2001 HSC Notes from the Examination Centre Physics

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2001 HSC NOTES FROM THE EXAMINATION CENTRE PHYSICS

Introduction

This document has been produced for the teachers and candidates of the Stage 6 course in Physics. It provides comments with regard to responses to the 2001 Higher School Certificate Examination, indicating the quality of candidate responses, and highlighting the relative strengths and weaknesses of the candidature in each section and each question.

It is essential for this document to be read in conjunction with the relevant syllabus, the 2001 Higher School Certificate Examination, the Marking Guidelines and other support documents which have been developed by the Board of Studies to assist in the teaching and learning of Physics.

General comments

The 2001 HSC Physics paper is the first examination of the current syllabus, and was attempted by approximately 8945 candidates. It represents a shift in the style and nature of questions from those in previous Higher School Certificate papers, and the following general comments should be noted, regarding the manner in which these questions were handled by the candidature. Candidates did not always observe the instruction of the key verb within each question. This omission often resulted in a loss of marks, for example if a candidate only provided a description when an explanation was required.

In answering larger-mark holistic questions, candidates are expected to be able to communicate their responses in a coherent and logical manner. Many responses to these questions were unnecessarily long and inappropriate essays that did not address the question and often contained contradictory statements. Successful responses to these questions showed structure, often with some evidence of planning the response. A common feature of better responses was the use of diagrams and/or tables to present information. Point form presentation, when appropriate, neatly presents structured logic.

Teachers and candidates should be aware that examiners may ask questions that address the syllabus outcomes in a manner that requires candidates to respond by integrating their knowledge, understanding and skills developed through studying the course. This reflects the fact that the knowledge, understanding and skills, developed through the study of discrete sections, should accumulate to a more comprehensive understanding than may be described in each section separately.

Section I

Part A – Multiple choice

The following table shows the correct response to each question.

Question	Correct Response
1	D
2	A
3	A
4	C
5	C
6	B
7	B
8	D

Question	Correct Response
9	B
10	A
11	D
12	D
13	C
14	C
15	D

Part B

Specific Comments

Question 16

This question tested candidates' understanding of the time dilation effect of relativity, although some candidates did not recognise time dilation as the relevant concept. Most candidates were not able to manipulate the time dilation equation sufficiently well to achieve the correct answer.

Question 17

This question tested candidates' understanding of the vertical acceleration of rockets. The most common error made by candidates was in thinking that the graph showed uniform acceleration – some candidates stated this explicitly while a significant number of candidates attempted to evaluate the acceleration using equations of uniform acceleration. A large number of candidates correctly justified the increase of acceleration shown in the graph by describing the constant force and decreasing mass experienced by a rocket. A minority of candidates evaluated the gradient of the curve at the points indicated.

Question 18

This question tested candidates' understanding of projectile and circular motion. Part (a) involved a simple calculation and was handled well by most candidates. However, some candidates did not use the value of 'g' provided in the data sheet. The most common error in the calculation of part (b) was assuming that $u_y = 20\ ms^{-1}$, rather than zero. Another common error was not assigning similar directions to a_y and Δy. In the comparison required by part (c), most candidates did not recognise that gravitational force was common to both situations and that the centripetal force on B was the resultant of gravitational force and the tension force of the arm towards the pivot, and was larger than the force on A as a result.

Question 19

This question assessed candidates' understanding of the Michelson-Morley experiment and its connection with the theory of special relativity. Many candidates were able to discuss relativity in the terms required by the question, however the link between relativity and the Michelson-Morley experiment was generally not well expressed. Many candidates included points not relevant to the results of the Michelson-Morley experiment.

Question 20

This question tested candidates' understanding of transformers and electricity distribution. Many candidates were able to give correct reasons for stepping-up and stepping-down voltages in a distribution network. Generally, the use of step-down transformers was better understood than step-up transformers.

Question 21

This question tested candidates' understanding of back EMF in motors and its role in opposing the applied voltage to the motor. Many candidates failed to recognise the role of back EMF, instead giving detail of how a motor operates. Candidates who did recognise the role of back EMF were usually able to describe it clearly and relate this to the need for a resistance at start-up.

Question 22

This question tested candidates' understanding of parallel current-carrying wires in parts (a) and (b), and an investigation of the motor effect in part (c). Most candidates performed well in part (a), although some confused direction in relation to the diagram. In part (b), most candidates realised that the relationship to be graphed was linear, although few recognised the initial length of the wire as 3 metres.

In part (c), most candidates were able to provide a clear definition of the motor effect. Some candidates had difficulty distinguishing the motor effect from the motor. The investigations that demonstrated the motor effect were wide ranging, and many candidates could provide a correct result from an investigation, although most had difficulty using the result to explain the motor effect.

Question 23

This question tested candidates' knowledge of the effects electrical generators have had on society and the environment. The majority of candidates were able to identify relevant issues, although many did not identify or discuss a sufficient variety of both positive and negative issues. Most candidates' responses were unnecessarily lengthy and contained irrelevant information, such as re-stating the question and repetition of statements. The use of essay-style structure was not required to gain full marks. Responses made in point form or as a table were infrequent but usually scored well.

Question 24

This question tested candidates' understanding of the X-ray diffraction methods used by the Braggs. Many candidates chose vague and general areas eg medicine, without giving specific examples and purposes. Many candidates were unable to outline clearly the process of diffraction and the link between diffraction and determination of structure, though many candidates could link reflected and interfering rays to the structure of the crystal. Many candidates confused X-ray diffraction with electron diffraction, and the Braggs' experiments with those of other physicists. A common error was to make correct statements about interference without outlining how the Braggs used this to determine structure.

