2006 HSC Notes from the Marking Centre Physics

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GPO Box 5300
Sydney 2001
Australia

Tel: (02) 9367 8111
Fax: (02) 9367 8484
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2006 HSC NOTES FROM THE MARKING 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 some questions in the 2006 Higher School Certificate Examination, indicating the quality of candidate responses and highlighting the relative strengths and weaknesses of the candidature in each section.

This document should be read along with the relevant syllabus, the 2006 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

In 2006, 9116 candidates attempted the Physics examination. The most popular options were From Quanta to Quarks (43.5%) and Medical Physics (27%).

Teachers and candidates should be aware that examiners may write 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, including the Prescribed Focus Areas. 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. It is important to understand that the Preliminary HSC course is assumed knowledge for the HSC course.

In 2006, at least one question in Section I Part B and one part of the Section II option questions focused on the mandatory skills content in Module 9.1. Candidates who had actively planned and performed practical experiences clearly demonstrated a deeper knowledge and understanding of the content described in this module.

Overall, the level of understanding of Physics concepts indicated by the responses was appropriate for most HSC candidates. Candidates need to be reminded that the answer space provided and the marks allocated are guides to the maximum length of response required. Similarly, the key word used in the question gives an indication of the depth of the required response. Candidates should use examination time to analyse the question and plan responses carefully, working within that framework to produce clear and concise responses. Responses may include the use of dot points, diagrams and/or tables, and should avoid internal contradictions. This is particularly so in holistic questions which need to be logical and well-structured. There was evidence that some candidates had a very poor knowledge of basic definitions specific to terminology associated with the course.

Better responses indicate that candidates had followed the instructions provided on the examination paper. In these responses candidates:

- set out all working for numerical questions
- thought carefully about the units to be used and the quantities to be substituted into formulae

- did not repeat the question as part of the response
- looked at the structure of the whole question and noted that in some questions the parts follow from each other ie responses in part (a) lead to the required response in part (b) etc
- used appropriate equipment, for example, pencils and a ruler to draw diagrams and graphs. (A clear plastic ruler helps candidates to plot points that are further from the axes and rule straight lines of best fit.)

In Section II the option question is divided into a number of parts. Candidates should clearly label each part of the question when writing in their answer booklets. In part (c) of the 2006 option questions the best responses presented ideas coherently and included the correct use of scientific principles and ideas. Many candidates wrote a lot of information that was not relevant to the question. Some responses showed evidence of rote learning of an anticipated answer based on a single source. These responses did not address the syllabus content and/or outcomes being assessed and hence did not score full marks. Candidates are required to attempt one question only in Section II, but some candidates responded to more than one option question. Candidates are strongly advised to answer the option they have studied in class.

Section I – Core

Part A – Multiple choice

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

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

Part B

Question 16

(a) Better responses displayed recognition of the vector nature of velocity and gave both magnitude and direction in the answer.

(b) Better responses used Pythagoras' theorem to calculate the initial velocity.

(c) Better responses used the relevant equation, correctly substituted data, and identified the directions of the vector quantities involved.

Question 17

Better responses focused on the forces on the spacecraft rather than on the astronauts and provided the analysis of two parts – geostationary orbit and re-entry. These responses clearly indicated that the centripetal force needed to maintain a stable orbit is provided by the gravitational force between the earth and the spacecraft and that the two forces do not cancel each other out. Better responses also described some of the forces involved in re-entry and explained their effects on the motion of the spacecraft.

Sample response:

During stationary orbit, the spacecraft travels at a constant speed in orbit around the Earth. The Earth's gravity provides the centripetal force for the spacecraft's orbit. In order to return to Earth, the spacecraft must decelerate by firing its boosters in the opposite direction of motion. This creates a force to slow the speed of the spacecraft and hence reduce its energy. When the energy is reduced, its radius of orbit must also decrease since the two are related so the spacecraft descends. The particles in the upper atmosphere provide a friction force opposite to the direction of motion of the craft, slowing it down further which lowers its orbit and increases the friction. Gravity pulls the spacecraft back to Earth where the craft can land.

Question 18

Better responses recognised the inverse relationship between E_p and r in the formula, and used ratios to logically determine the absolute value of E_{p3} and subtract it from 1MJ.

Question 19

The better responses described the motor effect clearly, and then outlined the effect and/or relationship of each component in the diagram on the galvanometer in a logical and concise way.

Question 20

The best responses plotted the data correctly, extracted data using the line of best fit, and demonstrated a clear understanding of the forces involved as well as their relationship to the graphical data.

Question 21

Most candidates were able to describe the impacts of identified applications on society and the environment. In the better responses, candidates indicated that they understood the significance of the word 'potential' and also made a clear judgement of the impacts. The more concise of these responses took less space than that provided in the question paper. A common misconception was that the Meisner effect is related to the use of superconductors in Maglev trains.

The following examples illustrate some of the different ways in which students structured their responses.

Sample response 1:

	Applications	*Advantages*	*Disadvantages*
Maglev Trains	*Society*	• *frictionless form of transport allowing super fast speeds*	• *the costs of implementation are detrimental* • *maintenance is a problem*
	Environment	• *does not use fossil fuels to provide transport*	• *the superconductors must be kept at a critical temperature which is difficult to maintain and uses a large amount of energy*
Energy Supply	*Society*	• *allows for large scale distribution of energy without power loss as there is no resistance in cables*	• *replacement of manual labour causing unemployment* • *lack of technology to maintain a large distribution grid*
	Environment	• *power lines are unaesthetic*	• *large amounts of energy used to keep cables at critical temperatures* • *costs and wastage of materials in creating cables for large scale supply*

Despite the obvious benefit of using superconductors because of their magnetic and conducting properties, potential applications are prohibited by the costs involved in implementation. Also, we lack the technology to implement all potential applications, however it may be possible in the future. Overall the large scale use of Maglev trains and superconducting power grids is advantageous to both society and the environment.

