2002 HSC Notes from the Marking Centre Physics

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

Tel: (02) 9367 8111

Fax: (02) 9367 8484

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

ISBN 174099 645 3

2003120

Contents

2002 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 the 2002 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 2002 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 2002, approximately 9200 candidates attempted the Physics examination.

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 – Core

Part A – Multiple choice

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

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

Part B

General Comments

Candidates are reminded that they should follow the instructions given at the beginning of each section of the paper and in each question. Marks are needlessly lost where a candidate provides an incorrect response to a numerical question and does not provide working for the response. Where a specific number of examples/responses is required by a question, candidates may disadvantage themselves by providing additional examples/responses, where the additional responses may be incorrect or may contradict initial responses given.

Candidates lost marks in holistic questions that require specific information, rather than vague and imprecise information.

Candidates should also realise that they can obtain full marks if they answer a question concisely and accurately without filling up all the space. Some candidates seem to feel obliged to fill up the space, and go beyond.

In some situations, candidates seemed to have the required knowledge of physics associated with the question, but then were unable to structure their responses correctly.

Candidates should, where appropriate, make use of labelled diagrams in their response.

Candidates should not cross out a response before they have provided an alternative response. In a number of cases candidates crossed out correct responses without replacing them at all, even with incorrect responses.

Specific Comments

Question 16

(a) This question was answered well by most candidates. Some candidates thought that maintaining a constant angle for release improved accuracy. Many candidates successfully identified replication as a means of improving accuracy of the experiment.

(b) Many candidates thought incorrectly that Kim's method was the better approach due to the subjectivity of the line of best fit used in Ali's method. Few candidates could successfully 'compare' and 'identify' Ali's method clearly as the better approach. Many candidates identified weaknesses in Ali's approach using vague terms such as 'human error'. Some candidates misinterpreted the question by providing an alternative method to the experiment.

(c) Few candidates calculated g using the gradient. Most resorted to finding a data point ON the line and substituting it into the equation. A number of candidates assumed that the gradient was the value of g. The most common manipulation error was candidates omitting to square the 2π term. Some candidates failed to show 'all relevant working' and were penalised.

Question 17

Most candidates performed well in this question, with the vast majority being able to at least identify two difficulties.

A high percentage of candidates wrote more than was necessary with a significant number of candidates identifying and describing three or more difficulties.

Many candidates wrote explanations rather than descriptions. A large number of candidates also described methods of overcoming the identified problems.

Question 18

Successful candidates were able to correctly calculate the wavelength corresponding to the transmission frequency and use the graph to justify the use of this frequency. Common errors involved: misinterpretation of information in the graph, mathematical errors (especially those involving powers of ten), misinterpretation of data in the graph (especially orders of magnitude of the wavelengths), not justifying the use of the frequency even though the graphical data was correctly described.

Question 19

(a) A small number of candidates gave answers related to the time at which the passenger and worker saw the light, that is, they answered in terms of relativity of simultaneity.

(b) This part was generally well answered. The most common errors involved transposing l_v and l_o not squaring (v^2/c^2). Many candidates did not use a methodical approach (Equation---> substitution----> answer).

Question 20

Many candidates failed to give the relevant information required in order to justify the conclusion. A significant number of candidates failed to refer to the observations made on the boat. Most candidates could describe an inertial frame of reference. The best candidates were succinct and their answers displayed a logical process.

Question 21

(a) Most candidates were able to do this question correctly, although a sizable number of candidates did not use the appropriate formula and/or made substitution errors in their calculations.

(b) The majority of candidates were able to recognise the implications of such a large acceleration on a living person. This part, however, required a reference to the answer given in 21a) which meant that some candidates, who answered incorrectly in part (a) had difficulty in subsequently answering part (b) correctly.

Question 22

(a) Most candidates understood the role of the brushes. Apart from its role as a contact between the circuit and the commutator, many candidates recognised that the brushes provided a sliding contact.

(b) In this section it was important to differentiate between the current produced within the coil and the rectified current. Many candidates were not able to make this distinction.

(c) A reasonable number of candidates related the need for the transformation of AC to high voltage to the energy loss during transmission. However many candidates did not answer with this degree of specificity so that they did not obtain full marks. In this section there were a number of candidates who confused AC motors and AC generators.

Question 23

(a) Many candidates knew Lenz's Law but failed to correctly state all components of the law.

(b) The first section of this question was well answered. Many candidates saw Lenz's law mentioned in (a) and attempted to answer every section using this law even though (b) clearly required application of Faraday's Law. Candidates often simply restated the language used in the stem and question and hence earned no marks in (b) (ii).

(c) This part was answered well, with many candidates talking about induction cook tops but failing to explain that changing magnetic flux induced current, which then, in turn, was used to heat the conductor. It was assumed by many candidates that they did not need to specify this connection in part (c) when they had already used a similar explanation in (b) (ii).