Question 25

This question tested candidates' understanding of experimental methods, based on the results of an experiment on the photoelectric effect. The drawing of the graph in part (a) was generally done well by the candidature. The most common errors were not placing the independent variable (frequency) on the horizontal axis, not drawing a line of best fit, and not using linear scales on the axes. In part (b), many candidates were able to explain that the reliability of the experiment could be improved by repetition and averaging.

Question 26

This question tested candidates' understanding of electrons and holes in semiconductors. The open-ended nature of this question meant that there was a wide range of valid responses. Candidates scored the full range of marks available, but only some candidates were able to score full marks on this question. A significant number of candidates were not able to explain the concept of a 'hole'. Some candidates confused semiconductors with superconductors.

Section II – Options

Specific Comments

Question 27 – Geophysics (attempted by approximately 1% of the candidature.)

(a) This part examined knowledge of gravity survey instruments and was answered well by most candidates.

(b) This part examined candidates' understanding of how a geological hot spot and a moving tectonic plate can produce an island chain. Most candidates did not identify the chain of islands as a hot spot path, instead interpreting the structure as an island arc and ignoring age.

(c) This part examined candidates' application of experimental technique to geophysics, and was poorly handled by the candidature in general. General experimental techniques were poorly understood in this context. Some candidates focused their attention on nuclear, rather than electromagnetic radiation. Only some candidates were able to score full marks on the question.

(d) This part required candidates to discuss the theory of plate tectonics and the evidence leading to its acceptance. Most candidates were able to score some marks on this question, by describing the theory of plate tectonics. Few candidates, however, discussed the evidence required by the question.

(e) This part required candidates to discuss the link between seismic observations and increased knowledge of the structure of the Earth. Many candidates did not distinguish the meaning of 'seismic' observations. Demonstrated knowledge of the structure of the Earth, as well as seismic principles, was quite poor. Diagrams were especially helpful in answering this question, however the use of good diagrams was quite rare. Most diagrams presented were poorly drawn or not labelled.

Question 28 – Medical Physics (attempted by approximately 21% of the candidature.)

(a) This part examined candidates' knowledge of optic fibres as used in endoscopes. Most candidates were able to identify the purpose of coherent bundles in the optic fibre. A common error in this part was to focus the response on incoherent bundles. Most candidates correctly identified that total internal reflection occurs at the core/cladding boundary, but did not describe the relative difference in refractive index.

(b) This part examined candidates' understanding of the physical principles of ultrasound scans. Most candidates were able to identify one property of ultrasound, usually by stating that frequency > 20 000 Hz. Some candidates were able to use the appropriate calculations to explain why some tissue boundaries show up more clearly than others. The most common error was to discuss the transmission of the ultrasound, not reflection. Another common error was failing to discuss how the ultrasound signal is detected.

(c) This part examined candidates' application of experimental technique to medical physics, by focusing on the Doppler effect. A significant error made by many candidates was in not understanding the difference between loudness, frequency and wavelength. Many candidates said the loudness increased, rather than the pitch.

(d) Most candidates correctly identified the nature of CAT scans. A number of candidates compared CAT scans and X-rays with other methods of diagnosis, rather than comparing CAT scans with X-rays.

(e) Some candidates provided excellent answers to this question, however there was a variety of common errors. Very few candidates used the term 'resonance'. Many candidates failed to explain precession and what it is that actually precesses. Many candidates left out essential steps in the operation of MRI. A number of candidates said that the magnetic field was switched off.

Question 29 – Astrophysics (attempted by approximately 27.5% of the candidature.)

(a) This was answered well by most candidates, though many had difficulty describing the concept of a common centre of mass. Many candidates correctly described red shifts and blue shifts, and the relative motions they represent. Few candidates, however, correctly described the periodic red shift/blue shift pattern characteristic of spectroscopic binaries.

(b) Most candidates could identify the hottest star. The majority of better answers involved calculating the absolute magnitudes of the stars, and using this information to judge comparative luminosities. Candidates who tried to reason out an answer in words only, usually made errors or had insufficient steps of logic.

(c) Many candidates demonstrated a basic understanding of the production of spectra, but only some candidates were able to express reasons for the difference between the spectra shown. Few candidates were able to describe the electron transitions that produce emission and absorption spectra. Some candidates simply restated information given in the stem of the question.

(d) Many candidates provided answers that described developments outside the scope of the question. Many of those who did direct their response appropriately, demonstrated a basic recall of recent advances in telescope design. Only some candidates were able to describe correctly how these advances result in improved telescope performance.

(e) Candidates had to relate each of the stellar evolutionary stages to the groups in the Hertzsprung-Russell diagram and known characteristics of those groups. Few candidates were able to do this well, often describing stellar evolution in detail without relating it correctly to the H-R diagram, or failing to describe the characteristics of each group. Some candidates gave detailed descriptions of stellar evolutionary stages that do not appear on the H-R diagram. Most candidates did not draw a H-R diagram and could only provide a poor description of it. Many candidates mistakenly believed that a ‘protostar’ is located at the right-hand top corner of the H-R diagram; and that stars move up or down the Main Sequence, from red to blue, or vice versa.

Question 30 – From Quanta To Quarks (attempted by approximately 48.5% of the candidature.)

(a) The first part required candidates to define ‘nucleon’, and was generally not well answered. Many candidates confused nucleon with nucleus or neutron. Many candidates had difficulty contrasting protons and neutrons, that is, showing how they are different.