Sample response 2:

Application of superconductor	*Impact on Society*	*Impact on environment*	*Assessment*
Maglev trains	• *Provides faster, more energy-efficient transport* • *More expensive to build - i.e. higher fares*	• *Less use of fossil fuels to power train, therefore less random emissions* • *Less coal needs to be mined for power stations*	*Beneficial to both society and environment – however is costly*
Transporting electricity	• *More efficient transportation* • *Zero power losses* • *Safer as DC is used* • *No need to have expensive transformers* • *Cheaper to transport* • *Smaller cables means more aesthetic benefits*	• *Less fossil fuels emitted into atmosphere – therefore, less air pollution* • *Reduced likelihood of acid rain*	*Beneficial to society as a cheaper, more efficient transportation takes place, less harm to society in the form of pollution*
Superconducting generation of power	• *More efficient power production* • *No need for AC and transformers* • *Cheaper electricity* • *Cleaner energy*	• *No fossil fuels used for power generation*	*Less environmental impacts, society gets cheaper energy*

Sample response 3:

Impacts on society and the environment

	Positive	*Negative*
Society	*Faster transit eg Maglev trains* *Scientific research – more powerful synchotrons*	
Environment	*Decreased fossil fuel dependence from for example Maglev trains.* *Less voltage required for a good electromagnet so less power needs to be generated, so less fossil fuels burnt.*	*More cooling, and therefore more power needed in many cases – for example many modern superconductors must be cooled with liquid helium. Fossil fuels are burnt to manufacture this.*

From the table, it is clear that overall, the potential applications of superconductors have a positive impact on society and the environment.

Question 22

(a) In most responses an attempt was made to include a 'cause and effect' relationship between the motion of the magnet and induced currents. In better responses there was a clear link between the resultant force and the interaction of the magnetic fields.

(b) A number of responses incorrectly identified that -50^{o}C was below the critical temperature of copper and incorrectly responded in terms of superconductivity.

Question 23

(a) Better responses showed the conductor with overlapping bands, using either labels or shading to show this, as well as indicating the appropriate energy gaps in semiconductors and insulators.

(b) Some better responses used tables to answer this part of the question.

Sample response:

Insulators	*Semiconductors*	*Conductors*
High electrical resistance as large amounts of energy are required to move electrons into conduction band, shown in large gap.	*Medium resistance as the energy gap is smaller and therefore less energy needed to move electrons across it.*	*Low resistance – in diagram it shows that the valence band is the same as the conduction band.*

(c) Better responses gave concise explanations of the relationship between the change in R and the dopant without referring to temperature change. Wordy responses often led to contradictions within the response.

Question 24

Better responses included more than one origin of unwanted heat production and linked a method of overcoming the problem with each of the sources of the heat production.

Sample response:

> *In transformers the soft iron core can have eddy currents induced in it due to the changing magnetic fields, producing heat. This is overcome through using laminations in between layers of soft iron in the core, making eddy currents. The resistance within the wires of the coils can also produce heat. This is overcome by using thicker wires (although this can increase current) or a coolant such as oil or water.*

Question 25

(a) Better responses clearly indicated the main features of the role of the deflecting plates and electrodes in the electron gun separately and provided additional information to that available from the stimulus material.

(c) The better responses manipulated the equation to provide a correct interpretation about the frame of reference.

Section II – Options

Question 28

(d) (ii) The majority of candidates who correctly applied the scale to determine distance and time values were able to establish the correct sea floor spreading rate.

Question 29

(a) (i) In the better responses, the calculations included the order of magnitude for acoustic impedance provided in the heading of the table.

(a) (ii) Better responses identified the significance of the similarity in acoustic impedance between gel and skin, calculated Ir/Io values for both interfaces and used the results of the calculation to describe the amount of ultrasound that penetrated into the body.

(b) (ii) Better responses identified the importance of increased water in cancerous tissue and described how MRI detects the presence of hydrogen nuclei.

(c) Better responses had a value statement affirming the positive effects of our understanding of the electromagnetic spectrum on the development of medical imaging technologies and related techniques together with a statement connecting each particular technique with the part of the electromagnetic spectrum upon which it relied.

(d) (ii) In some of the better responses information was represented in a table format demonstrating a clear comparison and understanding of the two techniques.

(d) (iii)Better responses identified the differences in the three techniques and the resulting differences in the data obtained. Representing the differences in a table format provided responses that were clear and unambiguous.

Question 30

(a) (i) Better responses correctly identified Doppler shifts involving two stars as occurring simultaneously and periodically.

(a) (ii) Better responses calculated the required distance by correctly identifying the period of the binary from the graph and also by using correct time units.

(b) (ii) Better responses described the appearance of the absorption spectrum of a star, in terms of dark spectral lines upon a continuum spectrum. The best responses explained their occurrence in terms of atomic electrons absorbing specific photons from the continuum spectrum emitted by the stellar core in order to ‘jump’ to higher-energy orbits.

(c) Most responses were able to give some technological advances and their benefits. Better responses clearly explained how these benefits lead to a better understanding of the cosmos.

Many responses demonstrated difficulty in relating the technological advances to an understanding of the cosmos suggesting that candidates are concentrating too much on individual 'dot points' and neglecting to synthesise the knowledge and understanding gained from the study of the option as a whole.