Question 24

This was a challenging question. It required the candidates to have very clear ideas regarding the nature of conductivity and resistance. It also demanded very clear ideas of the nature of band structure and the ability to contrast the nature of conductors, semi-conductors and insulators.

Many candidates failed to show an understanding of the nature of resistance. A majority of candidates talked about band structure but few demonstrated a proper understanding. Some candidates did not know the names of the bands.

A significant number of candidates described the band structures using properly drawn labelled diagrams.

Many candidates who offered an exposition of band structure did not respond to the resistance aspect of the question and did not score full marks.

Many candidates became side-tracked with doping and temperature issues and did not address the requirements of the question.

Question 25

Candidates either performed very well or very poorly in this question. Those who performed very well gave clear and succinct answers following a logical mathematical sequence.

(a) Many candidates coped well with the calculation of electric field strength. Some had difficulty completing the calculation correctly. A large proportion of candidates could not provide the correct unit.

(b) Many candidates used the correct formula, but a significant number could not rearrange the formula to make F the subject.

(c) Most candidates recognised the need to balance forces and managed to equate qE with qvB. Some realised that F = qvB was needed but could not identify the electric force from (b).

Many candidates failed to provide a direction for the magnetic field. Some applied the hand rule incorrectly and stated the direction of the field as opposite to the correct direction.

Some candidates confused v(velocity) with V(voltage) or E(electric field strength) with either epsilon(EMF) or E(energy).

Question 26

This question was well answered by candidates, most were able to *identify* superconducting properties. Many candidates also attempted to *explain* or *outline* the property.

Question 27

Most candidates answered the question as an *explain* or *outline* response rather than a *discussion* of 'energy savings' made possible by the use of superconductors. Most candidates did not discriminate between the two separate issues of generation and transmission. The better responses came from the few candidates discussing them as separate issues.

Most candidates were able to provide general issues from each area. Few candidates were precise in discussing where energy savings could be made; many responses outlined issues without the associated energy saving consequence. Many candidates confused transportation with transmission of electricity.

Section II – Options

Question 28

(a) It appears that a significant proportion of candidates who attempted this elective did so as a snap decision to change elective without adequate classroom preparation.

(b) A large number of candidates failed to draw the magnetic field correctly as field lines in space.

(c) The question dealing with gravity anomaly was answered poorly, particularly at point 'Y', the positive anomaly being attributed to the water. Incorrect predictions of satellite paths reflected a misunderstanding of gravity anomaly.

(d) Candidates demonstrated a sound understanding of P and S earthquake waves, but were unable to apply this knowledge to interpret the information provided in the complex figure. A lack of scientific language was evident in candidate responses with many candidates failing to complement their written responses with the use of diagrams.

(e) Candidates demonstrated very little in-depth knowledge of geophysical methods on mineral exploration, but wrote responses that were quite well-structured given the structure implied in the question.

Question 29

A significant number of responses did not distinguish correctly between the different types of scans or answered questions in general superficial terms.

(a) i) Many responses lacked the required detail. Some candidates gave comprehensive and well written answers.

ii) A number of candidates did not include the key features of the formation of CAT scans.

(b) i) Answered correctly by most candidates.

ii) Answered correctly by most candidates. A number of candidates correctly used a mathematical equation to solve the problem.

iii) Few candidates gained full marks as they did not indicate that the technetium 99m was attached to a pharmaceutical which needs time to be taken up by the organ being scanned.

(c) i) Many candidates gained full marks. Some confused gamma radiation, X radiation and radioactivity.

ii) Many candidates did not gain the second mark as they explained what the X-ray would do to bone but not why the X-ray would be ordered.

iii) The justification given was usually minimal. Candidates frequently gave reasons why NOT to use X rays rather than why to use MRI or the scan they chose.

(d) The candidates needed to make an assessment of the impact by elaborating on applications of both ultrasound and MRI used in modern society. Some candidates did not carry out proper assessments.

Question 30

(a) (i) Few candidates correctly described the light-curve as well as its periodic nature – a diagram was the most effective way to answer the question. Several actually drew the correct light-curve in a different part of the question. Many candidates discussed spectral lines and Doppler shifts.

(ii) The majority of candidates identified the correct equation, for this calculation, without stating what 'G' is. A significant number of candidates did not appreciate that 'calculate' implies that a correct equation is required in the answer.

(b) (i) and (b)(ii) were generally well done by the candidature.

(iii) The quality of the diagrams used varied greatly, some students failing to use a ruler. Several thought that the diameter of Earth is the 'baseline' for measuring the distance to Barnard's star.

Many candidates did not label their diagram at all.

(c) (i) The position of white dwarfs on the H-R diagram was well understood, but the ability to justify their choice varied.