(b) Most candidates were able to perform a subtraction to determine the energy of a photon produced by a particular transition. Many candidates presented alternative presentations of the information contained in the question. A common erroneous presentation was to draw electron orbits, often also adding the transitions of particular series, such as the Balmer and Paschen series.

(c) Many candidates were able to describe an investigation to detect the penetrating power of different radiations including a discussion of the use of a control in this investigation. However, discussion of monitoring and improving the reliability of the investigation was generally poorly handled. Many candidates gave the impression they had done the investigation as a computer simulation. These candidates did not provide good discussions of the issues of reliability or the use of a control.

(d) There was a wide variation in performance amongst the candidature. Most candidates provided responses that were insufficiently detailed. The more successful candidates on this question were conversant with the history of the period and gave a discussion appropriate to the scope of the question.

(e) The majority of candidates were able to state that Chadwick discovered the neutron and many could describe the relevant experiment in detail and apply the law of conservation of momentum to indicate that the suspected gamma rays were in fact particles. Analyses of Fermi's work varied from quite detailed to limited, many believing that Fermi discovered the neutrino and nuclear fission. Many candidates made some attempt to answer this question, although there was often a lack of direction in the responses. A significant number of candidates answered the question as if Chadwick and Fermi worked together.

Question 31 – The Age Of Silicon (attempted by approximately 2% of the candidature.)

(a) Most candidates were able to name the transducer commonly used in a light meter of a camera but were not generally able to identify whether the response of the transducer was linear or non-linear; and whether it was in direct or inverse proportionality to light intensity.

(b) Many candidates were able to identify the function of the feedback resistor, but the calculation in the second part was generally poorly handled.

(c) Generally, the candidature experienced a high level of success at deducing the output of a set of logic gates demonstrating a good understanding of the principles involved.

(d) This question was answered quite poorly. Discussions included vague generalisations, such as stating that as technology improves, computers get faster, without examining the technical reasons for this improvement. Most candidates restricted themselves to discussing speed increases without looking at other elements of computer 'power'.

(e) This part was generally poorly handled by the candidature. Many candidates confused the 'developments in electronics' with the 'use of electronics', and 'electronics' with 'electricity'. Hence, the weaker responses were simply a list of household appliances or electronic equipment.

Physics

2001 HSC Examination Mapping Grid

Question	Marks	Content	Syllabus outcomes
Section I: Part A			
1	1	p.50; 9.2.1; Col. 2; DP 1: p.50; 9.2.1; Col. 3; DP 3	H6, H9
2	1	p. 55; 9.3.1; Col. 2; DP 1: p. 59; 9.4.1; Col. 2; DP 4	H9
3	1	p. 62; 9.4.4; Col. 3; DP 2	H3, H14
4	1	p. 56; 9.3.3; Col. 2; DPs 1, 3	H9
5	1	p. 51; 9.2.2; Col. 2; DPs 5, 8	H6, H9, H14
6	1	p. 60; 9.4.2; Col. 2; DPs 6, 7 p. 60; 9.4.2; Col. 3; DP 5	H8, H10
7	1	p. 51; 9.2.2; Col. 3; DP2	H6, H9
8	1	p. 56; 9.3.2; Col. 2; DP 7: p. 56; 9.3.2; Col. 3; DP 4	H4, H7, H9
9	1	p. 52; 9.2.3; Col. 2; DP 2; p. 52; 9.2.3; Col. 3; DP 1	H7, H9, H12
10	1	Prelim; p. 32; 8.3.2; Col.3; DP 5 p.56; 9.3.2; Col. 2; DPs 4, 5, 6	H9, H14
11	1	p. 57; 9.3.4; Col. 2; DPs 3, 4, 5	H4, H7, H9
12	1	p. 62; 9.4.4; Col. 2; DP 7	H10, H14
13	1	p. 51; 9.2.2; Col. 2; DP 8	H6
14	1	p. 55; 9.3.1; Col. 3; DP 3 p. 55; 9.3.1; Col. 2; DP 2	H9, H14
15	1	p. 51; 9.2.2; Col2; DP 1	H6, H7, H9, H13, H14
Section I: Part B			
16(a)	1	p.53; 9.2.4; Col. 2; DP 11	H6
16(b)	3	p.53; 9.2.4; Col. 3; DP 5	H6
17(a)	2	Prelim; p. 38; 8.4.2; Col.2; DP 6 p. 51; 9.2.2; Col. 2; DP 8	H6, H14
17(b)	4	p. 51; 9.2.2; Col. 2; DP 8	H6, H14

Question	Marks	Content	Syllabus outcomes
18(a)	1	p.50; 9.2.1; Col.1 p.50; 9.2.1 Col.2, DP 1 p.50; 9.2.1 Col.3, DP3	H6, H9
18(b)	2	p.51: 9.2.2 Col3, DP2	H6, H9
18(c)	3	p.51; 9.2.2; Col.2, DPs 1, 2, 9 p.51; 9.2.2; Col.3, DPs 1, 2, 3 p.52; 9.2.2; Col.3, DP 1	H6, H9
19	4	p.53; 9.2.4; Col. 2; DPs 2, 3, 5, 6, 7, 11	H2, H6, H13, H14
20	4	p. 57; 9.3.4; Col. 1 p. 57; 9.3.4; Col. 2; DPs 1, 2, 4, 5 p. 57; 9.3.4; Col. 3; DP 4	H4, H7, H9, H14
21	3	p. 56; 9.3.2; Col. 2; DP 6	H7, H9, H13
22(a)	1	p. 55; 9.3.1; Col. 2; DP 3 p. 55; 9.3.1; Col. 3; DP 3	H9
22(b)	2	p. 55; 9.3.1; Col. 2; DPs 2, 3	H9, H13
22(c)	4	p. 55; 9.3.1; Col. 3; DP 2	H9
23	6	p. 56; 9.3.3; Col. 2; DP 5	H4, H13
24(a)	2	p. 62; 9.4.4; Col. 2; DP1	H1, H2, H3, H4
24(b)	4	p. 62; 9.4.4; Col. 2; DP1	H7, H8, H9
25(a)	4	p. 60; 9.4.2; Col. 2; DPs 6, 7	H13
25(b)	2	p. 46; 9.1 p. 47 p. 48	H11 H12 H14
26	8	p. 61; 9.4.3; Col. 2; DPs 2, 3, 4, 5; 8, 9 p. 61; 9.4.3; Col. 3; DPs.1, 2	H1, H8, H10, H13, H14