Question 31

(a) (i) In the best responses, candidates demonstrated an understanding of the information given at the beginning of the question regarding the energy of the photons to give a physical reason for the table being blank.

(ii) Better responses showed working that followed a logical sequence of several calculations to arrive at the correct answer.

(b) (ii) Better responses showed evidence of planning.

(c) The best responses were able to identify the source of nuclear energy in the mass defect from the equation and related this to the technology of the nuclear fission reactor to control the neutron numbers in the resulting chain reaction.

Most responses showed some understanding of the structure of the nuclear reactor in its role of providing useable thermal energy.

(d) (i) Better responses indicated a familiarity with the operation of the cyclotron and correctly identified that the alternating current caused the increase in speed of the charged particle and the magnetic field caused centripetal force on the particle.

(d) (ii) Better responses gave clear reasons to show how the cyclotron has added to our understanding of matter.

Question 32

(b) (i) Better responses provided evidence that candidates had carefully read the question and had structured their responses accordingly.

(b) (ii) Better responses clearly identified the resulting changes after each gate in the truth table.

(d) (ii) Better responses demonstrated that data had been accurately read from the graph.

(iii) Better responses demonstrated an understanding of the structure and function of a feedback amplifier using an operational amplifier as well as demonstrating the way this was to be linked to other devices.

Physics

2006 HSC Examination Mapping Grid

Question	Marks	Content	Syllabus outcomes
Section I Part A			
1	1	9.2.1.2.1, 9.2.1.2.3	H6, H7
2	1	9.2.2.2.8, 14.1 (a)	H6, H14
3	1	9.2.4.2.3, 9.2.4.3.1	H6
4	1	9.2.2.2.1, 14.1 (a)	H6, H9, H14
5	1	9.2.2.3.5, 9.2.2.2.10, 12.4 (b)	H6, H12
6	1	9.3.1.2.5	H9
7	1	9.1.2.1, 9.3.1.3.3, 12.4 (b)	H7, H9, H12
8	1	9.3.2.2.3, 14.1 (a)	H9, H14
9	1	9.3.3.2.1	H7
10	1	9.3.4.2.2, 14.3 (d)	H7, H14
11	1	9.4.4.2.1	H8, H10
12	1	9.4.1.2.3	H9
13	1	9.4.4.2.3	H7, H10
14	1	9.4.1.2.7, 9.4.1.3.3, 12.4 (b)	H7, H12
15	1	9.4.2.2.1, 12.3 (c)	H10, H12
Section I Part B			
16 (a)	1	9.2.2.3.1	H6, H9
16 (b)	1	9.2.2.3.2, 12.4 (b)	H6, H9, H12
16 (c)	2	9.2.2.3.2, 12.4 (b)	H6, H9, H12
16 (d)	2	9.2.2.3.2, 12.4 (b)	H6, H9, H12
17	6	8.4.2.2.10, 9.2.2.2.8, 9.2.2.2.9	H7, H9
18	3	9.2.1.2.2, 9.2.1.2.3, 12.4 (b)	H6, H12
19	3	9.3.1.2.4, 9.3.1.3.5	H7, H9

Question	Marks	Content	Syllabus outcomes
20 (a)	2	9.3.1.2.2, 12.3 (c)	H9, H12
20 (b)	2	9.3.1.2.2, 13.1 (f), (g)	H9, H13
20 (c)	1	9.3.1.2.4, 12.3 (c)	H9, H12
20 (d)	3	9.3.1.2.5, 12.4 (d)	H9, H12
21	6	9.4.4.2.7, 9.4.4.3.5, 9.4.3	H3, H4
22 (a)	3	9.3.2.2.5	H7, H9
22 (b)	2	9.3.2.2.7, 9.4.4.2.5, 14.1 (d)	H7, H9, H14
23 (a)	2	9.4.3.2.2, 13.1 (e)	H9, H13
23 (b)	2	9.4.3.2.2	H9
23 (c)	2	9.4.3.2.6	H9
24	3	9.3.4.3.3, 9.3.4.3.4	H6, H7, H9
25 (a)	2	9.4.1.2.9	H7, H9
25 (b)	2	9.2.4.3.5, 12.4 (b)	H6, H12
25 (c)	2	9.2.4.3.5, 12.4 (b)	H6, H12
26	4	9.4.2.2.3, 9.4.2.2.4, 9.4.2	H2, H8, H9
27 (a)	2	9.4.1.3.2, 11.3 (b)	H10
27 (b)	2	9.4.1.2.1, 9.4.1.3.2, 11.3 (b)	H10, H11
Section II **Question 28 — Geophysics**			
28 (a) (i)	1	9.5.2.2.6, 9.5.2.2.7	H9
28 (a) (ii)	4	9.5.2.2.8, 9.5.2.3.5, 12.3 (c), 13.1 (e)	H12, H13
28 (b) (i)	2	9.5.3, 11.2 (d)	H11
28 (b) (ii)	4	9.5.3.2.2, 9.5.3.2.3, 14.1 (a)	H8, H14
28 (c)	7	9.5.1.2.2, 9.5.2.2.1, 9.5.2.2.9, 9.5.3.2.5, 9.5.3.2.7, 9.5.4.2.2, 14.3 (b)	H1, H2, H3, H14
28 (d) (i)	4	9.5.4.2.1, 9.5.4.2.2, 9.5.4.2.3, 12.3 (c), 14.1 (c)	H9, H12, H14
28 (d) (ii)	3	9.5.4.3.2, 12.4 (b), 14.1 (a), (f)	H12, H14