(ii) Few understood the role of electrons in preventing white dwarf collapse. Some mistakenly attribute this to the Heisenberg Uncertainty principle rather than the Pauli Exclusion principle.

(iii) The unfortunate term of 'hydrogen burning' continues to confuse candidates. Consequently, some students fail to recognise that stellar reactions are nuclear rather than chemical.

(d) There was considerable confusion among candidates as to where lenses and mirrors are found in a telescope. The terms 'active' and 'adaptive' were sometimes confused. Few candidates managed to link their improvements to sensitivity and resolution.

The clarity of the discussion was enhanced where the response clearly defined the terms. Many responses lacked direction in providing relevant information in response to such a generalised question.

Question 31

(a) (i) Candidates had a very good understanding of the Davisson and Germer experiment.

(ii) Many candidates demonstrated a good understanding of the Bohr atom but had difficulty using de Broglie's hypothesis to explain the stability of the electrons orbits.

(b) (i) Many scientists were named, with the most common incorrect response being Fermi.

(ii) Candidates typically handled this question well. A number of candidates placed the electron on the wrong side of the equation or tried to determine the atomic mass from first principles using the data sheet and made errors in the calculation.

(iii) Many candidates had difficulty interpreting the data provided. Some attempted to use the photoelectric effect or nuclear decay in their answer.

(c) The better candidates handled this question well. However, the wording of the question led many candidates to assume that Bohr's theoretical work came first and that Balmer's empirical formula was the result of his experimental work. The majority of candidates showed that they were aware that electrons occupy specific energy levels (although many referred to them as orbits, orbitals, shells, bands and states). A significant number believed that the spectral lines represented the energy levels of the atom. Many attempted to use de Broglie's wavelengths as a way of explaining the wavelength of the Balmer series.

Overall the calculation in part (ii) was well handled, but only about half the candidates realised that the Balmer series was $n_f = 2$ and the next line was $n_i = 7$; the remainder used a variety of integers.

(d) Many candidates were able to provide only a small amount of information about neutron scattering, most confusing it with Chadwick's or Rutherford's experiments. Of those who did know about neutron scattering, most had a thorough knowledge of both the process and its uses.

Most candidates had a basic knowledge of one other process that has been used to increase our understanding of the structure of matter.

Very few responses could present the answer in a succinct and logical way. There were few attempts to develop answers in a logical sequence.

Question 32

(a) Part (i) was poorly answered with candidates typically explaining how the LED worked rather than describing its structure.

Part (ii) was well answered with candidates listing and then explaining sequentially the preferential use of LEDs in some applications.

(b) The reading of the LDR graph was exceptionally well done. Nearly all candidates were able to describe the trend in the data and were able to extract a value for the resistance in part (2).

Part (ii) was generally well answered, although there were a number of candidates who could not carry out an analysis of a series circuit.

(c) The answers to the section on amplifiers seem to indicate a significant lack of practical understanding of the limitations and requirements of an operational amplifier.

(d) Many candidates provided long and descriptive essays that often lacked the essential scientific facts. Thus, many answers adopted an historical and cultural approach rather than providing a stronger scientific structure and content. The role of 'cause-and-effect' in invention and innovation was poorly represented in the major stages in the development of the computer.

Physics

2002 HSC Examination Mapping Grid

Question	Marks	Content	Syllabus outcomes
Section I Part A			
1	1	9.2.2	H9
2	1	9.2.4	H6
3	1	9.2.1	H6, H9
4	1	9.2.2	H6
5	1	9.2.2	H9, H11
6	1	9.3.4	H7
7	1	9.3.1	H9
8	1	9.3.1	H9
9	1	9.3.2	H7, H9
10	1	9.3.3	H9
11	1	9.4.3	H9
12	1	9.4.4	H10
13	1	9.4.1	H10
14	1	9.4.3	H1
15	1	9.4.2	H8, H11.1(b)
Section I Part B			
16 (a)	2	9.1.12	H12, H13
16 (b)	3	9.1.12	H12, H13
16 (c)	3	9.1.12	H12
17	4	9.2.3	H3, H5, H7, H13
18	3	9.2.3	H3, H9, H12, H13, H14
19 (a)	1	9.2.4	H1, H6
19 (b)	3	9.2.4	H6, H14
20	3	9.2.4	H2, H6, H13
21 (a)	2	9.2.2	H6, H9
21 (b)	2	9.2.2	H13, H14
22 (a)	1	9.3.3	H7, H9
22 (b)	3	9.3.3	H7, H9, H13, H14
22 (c)	2	9.3.3	H3, H4, H7, H9, H13, H14
23 (a)	1	9.3.2	H9
23 (b) (i)	1	9.3.2	H9
23 (b) (ii)	3	9.3.2	H9, H13
23 (c)	2	9.3.2	H3, H9, H13
24	8	9.4.3	H3, H5, H10, H13