Question	Marks	Content	Syllabus outcomes
Section II			
Geophysics			
27(a)(i)	1	p. 65; 9.5.2; Col. 2, DPs 8, 11	H9
27(a)(ii)	2	p. 65; 9.5.2; Col. 2, DPs 8, 11	H9
27(b)(i)	1	p. 66; 9.5.4; Col. 2, DP 4	H1, H2, H14
27(b)(ii)	3	p. 66; 9.5.4; Col. 2, DP 4	H1, H2, H14
27(c)	4	p. 65; 9.5.2; Col. 3, DP 1	H8, H10, H12, H13
27(d)	6	p. 66; 9.5.4; Col. 2; DPs 4, 5	H1, H2, H4, H13, H14
27(e)	8	p. 66; 9.5.3; Col 1; p. 66; 9.5.5; Col. 3; DP 2	H1, H4, H8, H13, H14
Medical Physics			
28(a)(i)	1	p. 69; 9.6.2; Col. 2; DP 6	H8, H13
28(a)(ii)	2	p. 69; 9.6.2; Col. 2; DP 5	H8, H13
28(b)(i)	1	p. 68; 9.6.1; Col. 2; DP1	H1, H4
28(b)(ii)	3	p. 68; 9.6.1; Col. 2; DP 5 p. 68; 9.6.1; Col. 3; DP 5	H8, H14
28(c)	4	p. 68; 9.6.1; Col. 3; DP 6	H8, H12, H13
28(d)	6	p. 69; 9.6.2; Col. 2; DPs 3, 4 p. 69; 9.6.2; Col. 3; DP 2	H1, H4, H8, H10, H13, H14
28(e)	8	p. 70; 9.6.4; Col. 3; DPs1, 2	H1, H4, H9, H13, H14
Astrophysics			
29(a)(i)	1	p. 74; 9.7.5; Col. 2; DP 1	H9
29(a)(ii)	2	p. 74; 9.7.5; Col. 2; Dp 1	H7, H8, H9
29(b)(i)	1	p. 73; 9.7.3; Col2. DPs 3, 4, 5	H7
29(b)(ii)	3	p. 73; 9.7.4; Col. 2; DP 1 p. 73; 9.7.4; Col. 3; DP 1	H7, H8, H14
29(c)	4	p. 73; 9.7.3; Col. 2; DPs 1, 2, 3, 4 p. 73; 9.7.3; Col. 3; DPs 1, 3	H7, H8, H13, H14
29(d)	6	p. 72; 9.7.1; Col. 2; DP 5 p. 72; 9.7.1; Col. 3; DP 3, 4	H1, H4, H7, H13
29(e)	8	p. 74; 9.7.6; Col. 1 p. 74; 9.7.6; Col. 3; DPs2, 3	H1, H3, H7, H13

Question	Marks	Content	Syllabus outcomes
From Quanta to Quarks			
30(a)(i)	1	p. 77; 9.8.4; Col. 2; DP 2	H10
30(a)(ii)	2	p. 77; 9.8.4; Col. 2; DP 2	H10
30(b)(i)	1	p. 76; 9.8.1; Col 2; DP 2 p. 76; 9.8.1; Col 3; DP 2	H7, H8, H10
30(b)(ii)	3	p. 76; 9.8.1; Col 2; DP 2 p. 76; 9.8.1; Col 3; DP 2	H7, H8, H10
30(c)	4	p. 78; 9.8.5; Col. 3, DP 2	H11, H13
30(d)	6	p. 78; 9.8.5; Col. 3; DP 1	H1, H4, H13
30(e)	8	p. 77; 9.8.4; Col. 2; DP 1 p. 77; 9.8.4; Col. 3; DP 4	H1, H2, H10, H13, H14
The Age of Silicon			
31(a)(i)	1	p. 81; 9.9.3; Col. 2; DP 2	H7
31(a)(ii)	2	p. 81; 9.9.3; Col. 2; DP 2 p. 81; 9.9.3; Col. 3; DP 1	H7
31(b)(i)	1	p. 82; 9.9.6; Col. 2; DPs 3, 4	H2
31(b)(ii)	3	p. 82; 9.9.6; Col. 2; DPs 3, 4, 6, 7 p. 82; 9.9.6; Col. 3; DP 3	H4, H9, H14
31(c)	4	p. 82; 9.9.5; Col. 2; DP 1 p. 82; 9.9.5; Col. 3; DP 1, 2	H9, H13
31(d)	6	p. 82; 9.9.7; Col. 2; DPs 1, 2 p. 82; 9.9.7; Col. 3; DP 1	H3, H4, H9, H13, H14
31(e)	8	p. 80; 9.9.1; Col. 3; DP 1 p. 80; 9.9.1; Col. 2; DP 1, 2, 3	H1, H4, H9, H13