Question	Marks	Content	Syllabus outcomes
Section II Question 29 — Medical Physics			
29 (a) (i)	2	9.6.1.3.5	H8
29 (a) (ii)	3	9.6.1.2.3, 9.6.1.2.4, 9.6.1.2.6, 12.4 (b)	H3, H12
29 (b) (i)	3	9.6.4.3.1, 9.6.4.3.2, 11.1 (a), 11.2 (d), 11.3 (c), 12.3 (a)	H11, H12
29 (b) (ii)	3	9.6.4.3.2, 9.6.4.3.3	H8, H9
29 (c)	7	9.6.2, 9.6.3.2.5, 9.6.4.3.5, 14.3 (b)	H3, H9, H14
29 (d) (i)	1	9.6.2.3.4, 9.6.2.2.3, 12.3 (c)	H3, H12
29 (d) (ii)	3	9.6.2.2.4	H3, H10
29 (d) (iii)	3	9.6.2.3.2, 9.6.3.3.1, 14.1 (a)	H3, H14
Section II Question 30 — Astrophysics			
30 (a) (i)	2	9.7.5.2.1	H8
30 (a) (ii)	3	9.7.5.3.2	H8, H9
30 (b) (i)	2	9.7.3.3.1, 11.2 (d)	H11
30 (b) (ii)	4	9.7.3.2.5	H10
30 (c)	7	9.7.1, 9.7.3, 9.7.4, 14.3 (b)	H3, H10, H14
30 (d) (i)	3	9.7.6.2.3, 9.7.6.3.2	H9
30 (d) (ii)	2	9.7.6.3.2, 12.3 (c)	H9, H12
30 (d) (iii)	2	9.7.6.2.2, 14.1 (a), 14.3 (c)	H9, H14
Section II Question 31 — From Quanta to Quarks			
31 (a) (i)	1	9.8.1.2.2	H9, H10
31 (a) (ii)	4	9.8.1.3.3, 12.4 (d), (e)	H9, H10, H12
31 (b) (i)	2	9.8.2.3.2, 11.1 (a), (c), 12.3 (a), 12.4 (b)	H11, H12
31 (b) (ii)	4	9.8.2.3.2, 9.3.3.2.6	H1, H2, H10
31 (c)	7	9.8.3.2.3, 9.8.3.2.9, 9.8.3.3.2, 9.8.3.2.11, 9.8.4.2.1, 14.3.(b)	H4, H7, H14
31 (d) (i)	3	9.8.4.2.4, 12.3 (c), 14.1 (g)	H6, H7, H9, H12, H14
31 (d) (ii)	2	9.8.4.2.4	H6, H9

Question	Marks	Content	Syllabus outcomes
31 (d) (iii)	2	9.8.4.2.5, 12.3 (c)	H10, H12
Section II **Question 32 — The Age of Silicon**			
32 (a) (i)	2	9.9.4.2.3	H7
32 (a) (ii)	3	9.9.4.2.3, 9.9.4.3.3, 12.4 (b)	H7, H12
32 (b) (i)	3	9.9.5.3.2, 11.1 (a), 11.2 (d), 11.3 (c), 12.3 (a)	H11, H12
32 (b) (ii)	4	9.9.5.3.2	H12
32 (c)	7	9.9.1.2.2, 9.9.1.2.3, 9.9.1.3.1, 9.7, 14.3 (b)	H5, H7, H14
32 (d) (i)	1	9.9.3.2.5, 12.3 (c)	H7, H12
32 (d) (ii)	2	9.9.3.2.4, 12.3	H7, H12
32 (d) (iii)	4	9.9.6.2.3, 9.9.6.2.4, 9.9.6.3.3, 13.1 (e)	H7, H13

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2006 HSC Physics
Marking Guidelines

Section I, Part B

Question 16 (a)

Outcomes assessed: H6, H9

MARKING GUIDELINES

Criteria	Marks
• Gives correct answer	1

Question 16 (b)

Outcomes assessed: H6, H9, H12

MARKING GUIDELINES

Criteria	Marks
• Correctly determines magnitude of initial velocity	1

Question 16 (c)

Outcomes assessed: H6, H9, H12

MARKING GUIDELINES

Criteria	Marks
• Correctly calculates maximum height	2
• Identifies the equation(s) required but uses them incorrectly OR • Calculates time to reach maximum height, but does not correctly determine the height	1

Question 16 (d)

Outcomes assessed: H6, H9, H12

MARKING GUIDELINES

Criteria	Marks
• Correctly determines the range	2
• Correctly determines time of flight but not the range OR • Identifies the equation(s) required to produce the correct answer	1

Question 17

Outcomes assessed: H7, H9

MARKING GUIDELINES

Criteria	Marks
• Describes forces both during stable orbit and upon re-entry, and relates these to the result	5–6
• Describes forces either during stable orbit or upon re-entry, and relates to the result	3–4
• Identifies forces both during stable orbit and upon re-entry but does not relate them to the result	2
• Identifies one of the forces during stable orbit or upon re-entry	1

Question 18

Outcomes assessed: H6, H12

MARKING GUIDELINES

Criteria	Marks
• Demonstrates appropriate problem solving techniques to completion	3
• Calculates GPE at any of satellite positions OR • Calculates value of Gm_1m_2	2
• Identifies correct equation OR • Recognises W= ΔGPE	1

Question 19

Outcomes assessed: H7, H9

MARKING GUIDELINES

Criteria	Marks
• Describes how the components interact to enable the meter to operate including reference to the motor effect	3
• Correctly describes purpose of some components and origin of motor effect, but does not discuss radial field, constant torque, or linear scale	2
• Describes function of only ONE component of galvanometer	1

Question 20 (a)