Question	Marks	Content	Syllabus outcomes
25 (a)	1	9.4.1	H9
25 (b)	1	9.4.1	H9
25 (c)	4	9.4.1	H9
26	3	9.4.4	H2, H3, H10
27	4	9.3.4, 9.4.3	H3, H9, H10, H13
Section II			
Geophysics			
28 (a) (i)	2	9.5.4	H2, H9
28 (a) (ii)	4	9.5.4	H2, H9
28 (b) (i)	2	9.5.2	H9
28 (b) (ii) 1	2	9.5.2	H9, H14
28 (b) (ii) 2	2	9.5.2	H9, H14
28 (c) (i)	2	9.5.3	H8, H12, H14
28 (c) (ii)	2	9.5.3	H1, H8, H14
28 (c) (iii)	2	9.5.3	H1, H2, H8, H12, H14
28 (d)	7	9.5.1, 9.5.5	H4, H8, H9, H10, H13
Medical Physics			
29 (a) (i)	2	9.6.2	H3, H8
29 (a) (ii)	4	9.6.2	H8, H10
29 (b) (i)	1	9.6.3	H14
29 (b) (ii)	2	9.6.3	H14
29 (b) (iii)	3	9.6.3	H4, H8, H14
29 (c) (i)	2	9.6.4	H12
29 (c) (ii)	2	9.6.4	H3, H9, H10, H14
29 (c) (iii)	2	9.6.4	H9, H10, H12
29 (d)	7	9.6.1, 9.6.4	H4, H8, H9, H10, H13
Astrophysics			
30 (a) (i)	2	9.7.5	H2, H9
30 (a) (ii)	4	9.7.5	H2, H9
30 (b) (i)	1	9.7.4	H7, H14
30 (b) (ii)	2	9.7.4	H7, H14
30 (b) (iii)	3	9.7.4	H14
30 (c) (i)	2	9.7.6	H14
30 (c) (ii)	2	9.7.6	H1, H2, H9
30 (c) (iii)	2	9.7.6	H7
30 (d)	7	9.7.2, 9.7.6, 9.7.1	H2, H4, H13
From Quanta to Quarks			
31 (a) (i)	2	9.8.5	H2, H8

Question	Marks	Content	Syllabus outcomes
31 (a) (ii)	4	9.8.2	H1, H8
31 (b) (i)	1	9.8.4	H1, H7, H14
31 (b) (ii)	2	9.8.4	H7, H10
31 (b) (iii)	3	9.8.4	H7, H14
31 (c) (i)	3	9.8.1	H2, H7, H8, H10, H13, H14
31 (c) (ii)	3	9.8.1	H7, H8, H10
31 (d)	7	9.8.5, 9.8.6	H2, H5, H9, H10, H13
The Age of Silicon			
32 (a) (i)	2	9.9.4	H3, H7
32 (a) (ii)	4	9.9.4	H4, H7
32 (b) (i) 1	1	9.9.3	H7, H14
32 (b) (i) 2	1	9.9.3	H7, H14
32 (b) (ii)	4	9.9.3, 8.3.2	H3, H7, H14
32 (c) (i)	2	9.9.6	H3, H7, H14
32 (c) (ii)	2	9.9.6	H7, H14
32 (c) (iii)	2	9.9.6	H7, H14
32 (d)	7	9.9.7, 9.4.3	H4, H5, H7, H13

BOARD OF STUDIES
NEW SOUTH WALES

2002 HSC Physics Marking Guidelines

Section I, Part B

Question 16 (a)

Outcomes assessed: H12, H13

MARKING GUIDELINES

Criteria	Marks
• Outlines two changes that would improve the accuracy of the results	2
• Outlines one change that would improve the accuracy of the results	1

Question 16 (b)

Outcomes assessed: H12, H13

MARKING GUIDELINES

Criteria	Marks
• Identifies features of both methods and the differences between them • Identifies Ali's method as being superior OR • Kim's as being inferior	3
EITHER • Identifies the features of only one method and identifies which method is superior/inferior OR • Identifies the features of both methods but does not identify a superior/inferior method	2
• States Ali's method is superior OR • States Kim's method is inferior	1

Question 16 (c)

Outcomes assessed: H12

MARKING GUIDELINES

Criteria	Marks
• Calculates the gradient using the line-of-best-fit (LOBF) or a point on the LOBF and correctly substitutes into the equation to determine g	3
• Calculates a value of g using the operations listed, but with an error in substitution, gradient determination or equation manipulation	2
• Uses data points not on the LOBF in calculation of g OR • Calculates the gradient only OR • Only identifies a point on the LOBF for substitution into the equation	1