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2001 HSC Physics
Marking Guidelines

Question 16 (a) (1 mark)

Outcomes assessed: H6

MARKING GUIDELINES

Criteria	Marks
• Time dilation	1

Question 16 (b) (3 marks)

Outcomes assessed: H6

MARKING GUIDELINES

Criteria	Marks
• Calculates the correct answer (units necessary)	3
EITHER • Time dilation equation correctly stated. Then with t_v and t_0 incorrectly substituted (but with answer appropriate to incorrect substitution) and recognition that the answer is physically absurd ($\frac{v^2}{c^2} < 0$) OR • Algebraic errors (but with answer pertinent to incorrect manipulation)	2
EITHER • Time dilation equation (correct) OR • Incorrect use of equation leading to correct calculation ending with $\frac{v^2}{c^2} < 0$. No recognition of physical absurdity OR • Gives correct value but shows no working (units may be omitted)	1

Question 17 (a) (2 marks)

Outcomes assessed: H6, H14

MARKING GUIDELINES

Criteria	Marks
• Acceleration can be determined from the slope of velocity versus time graph • The acceleration is greater 100 s after lift-off **Note:** *either* a visual determination of the slope *or* a measurement from the graph, is acceptable.	2
• One only of the above points	1

Question 17 (b) (4 marks)

Outcomes assessed: H6, H14

MARKING GUIDELINES

Criteria	Marks
• Correctly explains the shape of both parts of the graph	4
EITHER • Correct explanation of the first part of the graph OR • Partly-correct explanation for the first part, second part of the graph correct	3
• Provides a correct statement relating to the first part of the graph, second part correct	2
EITHER • A correct statement relating to the first part of the graph OR • A correct statement relating to the second part of the graph	1

Question 18 (a) (1 mark)

Outcomes assessed: H6, H9

MARKING GUIDELINES

Criteria	Marks
• Correctly calculates the force	1

Question 18 (b) (2 marks)

Outcomes assessed: H6, H9

MARKING GUIDELINES

Criteria	Marks
• Uses the correct formula and substitutes correct values	2
• Identifies the correct formula	1

Question 18 (c) (3 marks)

Outcomes assessed: H6, H9

MARKING GUIDELINES

Criteria	Marks
• Correctly describes the resultant forces on *A* and *B* and correctly deduces that the force on *B* is greater than the forces on *A*	3
EITHER • Correctly describes the resultant forces on *A* and *B* but has an incorrect comparison OR • Correctly describes the resultant force on either *A* or *B* (but not both) and makes a correct comparison	2
One of the following: • Correctly describes the resultant force on *A* OR • Correctly describes the resultant force on *B* OR • Gives a correct comparison	1

Question 19 (4 marks)

Outcomes assessed: H2, H6, H13, H14

MARKING GUIDELINES

Criteria	Marks
• An accurate understanding of the results of the Michelson-Morley experiment • An understanding of the Special Theory of Relativity • Demonstrates the link between the Michelson-Morley experiment and the Special Theory of Relativity	4
EITHER • Demonstrates some understanding of both the Michelson-Morley experiment and the Special Theory of Relativity OR • Demonstrates an accurate understanding of either the Michelson-Morley experiment or the Special Theory of Relativity	2–3
EITHER • Reference to the constant speed of light OR • Reference to no aether	1

Question 20 (4 marks)

Outcomes assessed: H4, H7, H9, H14

MARKING GUIDELINES

Criteria	Marks
• Clearly and correctly explains why transformers are used, using a range of reasons relating to: – function of transformers – energy loss in transmission – safety and environmental issues	4
• Clearly and correctly explains why transformers are used, referring to two of the three above areas OR • Demonstrates a basic knowledge of the three above areas	3
• Correctly explains why transformers are used, referring to one of the three above areas OR • Demonstrates a basic knowledge of two of the three above areas	2
• States one reason	1

Question 21 (3 marks)

Outcomes assessed: H7, H9, H13

MARKING GUIDELINES

Criteria	Marks
• A complete explanation involving the description of back emf in motors, outlining the need for protective resistance at low speed, and the production of back emf at higher speeds that opposes the current through the windings	3
• An explanation, with reference to the back emf opposing the current through the windings. The back emf increases or decreases with the speed of the motor	2
• Some reference to back emf	1

Question 22 (a) (1 mark)

Outcomes assessed: H9

MARKING GUIDELINES

Criteria	Marks
• Gives correct direction (attractive)	1

Question 22 (b) (2 marks)

Outcomes assessed: H9, H13

MARKING GUIDELINES

Criteria	Marks
EITHER • Graph showing **linear** relationship, starting at 1 = 3 m indicated OR • Graph showing direct (linear) proportionality with 1 = 3 m indicated	2
• Graph showing a proportional relationship (linear relationship starting at origin)	1

Question 22 (c) (4 marks)

Outcomes assessed: H9

MARKING GUIDELINES

Criteria	Marks
• The explanation of how the results demonstrate the motor effect displays a thorough knowledge of the physics of the motor effect and relates to the specific investigation they undertook	4
EITHER • The explanation of how the results demonstrate the motor effect displays a sound knowledge of the physics of the motor effect and relates to the specific investigation they undertook	3
• States the motor effect and describes their investigation. Provides no link between the two	2
EITHER • Describes their investigation OR • States the motor effect	1

Question 23 (6 marks)