Outcomes assessed: H9, H12

MARKING GUIDELINES

Criteria	Marks
• Identifies current directions and justifies answer	2
• Identifies directions but does not justify OR • Explains observations but chooses the incorrect direction of current flow	1

Question 20 (b)

Outcomes assessed: H9, H13

MARKING GUIDELINES

Criteria	Marks
• Correctly plots data and draws an appropriate trend line/line of best fit	2
• Correctly plots data but does not draw a trend line/line of best fit OR • Incorrectly plots data but draws a plausible trend line/line of best fit	1

Question 20 (c)

Outcomes assessed: H9, H12

MARKING GUIDELINES

Criteria	Marks
• Correctly finds mass	1

Question 20 (d)

Outcomes assessed: H9, H12

MARKING GUIDELINES

Criteria	Marks
• Correctly determines slope of trend line or uses an appropriate data point, identifies force relationship formula, substitutes constant values, and determines value of separation	3
• Identifies force relationship formula and determines slope of trend line but goes no further	2
• Identifies force relationship formula	1

Question 21

Outcomes assessed: H3, H4

MARKING GUIDELINES

Criteria	Marks
• Identifies at least two applications. For at least two describes at least one impact on society and/or the environment • Makes a value statement with respect to at least two impacts identified	5–6
• Identifies at least two applications. For at least two describes an impact on society and/or the environment	3–4
• Identifies at least two applications OR • Identifies one application and an impact	2
• Identifies an application OR • Identifies an impact	1

Question 22 (a)

Outcomes assessed: H7, H9

MARKING GUIDELINES

Criteria	Marks
• Explains the creation of eddy currents and their effects	3
• Identifies the presence of eddy currents and their effect on the motion of the magnet	2
• Identifies eddy currents OR • Identifies Lenz's law OR • Attributes the motion solely to gravity	1

Question 22 (b)

Outcomes assessed: H7, H9, H14

MARKING GUIDELINES

Criteria	Marks
• Identifies that the magnet slows down more than in a) due to a reduction in temperature causing a decrease in resistance of the copper, thus producing larger currents in eddy loops; the larger currents have a stronger magnetic field associated with them, causing the magnet to slow down more than at room temperature	2
• Identifies that the magnet slows down more than in part (a)	1

Question 23 (a)

Outcomes assessed: H9, H13

MARKING GUIDELINES

Criteria	Marks
• Diagrams have conduction and valence bands, and a suitable gap between	2
• Diagrams illustrate the gap without mentioning bands OR • Indicates bands with incorrect gaps	1

Question 23 (b)

Outcomes assessed: H9

MARKING GUIDELINES

Criteria	Marks
• Refers to diagrams and correctly links to resistance for all three	2
• Refers to diagrams and correctly links to resistance for one or two of the cases OR • Describes generally the difference in R between conductors, semiconductors and insulators without reference to the diagram OR • Refers differences in diagrams without reference to conductors, semiconductors or insulators	1

Question 23 (c)

Outcomes assessed: H9

MARKING GUIDELINES

Criteria	Marks
• Identifies that changes occur when semiconductors are doped this way, and refers to difference in number of valence electrons between impurity and host material, relating this to a decrease in resistance	2
• Identifies that doping changes the number of electrons or holes, but does not explain how this relates to resistance	1

Question 24

Outcomes assessed: H6, H7, H9

MARKING GUIDELINES

Criteria	Marks
• Two valid strategies discussed	3
• Clearly links AC current and/or change in flux, eddy currents and heat OR • Links heat production to resistance to current flowing in the primary and secondary coils OR • Links eddy currents to heat and identifies two strategies OR • Links eddy currents to heat and describes a valid strategy	2
• States eddy current production OR • States heating in windings due to current flow OR • Outlines a strategy for heat reduction	1

Question 25 (a)

Outcomes assessed: H7, H9

MARKING GUIDELINES

Criteria	Marks
• Correctly outlines roles of the deflection plates and the electrodes in the electron gun	2
• Correctly outlines role of either the deflection plates or the electrodes in the electron gun	1

Question 25 (b)

Outcomes assessed: H6, H12

MARKING GUIDELINES

Criteria	Marks
• Correctly identifies and substitutes data into equation	2
• Identifies correct equation	1

Question 25 (c)

Outcomes assessed: H6, H12

MARKING GUIDELINES

Criteria	Marks
• Correctly identifies and substitutes data into equation	2
• Identifies correct equation	1

Question 26

Outcomes assessed: H2, H8, H9

MARKING GUIDELINES

Criteria	Marks
• Explains the components of scientists' methods in relation to testing and validating a model and uses specific information relating to investigations into black body radiation and photoelectric effect	4
• Explains the components of scientists' methods in relation to testing and/or validating a model refers briefly to information relating to black body radiation or photoelectric effect	3
• Describes scientists' methods with no reference to black body radiation or photoelectric effect OR • Describes black body radiation and photoelectric effect	2
• Outlines methods used by scientists OR • Describes either black body radiation or photoelectric effect	1

Question 27 (a)

Outcomes assessed: H10

MARKING GUIDELINES

Criteria	Marks
• Describes valid observation	2
• States procedure without describing effect	1

Question 27 (b)

Outcomes assessed: H10, H11

MARKING GUIDELINES

Criteria	Marks
• Identifies one valid hazard and offers relevant safe work practice	2
• Identifies one valid hazard	1

Section II

Question 28 (a) (i)

Outcomes assessed: H9

MARKING GUIDELINES

Criteria	Marks
• States the role of the correction factor	1

Question 28 (a) (ii)