Question 17

Outcomes assessed: H3, H5, H7, H13

MARKING GUIDELINES

Criteria	Marks
• Two difficulties identified and described	4
• Two difficulties identified, only one described OR • One difficulty identified, two described	3
• One difficulty identified and described OR • One difficulty identified but another one described OR • Two difficulties identified	2
• One difficulty identified	1

Question 18

Outcomes assessed:H3, H9, H12, H13, H14

MARKING GUIDELINES

Criteria	Marks
• Correctly relates the wavelength of the transmission to its frequency • Recognises that this signal wavelength corresponds to maximum 100% transmission	3
• Correctly calculates or states that 2295 MHz corresponds to the wavelength/range giving a high degree of transmission	2
• Recognises the wavelength/range corresponds to a high degree of transmission • OR • Correctly calculates the wavelength only	1

Question 19 (a)

Outcomes assessed: H1, H6

MARKING GUIDELINES

Criteria	Marks
• Correctly states ratio is 1:1 OR • Velocity is seen to be the same value	1

Question 19 (b)

Outcomes assessed: H6, H14

MARKING GUIDELINES

Criteria	Marks
• Identifies the length contraction equation and calculates the correct answer	3
• Length contraction equation used correctly but student makes algebraic errors such as – no square root/squaring – fraction is inverted – fraction is not subtracted from 1	2
• Correct choice of equation but incomplete or incorrect substitutions • OR • Length contraction equation used but l_V and l_o transposed so that the incorrect answer 27.5 m obtained	1

Question 20

Outcomes assessed: H2, H6, H13

MARKING GUIDELINES

Criteria	Marks
• Falling ball's acceleration due to gravitational force only • Balls moving horizontally do not exhibit acceleration • An inertial frame of reference is defined or described correctly	3
• Any two of the above criteria	2
• Falling ball's acceleration due to gravitational force only OR • Balls moving horizontally do not exhibit acceleration OR • An inertial frame of reference is defined or described correctly	1

Question 21 (a)

Outcomes assessed: H6, H9

MARKING GUIDELINES

Criteria	Marks
• Uses appropriate formula and substitutes correct values	2
• Uses appropriate formula and makes incorrect substitution	1

Question 21 (b)

Outcomes assessed: H13, H14

MARKING GUIDELINES

Criteria	Marks
• Gives clear explanation why method is not suitable using a reference to answer obtained in part (a)	2
• States that method is not suitable and refers to part (a) OR • Explains why method is not suitable, without referring to part (a)	1

Question 22 (a)

Outcomes assessed: H7, H9

MARKING GUIDELINES

Criteria	Marks
• States the functions of the brush correctly	1

Question 22 (b)

Outcomes assessed: H7, H9, H13, H14

MARKING GUIDELINES

Criteria	Marks
• Correctly identifies *Q* • Indicates that current generated in the coil is AC • Identifies the role of the split ring commutator in rectifying the current	3
• Correct answer *Q* • Partial explanation	2
• Correct answer *Q*	1

Question 22 (c)

Outcomes assessed: H3, H4, H7, H9, H13, H14

MARKING GUIDELINES

Criteria	Marks
• Outlines importance of transmitting power at high voltages and relates this to the need to step up using transformers operating on AC to reduce power loss in transmission	2
• Outlines importance of transmitting power at high voltages OR • AC is easily transformed OR • Step up AC supply or vice versa OR • High voltage needed/step up OR • AC generation allows for minimum energy losses	1

Question 23 (a)

Outcomes assessed: H9

MARKING GUIDELINES

Criteria	Marks
• States Lenz's law	1

Question 23 (b)(i)

Outcomes assessed: H9

MARKING GUIDELINES

Criteria	Marks
• Identifies correct end	1

Question 23 (b)(ii)

Outcomes assessed: H9, H13

MARKING GUIDELINES

Criteria	Marks
• A thorough explanation with reference to change of flux OR • A thorough explanation using relative movement of charge in a field that experiences a force, moves in the direction of that force to produce a separation of charge in the rod (an emf) OR • A thorough explanation using reference to the work done on charges in the rod	3
• A sound description with reference to change in flux OR • A sound description referring to the production of separation of charge in the rod OR • A sound description using reference to the work done on charges in the rod	2
• States emf is produced by a change in flux with no reference to the situation OR • States emf arises from charge separation with no reference to the situation OR • States work is done on charge to produce emf with no reference to the situation	1

Question 23 (c)

Outcomes assessed: H3, H9, H13

MARKING GUIDELINES

Criteria	Marks
• Relative motion between magnetic field and conductor induces curent AND • Current in conductor produces heat	2
• Either of the points above	1