Outcomes assessed: H4, H13

MARKING GUIDELINES

Criteria	Marks
• Demonstrates a thorough understanding of the effects of generators on society and the environment by discussing a positive and a negative aspect of at least one societal effect and at least one environmental effect	5–6
EITHER • Provides at least one positive aspect on both society and the environment indicating a thorough understanding of the issues OR • Provides at least one negative aspect on both society and the environment indicating a thorough understanding of the issues OR • Provides positive and negative aspects of at least one societal effect and at least one environmental effect, indicating a sound understanding of the issues	3–4
• States both one aspect of a societal issue AND an environmental issue OR • Indicates a sound understanding of a societal issue OR • Indicates a sound understanding of an environmental issue	2
• States either one aspect of a societal issue or one aspect of an environmental issue	1

Question 24 (a) (2 marks)

Outcomes assessed: H1, H2, H3, H4

MARKING GUIDELINES

Criteria	Marks
BOTH • States an example in which an understanding of crystal structure is useful AND • A purpose for this use	2
EITHER • States an example in which an understanding of crystal structure is useful OR • A purpose for this use	1

Question 24 (b) (4 marks)

Outcomes assessed: H7, H8, H9

MARKING GUIDELINES

Criteria	Marks
• Provides general features of the methods used by the Braggs and demonstrates a thorough knowledge of how crystal structure was determined	3–4
• Provides general features of the methods used by Braggs and demonstrates a basic knowledge of how crystal structure was determined	1–2

Question 25 (a) (4 marks)

Outcomes assessed: H13

MARKING GUIDELINES

Criteria	Marks
• Provides labelled axes and indicates proper units • Provides a linear scale which is appropriately chosen • Correctly plots the data points • Draws a reasonable line of best fit which may, or may not, include the outlier point. (Neither dot-to-dot connecting nor curves are acceptable.)	4
• One error or omission with the remaining features correct	3
• Two errors or omissions with remaining features correct	2
• One feature correct	1

Question 25 (b) (2 marks)

Outcomes assessed: H11, H12, H14

MARKING GUIDELINES

Criteria	Marks
• Provides examples of how to improve the reliability of the experiment	2
• Describes one way in which reliability can be improved	1

Question 26 (8 marks)

Outcomes assessed: H1, H8, H10, H13, H14

MARKING GUIDELINES

Criteria	Marks
• Demonstrates an extensive knowledge and understanding of the physics of electrons and holes through a well-connected explanation	7–8
• Demonstrates a knowledge of the major points relating to electrons and holes with an amplification of some of them. Communicates the ideas effectively	5–6
• Demonstrates a basic knowledge of some of the major points relating to electrons and holes. Communicates the ideas clearly	3–4
• States ONE or TWO of the points relating to electrons and holes	1–2

Question 27 (a) (i) (1 mark)

Outcomes assessed: H9

MARKING GUIDELINES

Criteria	Marks
• Either *Gravity meter* or *Gravimeter*	1

Question 27 (a) (ii) (2 marks)

Outcomes assessed: H9

MARKING GUIDELINES

Criteria	Marks
• A description is given of the information provided by the instrument and the scope of its use	2
EITHER • A description is given of the information provided by the instrument OR • A description is given of the use of the instrument	1

Question 27 (b) (i) (1 mark)

Outcomes assessed: H1, H2, H14

MARKING GUIDELINES

Criteria	Marks
One of: • Plate tectonics OR • Continental drift OR • Sea-floor spreading	1

Question 27 (b) (ii) (3 marks)

Outcomes assessed: H1, H2, H14

MARKING GUIDELINES

Criteria	Marks
• Thoroughly explains both the formation and alignment with some correct reference to time	3
EITHER • Thoroughly explains both the formation and alignment but has no reference to time OR • Partly explains both the formation and alignment and has some correct reference to time	2
EITHER • Links existence of a hot-spot and plate motion OR • Relates the change in orientation of the island chain and seamount chain to change in motion of the plate	1

Question 27 (c) (4 marks)

Outcomes assessed: H8, H10, H12, H13

MARKING GUIDELINES

Criteria	Marks
• Correctly describes an appropriate experiment with proper experimental procedures, including the specific points: – control of variables – repetition – measurement and observation	4
• Correctly describes an appropriate experiment including ANY TWO of the specific points	3
• Correctly describes an appropriate experiment including ONE of the specific points	2
• Provides a partial description of an appropriate experiment	1

Question 27 (d) (6 marks)

Outcomes assessed: H1, H2, H4, H13, H14

MARKING GUIDELINES

Criteria	Marks
• Discuss the issues, showing a detailed understanding of the theory and the evidence leading to its acceptance, including some discussion of the initial reservations	5–6
EITHER • Discusses the issues, showing a good understanding of the theory and some understanding of the evidence leading to its acceptance OR • Communicates some understanding of the theory and a good understanding of the evidence leading to its acceptance	3–4
• States some aspects of either the theory *or* the evidence leading to its acceptance	1–2

Question 27 (e) (8 marks)

Outcomes assessed: H1, H4, H8, H13, H14

MARKING GUIDELINES

Criteria	Marks
• Demonstrates extensive knowledge and understanding of how information gathered from seismic observations has led to greater understanding of the structure of the Earth in a coherent way	7–8
• Demonstrates a thorough knowledge and understanding of how information gathered from seismic observations has led to greater understanding of the structure of the Earth	5–6
• Demonstrates a basic knowledge and understanding of how information gathered from seismic observations has led to greater understanding of the structure of the Earth	3–4
• Demonstrates a limited knowledge of the information gathered from seismic observations	1–2

Question 28 (a) (i) (1 mark)