Outcomes assessed: H12, H13

MARKING GUIDELINES

Criteria	Marks
• Makes a suitable inference about the geology of the survey data • Produces a table that correctly applies the three corrections to correctly reduce the gravity data for Stations B and C to produce the required gravity anomalies	4
• Makes a suitable inference about the geology of the survey data, and • Produces a data table that correctly applies two of the corrections to the gravity data but does not correctly apply the other OR • Produces a data table that correctly reduces data for either Station B or Station C	3
• Produces a data table that correctly applies the three corrections to correctly reduce the gravity data for Stations B and C to produce the required gravity anomalies OR • Makes a suitable inference about the geology of the survey data, and • Produces a data table that correctly applies at least one correction to both Stations B and C OR • Produces a data table that correctly applies at least two corrections to either Station B or C	2
• Produces a data table that correctly applies at least one correction to both Stations B and C OR • Produces a data table that correctly applies at least two corrections to either Stations B and C OR • Makes a suitable inference about the geology of the survey data	1

Question 28 (b) (i)

Outcomes assessed: H11

MARKING GUIDELINES

Criteria	Marks
• Provides features of the procedure that increases reliability OR • Provides one feature of the procedure that increases reliability and provides a good description of the process	2
• Provides one feature of the procedure that increases reliability	1

Question 28 (b) (ii)

Outcomes assessed: H8, H14

MARKING GUIDELINES

Criteria	Marks
• States that all waves follow a curved path because the density of the medium changes • Explains that S-type waves do not propagate through liquids because they are transverse waves • Explains that P-type waves do propagate through liquids because they are compression waves	4
• States that all waves follow a curved path because the density of the medium changes, and EITHER • Explains that S-type waves do not propagate through liquids because they are transverse waves OR • Explains that P-type waves do propagate through liquids because they are compression waves	3
• Explains that S-type waves do not propagate through liquids because they are transverse waves, and • Explains that P-type waves do not propagate through liquids because they are compression waves OR • States that the wave path is curved because the density of the medium changes, and • States P-type waves do propagate through liquids or states that S-type waves do not propagate through liquids	2
• States that the wave path is curved because the density of the medium changes OR • States that S-type waves do not propagate through liquids OR • States that P-type waves do propagate through liquids OR • States that outer core is liquid	1

Question 28 (c)

Outcomes assessed: H1, H2, H3, H14

MARKING GUIDELINES

Criteria	Marks
• Makes a value judgement regarding our changing understanding of Earth's geology and supports this with a detailed description of the impact of technical developments on at least two geophysical methods • Provides a response that demonstrates coherence and logical progression and includes correct use of scientific principles and ideas	7
• Makes a judgement regarding our changing understanding of Earth's geology and supports this with a detailed description of the impact of technical developments on at least two geophysical methods	5–6
• Describes the geophysical methods , and • Shows the development of one method OR • Shows the impact of one method regarding our changing understanding of the Earth's geology	3–4
• Describes a geophysical method OR • Recalls the names of two geophysical methods	1–2

Question 28 (d) (i)

Outcomes assessed: H9, H12, H14

MARKING GUIDELINES

Criteria	Marks
• Describes how an ancient imposed magnetic alignment and the Earth's current magnetic field can interact to produce either a positive (OR negative) anomaly, and indicates that the Earth's magnetic field reverses over time, and indicates that a spreading seabed will produce a pattern of magnetic anomalies	4
• Describes how an ancient imposed magnetic alignment and the Earth's current magnetic field can interact to produce either a positive (OR negative) anomaly • Indicates that the Earth's magnetic field reverses over time OR indicates how the seabed spreads to produce a pattern of magnetic anomalies	3
• Describes how an ancient imposed magnetic alignment and the Earth's current magnetic field can interact to produce either a positive or negative anomaly OR • Describes how a magnetic alignment can form in a cooling volcanic rock and indicates that the Earth's magnetic field reverses over time	2
• Identifies a magnetic anomaly as an area of different magnetic field strength OR • Identifies that igneous extruded rocks have ferromagnetic minerals OR • Identifies that the Earth's magnetic field reverses over time	1

Question 28 (d) (ii)

Outcomes assessed: H12, H14

MARKING GUIDELINES

Criteria	Marks
• Correctly calculates the rate of sea-floor spreading using the specified units	3
• Identifies the position of a magnetic polarity reversal from the magnetic anomaly profile • Identifies the age of the identified magnetic polarity reversal from the magnetic polarity time scale	2
• Identifies the position of a magnetic polarity reversal from the magnetic anomaly profile OR • Identifies the age of the identified magnetic polarity reversal from the magnetic polarity time scale	1

Question 29 (a) (i)

Outcomes assessed: H8

MARKING GUIDELINES

Criteria	Marks
• Correctly identifies and substitutes data into appropriate equation	2
• Identifies correct equation	1

Question 29 (a) (ii)

Outcomes assessed: H3, H12

MARKING GUIDELINES

Criteria	Marks
• Explains reasons including supporting calculations	3
• Explains reasons with reference to only two values OR • Performs appropriate calculations without any explanation	2
• Identifies two values as giving indication of reflection OR • Explains without calculations/values	1

Question 29 (b) (i)

Outcomes assessed: H11, H12

MARKING GUIDELINES

Criteria	Marks
• Provides characteristics and features of at least two appropriate criteria	3
• Lists at least two appropriate criteria and provides a basic description of both	2
• Lists at least two appropriate criteria OR • Describes one appropriate criterion	1

Question 29 (b) (ii)