Question 24

Outcomes assessed: H3, H5, H10, H13

MARKING GUIDELINES

Criteria	Marks
• Demonstrates a clear and coherent understanding of the characteristic features of conductors, insulators and semi-conductors in terms of band structures and electrical resistance and uses these features to highlight the differences between the three groups	7–8
• Demonstrates a sound understanding of the above points	5–6
• Demonstrates some understanding of the above points	3–4
• Identifies relative resistance of insulators, semi-conductors OR conductors • AND relates to number of free electrons • BUT does not address band theory • OR provides a reasonable description of band theory but does not relate this to electrons' freedom to move or resistance	2
• Identifies relative resistance of semiconductors, insulators OR conductors	1

Question 25 (a)

Outcomes assessed: H9

MARKING GUIDELINES

Criteria	Marks
• Correct substitution into equation	1

Question 25 (b)

Outcomes assessed: H9

MARKING GUIDELINES

Criteria	Marks
• Correct substitution into $F = E.q_e$ with E from part (a)	1

Question 25 (c)

Outcomes assessed: H9

MARKING GUIDELINES

Criteria	Marks
• Equates electrostatic force with magnetic force • Correct substitution into equation • Correct direction given	4
• Equates electrostatic force with magnetic force • Correct substitution into equation • BUT correct direction not given OR algebraic error leads to incorrect answer	3
• Equates electrostatic force with magnetic force • Incorrect or incomplete substitution into equation • Correct direction given	2
• Recognises that magnetic force must balance electrostatic force BUT cannot perform calculation OR • Correct direction only given	1

Question 26

Outcomes assessed: H2, H3, H10

MARKING GUIDELINES

Criteria	Marks
• Three properties listed	3
• Two properties listed	2
• One property listed in answer	1

Question 27

Outcomes assessed: H3, H9, H10, H13

MARKING GUIDELINES

Criteria	Marks
• Provides one issue for each area and the associated energy saving consequence – both generation and transmission issues are discussed in the electricity area	4
• Provides one issue for each area with reference to any energy saving consequence • OR • Provides an energy saving consequence from each area and provides one issue	3
• Provides any issue and its associated energy saving consequence OR • Provides any two issues	2
• Provides one issue only • OR • Provides any energy saving consequence of superconductors	1

Section II

Question 28 — Geophysics

Question 28 (a) (i)

Outcomes assessed: H2, H9

MARKING GUIDELINES

Criteria	Marks
• Describes the shape of the magnetic field • Describes direction of magnetic field lines	2
• Describes the shape of the magnetic field OR • Correctly describes direction of magnetic field lines	1

Question 28 (a) (ii)

Outcomes assessed: H2, H9

MARKING GUIDELINES

Criteria	Marks
• Provides an extensive explanation for the magnetic anomaly pattern, by addressing at least four valid points	4
• Provides a thorough explanation by addressing at least three valid points	3
• Provides a sound explanation by addressing the points: – Plate movement – Black and white pattern representing normal and reversed magnetic field pattern in the crust	2
• Provides a limited explanation by addressing EITHER – Plate movement OR – Black and white pattern representing normal and reversed magnetic field patterns in the crust	1

Question 28 (b) (i)

Outcomes assessed: H9

MARKING GUIDELINES

Criteria	Marks
• Recounts two steps involved in gravity data reduction	2
• Recounts one step involved in gravity data reduction	1

Question 28 (b) (ii) 1

Outcomes assessed: H9, H14

MARKING GUIDELINES

Criteria	Marks
• Links the variation in density of the crust with observed gravity anomaly	2
• Identifies that the density of the crust may vary or topography may affect gravity readings	1

Question 28 (b) (ii) 2

Outcomes assessed: H9, H14

MARKING GUIDELINES

Criteria	Marks
• Predicts a decrease in orbital radius as satellite moves over *Y* as compared to orbital radius over *X*	2
• Predicts a difference in orbital radius over *Y* as compared to orbital radius over *X*	1

Question 28 (c) (i)

Outcomes assessed: H8, H12, H14

MARKING GUIDELINES

Criteria	Marks
• Correctly describes two differences between *P* and *S* waves	2
• Correctly states one difference between *P* waves and *S* waves	1

Question 28 (c) (ii)

Outcomes assessed: H1, H8, H14

MARKING GUIDELINES

Criteria	Marks
• Provides clear reasons for the absence of *S* waves beyond 11,000 km with reference to the existence of a liquid core structure and inability of *S* waves to travel through a liquid	2
• Identifies *S* waves cannot travel through the liquid outer core OR • Identifies that Earth has liquid outer core but does not identify that *S* waves cannot travel through a liquid	1

Question 28 (c) (iii)