Outcomes assessed: H8, H13

MARKING GUIDELINES

Criteria	Marks
• Correct purpose identified	1

Question 28 (a) (ii) (2 marks)

Outcomes assessed: H8, H13

MARKING GUIDELINES

Criteria	Marks
Describes the role by EITHER • referring to both total internal reflection and that $n_{core} > n_{cladding}$ OR • drawing a well-labelled diagram	2
EITHER • refers to total internal reflection or $n_{core} > n_{cladding}$ OR • draws and unlabelled / poorly-labelled diagram	1

Question 28 (b (i) (1 mark)

Outcomes assessed: H1, H4

MARKING GUIDELINES

Criteria	Marks
• One property correctly identified	1

Question 28 (b) (ii) (3 marks)

Outcomes assessed: H8, H14

MARKING GUIDELINES

Criteria	Marks
EITHER • States that reflection of ultrasound occurs at a boundary between media with dissimilar acoustic impedances • The largest reflected energy results in the biggest signal returned to transducer. This occurs when the acoustic impedances are most dissimilar OR • Correct calculations of reflection coefficients with correct interpretations	3
EITHER • Gives a statement such as "reflection of ultrasound occurs most strongly at a boundary between media with the most dissimilar acoustic impedances" OR • Correct calculations of reflection coefficients without interpretation	2
EITHER • Gives a statement such as "reflection of ultrasound occurs at a boundary between media with dissimilar acoustic impedances" OR • Identifies correct equation and substitutes numbers but does not reach correct answer(s)	1

Question 28 (c) (4 marks)

Outcomes assessed: H8, H12, H13

MARKING GUIDELINES

Criteria	Marks
• Complete description of investigation methods (results) and conclusion	3–4
• Partial description of methods and /or conclusion	1–2

Question 28 (d) (6 marks)

Outcomes assessed: H1, H4, H8, H10, H13, H14

MARKING GUIDELINES

Criteria	Marks
• Demonstrates a thorough knowledge of limitations and advantages of CAT scans as compared to traditional X-rays	5–6
• Demonstrates a basic knowledge of limitations and advantages of CAT scans as compared to traditional X-rays	3–4
• Mentions only one or two limitations or advantages of CAT scans or X-rays	1–2

Question 28 (e) (8 marks)

Outcomes assessed: H1, H4, H9, H13, H14

MARKING GUIDELINES

Criteria	Marks
• Demonstrates an accurate understanding of the physical principles involved: magnetic fields, precession, resonance • Applies this understanding to explain why cancerous cells can be detected using MRI • Presents the information coherently	7–8
• Demonstrates some understanding of the physical principles involved in MRI • Relates this understanding to cancerous cells	5–6
• Demonstrates some understanding of some of the physical principles involved in MRI	3–4
EITHER • Recalls the names of 1 or 2 of the physical principles involved: magnetic fields, precession, resonance OR • Identifies the water content of cancerous cells as their distinguishing feature	1–2

Question 29 (a) (i) (1 mark)

Outcomes assessed: H9

MARKING GUIDELINES

Criteria	Marks
• Correct answer	1

Question 29 (a) (ii) (2 marks)

Outcomes assessed: H7, H8, H9

MARKING GUIDELINES

Criteria	Marks
• Describes the periodic red/blue shift of the spectrum	2
• Mentions the red/blue shift in the spectrum	1

Question 29 (b) (i) (1 mark)

Outcomes assessed: H7

MARKING GUIDELINES

Criteria	Marks
• Correct answer	1

Question 29 (b) (ii) (3 marks)

Outcomes assessed: H7, H8, H14

MARKING GUIDELINES

Criteria	Marks
• Correctly calculates M for both stars • Correctly relates absolute magnitude to brightness • Explains that Deneb's more negative number means it is brighter	3
• Correctly calculates M for ONE star • Correctly relates absolute magnitude to brightness	2
EITHER • Incorrectly calculates M for both stars, and • Correctly relates absolute magnitude to brightness OR • Statement that Deneb has more negative absolute magnitude than Betelgeuse	1

Question 29 (c) (4 marks)

Outcomes assessed: H7, H8, H13, H14

MARKING GUIDELINES

Criteria	Marks
• Identifies the differences and provides correct reasons for those differences	3–4
• Indicates a basic knowledge and understanding of the reasons for the differences	1–2

Question 29 (d) (6 marks)

Outcomes assessed: H1, H4, H7, H13

MARKING GUIDELINES

Criteria	Marks
• Demonstrates a thorough knowledge of recent advances in telescope design. The answer should indicate how these developments led to improvements in the resolution, sensitivity, or cost-effectiveness of telescopes	5–6
• Demonstrates a basic knowledge of recent advances in telescope design. The answer should give some indication as to how these developments led to improvements in the resolution, sensitivity, or cost-effectiveness of telescopes	3–4
• Mentions only one or two recent advances in telescope design	1–2

Question 29 (e) (8 marks)

Outcomes assessed: H1, H3, H7, H13

MARKING GUIDELINES

Criteria	Marks
• In a coherent discussion, demonstrates an extensive knowledge of how the H–R diagram may be used to understand the evolution of stars	7–8
• Demonstrates a thorough knowledge of how the H–R diagram may be used to understand the evolution of stars	5–6
• Demonstrates a sound knowledge of how the H–R diagram may be used to understand the evolution of stars	3–4
• Demonstrates a basic knowledge of how the H–R diagram may be used to understand the evolution of stars	1–2

Question 30 (a) (i) (1 mark)

Outcomes assessed: H10

MARKING GUIDELINES

Criteria	Marks
EITHER • Both nuclear particles named OR • Statement such as "Nucleons are the particles in the nucleus"	1