Outcomes assessed: H8, H9

MARKING GUIDELINES

Criteria	Marks
• Describes how cancerous tissue is detected, with reference to MRI process and water content of tumour	3
• Describes MRI process OR • Outlines MRI process with reference to water content of tumour	2
• Outlines MRI process OR • States tumour has higher water content	1

Question 29 (c)

Outcomes assessed: H3, H9, H14

MARKING GUIDELINES

Criteria	Marks
• Assesses impact of advances including clear value statement and comprehensive supporting discussion referring to CAT scan, PET scan, endoscopy and MRI • Provides a response that demonstrates coherence and logical progression and includes correct use of scientific principles and ideas	7
• Comprehensive discussion of uses of EMR in medical imaging	5–6
• Assesses impact with value statement and minimal discussion (referring to 1/4 of CAT scan, PET scan, endoscopy and MRI) OR • Discussion of only a limited number of uses of EMR in medical imaging (referring to 3/4 of CAT scan, PET scan, endoscopy and MRI) without value statement	4
• Discusses impact in detail and no reference to EMR OR • Discussion of uses of EMR in medical imaging (referring to 2/4 of CAT scan, PET scan, endoscopy and MRI) without value statement	3
• Describes impact without reference to EMR OR • Describes one use or EMR in medical imaging	2
• Single value statement OR • Any correct relevant fact	1

Question 29 (d) (i)

Outcomes assessed: H3, H12

MARKING GUIDELINES

Criteria	Marks
• Correctly identifies all three images	1

Question 29 (d) (ii)

Outcomes assessed: H3, H10

MARKING GUIDELINES

Criteria	Marks
• Compares in detail advantages/disadvantages	3
• Identifies one advantage and one disadvantage of CAT scans over X-rays OR • Identifies two advantages OR • Identifies two disadvantages OR • Compares in detail one disadvantage/advantage	2
• Identifies one advantage or one disadvantage of CAT scans over X-rays	1

Question 29 (d) (iii)

Outcomes assessed: H3, H14

MARKING GUIDELINES

Criteria	Marks
• Contrasts bone scan to X-rays/CAT scans in more than one area (eg, resolution, nature of information) by describing differences or in table format	3
• Compares bone scan to X-ray/CAT scan in one area by describing differences or in table format	2
• States one difference between bone scan and X-ray/CAT scan	1

Question 30 (a) (i)

Outcomes assessed: H8

MARKING GUIDELINES

Criteria	Marks
• Describes observations specifically	2
• Provides a general statement referring to Doppler shift effect OR • Identifies red and blue shift	1

Question 30 (a) (ii)

Outcomes assessed: H8, H9

MARKING GUIDELINES

Criteria	Marks
• Correctly calculates distance	3
• Identifies correct formula and substitutes appropriate values which may be in incorrect units	2
• Identifies correct formula OR • Determines period	1

Question 30 (b) (i)

Outcomes assessed: H11

MARKING GUIDELINES

Criteria	Marks
• Provides features of the procedure that increases reliability	2
• Provides one feature of the procedure that increases reliability	1

Question 30 (b) (ii)

Outcomes assessed: H10

MARKING GUIDELINES

Criteria	Marks
• Describes an absorption spectrum and explains its production in stars involving e^- transitions • Uses the description of the spectrum to explain how the composition may be determined	4
• Describes an absorption spectrum and how it is produced, and • Identifies how a feature is used to determine composition OR • Describes an absorption spectrum, and • Gives a full description of how it is used to determine a star's composition	3
• Describes an absorption spectrum OR • Identifies how a feature is used to determine a star's composition OR • Explains how one feature is produced	2
• Identifies a feature of an absorption spectrum OR • Identifies a part of the requirements to create an absorption spectrum	1

Question 30 (c)

Outcomes assessed: H3, H10, H14

MARKING GUIDELINES

Criteria	Marks
• Identifies several technological advances (including one or more other than adaptive/active optics or optical telescopes) • Clearly describes two or more impacts on our understanding of the cosmos arising from these advances • Makes a statement of the value of at least one technology or new understanding • Provides a response that demonstrates coherence and logical progression and includes correct use of scientific principles and ideas	6–7
• Identifies several technological advances • Clearly describes one impact on our understanding of the cosmos arising from these advances • Provides a response that demonstrates limited coherence and logical progression and includes correct use of scientific principles and ideas	4–5
• Identifies technological advances and describes the technical benefits of the identified advances OR • Identifies one or two technological advance(s) and describes the impact of one upon our understanding of the cosmos	2–3
• Identifies one or more advances	1

Question 30 (d) (i)

Outcomes assessed: H9

MARKING GUIDELINES

Criteria	Marks
• Correctly describes possible reactions occurring at each point	3
• Correctly describes one or two of possible reactions OR • Identifies reactions at each point	2
• Identifies one or two reactions OR • Identifies reactions as fusion reactions	1

Question 30 (d) (ii)

Outcomes assessed: H9, H12

MARKING GUIDELINES

Criteria	Marks
• Identifies that the star is on the main sequence and of approximately one solar mass, and provides suitable reason	2
• Correctly identifies type and mass of star • OR • Correctly identifies one and provides a suitable reason	1

Question 30 (d) (iii)

Outcomes assessed: H9, H14

MARKING GUIDELINES

Criteria	Marks
• Identifies that a star of ten solar masses expands to a supernova and concludes as a black hole or neutron star	2
• Relates this observation to the path depicted in the diagram	1

Question 31 (a) (i)

Outcomes assessed: H9, H10

MARKING GUIDELINES

Criteria	Marks
• Identifies the initial state must be higher, more energetic, further out than the final state	1

Question 31 (a) (ii)