Outcomes assessed: H1, H2, H8, H12, H14

MARKING GUIDELINES

Criteria	Marks
• Demonstrates a sound understanding of the effect of reflection/refraction by the Earth's solid core resulting in the delayed arrival of *P* waves at the surface between 11,000 and 16,000 km from the epicentre	2
• Identifies the arrival of *P* waves on the surface at distance beyond 11,000 km from the epicentre as being due to the existence of a solid inner core • OR • Demonstrates a recognition that the graph indicates the movement of the waves into a liquid outer core	1

Question 28 (d)

Outcomes assessed: H4, H8, H9, H10, H13

MARKING GUIDELINES

Criteria	Marks
• Provides a succinct and logical assessment of the contribution of two different geophysical methods in mineral exploration incorporating a clear link between the nature of their application and the advantages each method has in revealing detailed information about deposit(s)	6–7
• Provides a well structured response detailing at least one method, its application and its advantage over the other methods OR • Provides a succinct and logical assessment of the contribution of only one geophysical method including a clear link between the application of the method and its utility in revealing detailed information about deposits OR • Provides a clear response detailing two methods and their applications and advantages	4–5
• Provides a clear response detailing one method and its application and advantages over other methods but providing a less detailed response for the second method identified	2–3
EITHER • Provides a response of the application and advantages of one method only OR • Provides a brief description of two methods with minimal reference to applications and/or advantages of both	1

Question 29 — Medical Physics

Question 29 (a) (i)

Outcomes assessed: H3, H8

MARKING GUIDELINES

Criteria	Marks
• Correctly describes how an endoscope works in terms of fibre optics and total internal reflection	2
• Incomplete description of how an endoscope works	1

Question 29 (a) (ii)

Outcomes assessed: H8, H10

MARKING GUIDELINES

Criteria	Marks
• Correctly explains how a CAT scan is produced	4
• Describes the production of a CAT scan using most but not all the points	3
• Limited description of how a CAT scan is produced	2
• States that CAT scans use X-rays	1

Question 29 (b) (i)

Outcomes assessed: H14

MARKING GUIDELINES

Criteria	Marks
• Correct reading of half life from the graph	1

Question 29 (b) (ii)

Outcomes assessed: H14

MARKING GUIDELINES

Criteria	Marks
• Correctly determines the quantity of technetium 99 m remaining after 4 hours (in kg)	2
• Correctly determines the percentage of technetium 99 m remaining after 4 hours	1

Question 29 (b) (iii)

Outcomes assessed: H4, H8, H14

MARKING GUIDELINES

Criteria	Marks
• Proposes reasons for the timing, taking into account the half-life and the need for absorption of the radioisotope	3
• Identifies each factor in proposing a reason	2
• Identifies one factor in proposing a reason	1

Question 29 (c) (i)

Outcomes assessed: H12

MARKING GUIDELINES

Criteria	Marks
• Any two valid advantages	2
• Any one valid advantage	1

Question 29 (c) (ii)

Outcomes assessed: H3, H9, H10, H14

MARKING GUIDELINES

Criteria	Marks
• Relates advantages of X-rays to reason for choice	2
• States one feature of X-rays	1

Question 29 (c) (iii)

Outcomes assessed: H9, H10, H12

MARKING GUIDELINES

Criteria	Marks
• Suggests correct technique with good justification	2
• Names a correct scanning technique to view the brain with minimal justification	1

Question 29 (d)

Outcomes assessed: H4,H8, H9, H10, H13

MARKING GUIDELINES

Criteria	Marks
• Makes an appropriate judgement based on a demonstrated extensive knowledge and understanding of the use of the medical applications of physics on modern society	7
• Makes an appropriate judgement based on a demonstrated thorough knowledge and understanding of the use of the medical applications of physics on modern society	6
• Makes an appropriate judgement based on a demonstrated sound knowledge and understanding of the use of the medical applications of physics on modern society OR • Makes an appropriate judgement based on a demonstrated extensive knowledge and understanding of the use of one medical application of physics on modern society	4–5
• Makes an appropriate judgement based on a basic knowledge and understanding of the use of the medical applications of physics on modern society	2–3
• Correctly states the two medical applications of physics and how they are utilised as diagnostic tools	1

Question 30 — Astrophysics

Question 30 (a) (i)

Outcomes assessed: H2, H9

MARKING GUIDELINES

Criteria	Marks
Answer includes reference to • (Regular) periodic event • Changes in brightness different from those of a Cepheid	2
Clear reference to either • Periodic OR • Changes in brightness different from those of a Cepheid	1

Question 30 (a) (ii)

Outcomes assessed: H2, H9

MARKING GUIDELINES

Criteria	Marks
• Identifies the correct equation, and identifies all three of the significant terms *r* and *T* and *G*	4
• Identifies the correct equation, and identifies two of the significant terms, *r* and *T* and *G*	3
• Identifies the correct equation, and identifies one of the significant terms, *r* and *T* and *G*	2
• Identifies the correct equation	1

Question 30 (b) (i)