Question 30 (a) (ii) (2 marks)

Outcomes assessed: H10

MARKING GUIDELINES

Criteria	Marks
• Correctly identifies ONE property and correctly states the difference	2
• Identifies ONE property that differs. (In the case of charge, the charge on ONE particle must be correctly indicated eg. positive or neutral)	1

Question 30 (b) (i) (1 mark)

Outcomes assessed: H7, H8, H10

MARKING GUIDELINES

Criteria	Marks
• Gives correct answer	1

Question 30 (b) (ii) (3 marks)

Outcomes assessed: H7, H8, H10

MARKING GUIDELINES

Criteria	Marks
EITHER • Sketch of energy level diagram with line spacings (approx.) correct; quantum numbers (n = 1-4) and energies of levels identified with some indication of where energy levels lie for $n > 4$ OR • Sketch of energy level diagram, with line spacings (approx.) correct, series limit or location of levels for $n > 4$ identified, but with EITHER quantum numbers OR energies of levels omitted	3
EITHER • Sketch of energy level diagram, with line spacings (approx.) correct , but with EITHER quantum numbers OR energies of levels omitted OR • Sketch of energy level diagram, with line spacings even or similarly inappropriate, but quantum numbers and energies of levels identified	2
EITHER • Sketch of energy level diagram, with line spacings even or similarly inappropriate, and EITHER quantum numbers OR energies of levels omitted OR • Sketch of energy level diagram, with line spacings (approx.) correct , but with NEITHER quantum numbers NOR energies of levels identified	1

Question 30 (c) (4 marks)

Outcomes assessed: H11, H13

MARKING GUIDELINES

Criteria	Marks
• Correctly describes an appropriate experiment with proper experimental procedures, including the specific points: – control of variables – repetition – measurement and observation	4
• Correctly describes an appropriate experiment including ANY TWO of the specific points	3
• Correctly describes an appropriate experiment including ONE of the specific points	2
• Provides a partial description of an appropriate experiment	1

Question 30 (d) (6 marks)

Outcomes assessed: H1, H4, H13

MARKING GUIDELINES

Criteria	Marks
• Demonstrates a thorough knowledge of the positive and negative effects of the Manhattan Project on society	5–6
• Demonstrates a sound knowledge of the positive and negative effects of the Manhattan project on society	3–4
• Mentions only one or two effects of the Manhattan Project on society	1–2

Question 30 (e) (8 marks)

Outcomes assessed: H1, H2, H10, H13, H14

MARKING GUIDELINES

Criteria	Marks
• Answer demonstrates an extensive knowledge of the work of both scientists, expressed in a coherent way, and showing an analysis of how their work contributed to an understanding of the atom	7–8
• Answer includes a thorough description of the work of both scientists, and how their work led to an understanding of the atom	5–6
EITHER • Answer shows a basic knowledge of the work of both scientists OR • Answer demonstrates a sound knowledge of the work of one scientist	3–4
EITHER • Answer shows a limited knowledge of the work of both scientists OR • Answer shows a basic knowledge of the work of one scientist	1–2

Question 31 (a) (i) (1 mark)

Outcomes assessed: H7

MARKING GUIDELINES

Criteria	Marks
• Correct answer	1

Question 31 (a) (ii) (2 marks)

Outcomes assessed: H7

MARKING GUIDELINES

Criteria	Marks
• Mathematical relationship or a statement of that relationship or a graph showing the relationship	2
• Gives a statement such as "Resistance goes down with increasing light level"	1

Question 31 (b) (i) (1 mark)

Outcomes assessed: H2

MARKING GUIDELINES

Criteria	Marks
• Provides an explanation of the function of the 500 kΩ resistor	1

Question 31 (b) (ii) (3 marks)

Outcomes assessed: H4, H9, H14

MARKING GUIDELINES

Criteria	Marks
• Correct output voltage (sign must be correct)	3
• Uses a correct calculation method, but gets wrong answer	2
EITHER • Statement about virtual earth OR • At least ONE step in derivation	1

Question 31 (c) (4 marks)

Outcomes assessed: H9, H13

MARKING GUIDELINES

Criteria	Marks
• Table all correct	4
• Output from 3 of the 4 gates correct, consistent with whatever error has been made	3
• Output from 2 gates correct, consistent with other errors	2
• Output from 1 gate correct, consistent with other errors	1

Question 31 (d) (6 marks)

Outcomes assessed: H3, H4, H9, H13, H14

MARKING GUIDELINES

Criteria	Marks
• Demonstrates a thorough knowledge of limitations to the growth of computer power and how they arise. Mentions alternative(s) to current technologies.	5–6
• Demonstrates a basic knowledge of limitations to the growth of computer power and reasons (may mention alternative technologies)	3–4
EITHER • Mentions only a few limitations, OR • Discusses computing power in terms of either speed or memory only	1–2

Question 31 (e) (8 marks)

Outcomes assessed: H1, H4, H9, H13

MARKING GUIDELINES

Criteria	Marks
• Demonstrates an extensive knowledge and describes a number of key developments in electronics and discusses, discussing their social impacts in a coherent way	7–8
• Demonstrates a thorough knowledge and describes some of the key developments in electronics and discusses their social impacts	5–6
• Demonstrates a sound understanding of the way in which electronics has affected society, but mentions only a few examples of developments in electronics or does not have a coherent discussion	3–4
• Provides only a couple of examples of developments in electronics or provides a cursory discussion of their social impact or does not make clear the impacts on society	1–2