Outcomes assessed: H9, H10, H12

MARKING GUIDELINES

Criteria	Marks
• Substitutes table entries into formula, correctly calculates and identifies correct means of obtaining photon energy from wavelength	4
• Substitutes table entries into formula and correctly calculates OR • Further identifies correct means of obtaining photon energy from wavelength	3
• Identifies correct formula(e) AND • Selects correct table entries	2
• Identifies correct formula OR • Selects table entries appropriate for identified transition	1

Question 31 (b) (i)

Outcomes assessed: H11, H12

MARKING GUIDELINES

Criteria	Marks
• Identifies at least two sources of information • Outlines how reliability of information was achieved	2
• Outlines how reliability of information was achieved	1

Question 31 (b) (ii)

Outcomes assessed: H1, H2, H10

MARKING GUIDELINES

Criteria	Marks
• Correct statements regarding problems to be addressed by both Heisenberg and Pauli • Provides a full description of both Heisenberg's and Pauli's contribution	4
• Provides a correct statement regarding one problem to be addressed by both Heisenberg and Pauli • Provides a correct description of both Heisenberg's and Pauli's contribution	3
• Provides a correct statement regarding one problem to be addressed by either Heisenberg or Pauli, and • Provides a description of either Heisenberg's or Pauli's contribution OR • Provides a correct description of both Heisenberg's and Pauli's contribution	2
• Provides a correct statement regarding one problem to be addressed by either Heisenberg or Pauli OR • Provides an identification of either Heisenberg's or Pauli's contribution	1

Question 31 (c)

Outcomes assessed: H4, H7, H14

MARKING GUIDELINES

Criteria	Marks
• Describes in detail the fission process, including the role of the three neutrons and controlling nature of the reactor moderator • Relates production of energy to mass defect and described how this energy may be used in the production of electricity • Provides a response that demonstrates coherence and logical progression and includes correct use of scientific principles and ideas	6–7
• Describes the fission process in reactor technology and recognizes that the process in the transmutation equation results in energy production • States that thermal energy may be used in the production of electricity	3–5
• Describes the fission process OR • Identifies mass defect AND • States that thermal energy may be used in the production of electricity	1–2

Question 31 (d) (i)

Outcomes assessed: H6, H7, H9, H12, H14

MARKING GUIDELINES

Criteria	Marks
• Provides a detailed analysis of the physical principles in the operation of the cyclotron, including the effect of a magnetic field and high frequency voltage	3
• Describes two physical principles in the operation of the cyclotron, stating the effect of each of these	2
• States two physical principles involved in the cyclotron OR • Describes one physical principle involved	1

Question 31 (d) (ii)

Outcomes assessed: H6, H9

MARKING GUIDELINES

Criteria	Marks
• Provides a detailed account of the use of particle accelerators in increasing our understanding of matter	2
• Provides a basic account of the use of particle accelerators in increasing our understanding of matter	1

Question 31 (d) (iii)

Outcomes assessed: H10, H12

MARKING GUIDELINES

Criteria	Marks
• Identifies the composition of both the proton and neutron	2
• Identifies the composition of either the proton or the neutron	1

Question 32 (a) (i)

Outcomes assessed: H7

MARKING GUIDELINES

Criteria	Marks
• Describes structure and operation	2
• Describes structure or operation	1

Question 32 (a) (ii)

Outcomes assessed: H7, H12

MARKING GUIDELINES

Criteria	Marks
• Gives at least three valid reasons	3
• Gives two valid reasons	2
• Gives one valid reason	1

Question 32 (b) (i)

Outcomes assessed: H11, H12

MARKING GUIDELINES

Criteria	Marks
• Provides features and characteristics of at least two appropriate criteria	3
• Lists at least two appropriate criteria and provides a basic description of both	2
• Lists at least two appropriate criteria OR • States one criterion and gives a brief description	1

Question 32 (b) (ii)

Outcomes assessed: H12

MARKING GUIDELINES

Criteria	Marks
• Gives correct answer with supporting truth table	3
• Uses correct method but makes an error in one of the columns	2
• Uses correct method but makes an error in two of the columns OR • Gives correct answer without justification OR • Identifies all gates correctly	1

Question 32 (c)

Outcomes assessed: H5, H7, H14

MARKING GUIDELINES

Criteria	Marks
• Makes valid assessment • Lists three to four developments (eg, valves, transistors, ICs, storage, display technology, manufacturing techniques, packing density of components, etc) • Discusses potential future developments and the physics on which they may depend • Provides a response that demonstrates coherence and logical progression and includes correct use of scientific principles and ideas	5–7
• Describes three technological advances and relates them to computer performance • Makes poor reference to second part of statement	3–4
• Gives one to two advances with little or no reference to second part of statement OR • Discusses second part but not first part of the statement	2
• Mentions one development • Does not make assessment and does not refer to second part of the statement	1

Question 32 (d) (i)

Outcomes assessed: H7, H12

MARKING GUIDELINES

Criteria	Marks
• Gives correct answer with justification	1

Question 32 (d) (ii)

Outcomes assessed: H7, H12

MARKING GUIDELINES

Criteria	Marks
• Correctly determines sensitivity	2
• Sets up a valid ratio OR • Identifies from the graph the voltage range corresponding to the temperature range	1

Question 32 (d) (iii)

Outcomes assessed: H7, H13

MARKING GUIDELINES

Criteria	Marks
• Gives correct answer, including circuit diagram	4
• Gives correct circuit diagram • Calculates required gain • Selects R_i (or R_f) but does not calculate R_f (or R_i)	3
• Calculates gain and appropriate resistors for an incorrect circuit	2
• Identifies gain formula OR • Identifies feedback circuit element	1