisions, and change in direction of velocity on collision.

(iv) Some candidates had difficulty converting the equation for frequency given in the syllabus to the required equation for period ie $T = 2\pi\sqrt{(m/k)}$. Most candidates were however able to calculate a value for the maximum force using $F = k\,x$.

(d) (i) Many candidates found it difficult to explain what was meant by the term resonance in the context of the described experiment.

(ii)-(iii) The concept of end errors and the technique for eliminating them was poorly understood by many candidates.

Question 12 – Light

(a) (i) Many candidates could not provide the necessary construction of wavelets shown by Huygens. Others were unsure of where to draw the wavelets, and some confused the concept of a ray with that of a wavelet.

(ii) The concept of refraction was reasonably well understood by the majority of candidates.

(b) (i) Many candidates knew what a parabolic mirror was, but some could not apply the concept to an everyday example such as a spotlight. Rays were often drawn in the wrong direction. Similarly, in trying to explain how a spherical mirror increases the size of the field of view, many candidates had difficulty with the direction of travel of the rays.

(ii) Most candidates could accurately construct a diagram to show the formation of the image produced by the lens and could use appropriate terminology to describe the image as real, inverted and diminished.

(c) (i) The better candidates included in their explanations of the phenomenon diffraction of coherent light at the double slit, interference of the two resultant wavefronts arising from the path difference of the two wavefronts, interference producing cancellation and reinforcement.

(ii) Most candidates were able to apply the equation $d = \lambda l/x$, although some had difficulty converting units, especially nanometres.

(iii) Candidates had difficulty describing the changes that would occur if one of the slits were to be covered up. Candidates needed to describe the central maximum in the single slit being twice as wide as that for the double slit, the intensity of the central maximum for the single slit being brighter, and the intensity of the adjacent maxima being reduced.

(d) While there were significant difficulties with defining the term ‘polarised light’, there were fewer problems with describing a test for ‘polaroid’ glasses.

(e) (i) There were some difficulties with this concept, particularly with the orientation of the fields.

(ii) This question allowed the better candidates to demonstrate the extent of their understanding of the photoelectric effect.

(iii) Most candidates were able to explain what is meant by the term ‘wave-particle dilemma’ and give one piece of experimental evidence that supports the wave theory.

Question 13 – Biochemistry

(a) Candidates had few problems describing the primary, secondary and tertiary structure of proteins.

(b) The term 'enzyme specificity' was well understood as was the identification of enzyme *A* as the human enzyme.

(c) A surprising number of candidates could not clearly explain what protein denaturation meant.

(d) Most candidates could provide a distinguishing test and its result for protein.

(e) Similarly, most candidates were able to answer this part of the question.

(f) (i) Many candidates had difficulty in correctly describing the three named processes.

(ii) Most candidates could name two metallic ions that plants obtain from the soil, but very few were able to give a role for the chosen ions.

(g) This part was reasonably well answered, although some answers were marred by poor expression and others were not of sufficient depth.

(h) Most candidates were able to identify C, B, and A respectively as the required answers and were able to justify their choices.

(i) Again most candidates were able to provide correct answers to these parts of the question.

Question 14 – Photography

(a) (i) Most candidates were able to state that the required diaphragm setting was *f* 11.

(ii)-(iii) The most common error in answering this question was to use only three interfaces rather than the required six. Some candidates then calculated the proportion of light transmitted as being (((100-4)-4)-4) ie. 100- (3 × 4).

(iv) Many candidates were able to state that anti-reflection coatings reduce ghosting. Some of these candidates gave quite detailed descriptions of this effect.

(b) The majority of candidates identified the feature as being either soil or soil with some vegetation and gave good explanations of their reasoning. These explanations included comparisons between all four photographs and related their observations to the information supplied in the graph.

(c) (i) The explanations of how a focal-plane shutter works were generally poor. Candidates too often gave explanations in terms of the width of the slit separating the blinds rather than the time delay between the tail end of the first blind and the start of the second blind.

(ii) Most candidates were able to provide an advantage of the positioning of a focal-plane shutter.

(iii) Those that knew how the focal-plane shutter operated were able to explain how blurring or distortion of a rapidly moving object could occur.

(d) (i)-(ii) The causes of these aberrations were well understood and many candidates used diagrams effectively to describe the effect of each aberration.

(iii) Most candidates were able to give 'stopping down' as a simple method of reducing both effects.

(e) (i) The latent image was correctly described by a large proportion of the candidature. Some supported their answers with detailed equations of the oxidation of bromide ions to bromine, releasing an electron that reduces the silver ion to silver metal.

(ii) This part was not well answered. Many candidates attempted to answer the question in terms of developer, stop bath, fixer, hardener, and washing, rather than the chemical constituents of developer.

(iii) The majority of candidates were able to describe three factors that may affect the successful developing of the film. Candidates should however be aware that development is only one stage in the processing of flim.

Question 15 – Physics in Medicine

(a) The responses to this part ranged from those that demonstrated a thorough knowledge of the techniques of ultrasound and X-rays to those that attempted to discuss both techniques in terms of high speed electrons forming the images.

(b) Only a few candidates were able to give a satisfactory explanation for the Doppler shift and a diagram showing how ultrasonics could be used to measure the rate of blood flow in a blood vessel.

(c) All parts of this question were reasonably well answered. Some candidates had problems with the calculation of the mass of ^{131}I, others with providing two reasons for the use of each isotope.

(d) This question was reasonably straightforward and candidates had few difficulties in naming and identifying a use for EEG and ECG machines.

(e) This part was not well answered with few candidates being able to explain clearly how the diastolic and systolic measurements are produced.

Question 16 – Space Science

(a) The majority of candidates were able to give the inclined nature and elliptical shape of the orbit as reasons to believe that Pluto is a captured satellite rather than a true planet. Others mentioned Pluto's small size compared with its near neighbours. The question was generally well attempted.

(b) The most common responses involved the discoveries of life on Earth in extreme physical conditions such as near ocean volcanic vents or deep in the crust. Others mentioned biomolecules found in meteorites in Antarctica.

(c) Most candidates had specific knowledge of Goddard's contribution, but fewer could provide information on von Braun.

(d) Candidates had little difficulty providing descriptions of three Russian achievements.

(e) The Gemini series of missions was less well known than the Apollo missions.

(f) Candidates had good knowledge of Skylab.

(g) Descriptions of a named propulsion system tended to be rather vague.

(h) While most candidates could state three essential functions of a life support system, some of the descriptions in the second part of the responses were very simplistic.

(i) (i) The derivation of Kepler's Third Law was beyond almost all candidates.

(ii) Most candidates were able to state two characteristics of geostationary satellites.

(iii) Many candidates had difficulty in providing a reason for near-polar orbits.

(iv) As many did not know Kepler's Third Law, this calculation was also beyond most candidates.