Outcomes assessed: H7, H14

MARKING GUIDELINES

Criteria	Marks
• Identifies the correct star	1

Question 30 (b) (ii)

Outcomes assessed: H7, H14

MARKING GUIDELINES

Criteria	Marks
• Correct substitution of '*A*' and '*B*' quantities into formula • Answer that demonstrates that Ross 154 is brighter	2
• Substitute into formula correctly	1

Question 30 (b) (iii)

Outcomes assessed: H14

MARKING GUIDELINES

Criteria	Marks
• Correctly labelled diagram showing position of Sun and Earth (or two Earths), position of parallax angle OR *q* and B's Star, plus 1AU marked	3
• As below, plus one dimension of EITHER 1AU (or "known radius of Earth's orbit") OR *q*	2
• Sketch of sun (or two Earths), Earth, and Barnard's Star, with Earth plus EITHER Sun OR Barnard's Star labelled	1

Question 30 (c) (i)

Outcomes assessed: H14

MARKING GUIDELINES

Criteria	Marks
• Selects position and justifies choice	2
• Correct choice	1

Question 30 (c) (ii)

Outcomes assessed: H1, H2, H9

MARKING GUIDELINES

Criteria	Marks
• Outlines the conditions found in white dwarf stars and links these conditions to explain the stability of these stars	2
• Outlines the conditions found in white dwarf stars	1

Question 30 (c) (iii)

Outcomes assessed: H7

MARKING GUIDELINES

Criteria	Marks
• Provides an accurate description of a fusion reaction including reactants and products	2
• Describes a fusion reaction but gives no specific details	1

Question 30 (d)

Outcomes assessed: H2, H4, H13

MARKING GUIDELINES

Criteria	Marks
• Provides a clear and logical response which demonstrates detailed knowledge of both developments, an understanding of resolution and sensitivity AND the link between the development and improved resolution and sensitivity	7
• Provides a response which lacks detail of the above in terms of – Either development – Understanding of resolution and/or sensitivity – Link between the development and improved resolution AND sensitivity	5–6
• Describes two developments in detail (one being adaptive optics) OR • Demonstrates an understanding of resolution and sensitivity AND describes one development in detail only	3–4
• Describes adaptive optics OR another in detail OR • Identifies issues such as seeing as a problem for resolution or sensitivity, AND describes adaptive optics OR another OR • Demonstrates understanding of resolution and sensitivity	2
• Identifies issues such as seeing as a problem for resolution OR sensitivity OR • States what adaptive optics is OR • States and describes another development OR • Demonstrates understanding of resolution OR sensitivity	1

Question 31 — From Quanta to Quarks

Question 31 (a) (i)

Outcomes assessed: H2, H8

MARKING GUIDELINES

Criteria	Marks
• Describes the D + G experiment and relates the results to the wave-nature of electrons	2
• Provides a broad outline of D + G experiment (ie diffraction of electrons) but omits the experimental detail OR • Provides experimental detail of the D + G experiment but does not relate diffraction to the wave nature of electrons	1

Question 31 (a) (ii)

Outcomes assessed: H1, H8

MARKING GUIDELINES

Criteria	Marks
• States de Broglie's hypothesis • Relates a stable electron orbit to a standing wave • Relates stable electron orbits to standing waves in a Bohr atom • Relates this to the quantisation of angular momentum postulated by Bohr	4
• Any three of the above criteria	3
• Any two of the above criteria	2
• Any one of the above criteria	1

Question 31 (b) (i)

Outcomes assessed: H1, H7, H14

MARKING GUIDELINES

Criteria	Marks
• Identifies the scientist	1

Question 31 (b) (ii)

Outcomes assessed: H7, H10

MARKING GUIDELINES

Criteria	Marks
• Correct calculation	2
• Recognises ΔM = M parent – M daughters but cannot substitute appropriate values from table	1

Question 31 (b) (iii)

Outcomes assessed: H7, H14

MARKING GUIDELINES

Criteria	Marks
• Explains that KE of an electron can vary OR similar correct statement • Relates different values to another particle	3
• Explains that the missing energy is with another particle • OR • Explains that the KE of an electron can vary plus one other statement that doesn't relate to neutrino energy	2
• A single true statement related to the situation	1

Question 31 (c) (i)

Outcomes assessed: H2, H7, H8, H10, H13, H14

MARKING GUIDELINES

Criteria	Marks
• Explains the main prediction of Bohr's model of the hydrogen atom, specifically quantisation of energy levels leading to a line spectrum and links the wavelengths of the lines shown to the transition of electrons between energy levels ie photons have the same E, f or l as predicted by Bohr	3
• Mentions Bohr's quantised energy levels and Balmer's spectrum being photons released when electrons move between energy levels but does not link the wavelengths specifically to Bohr's quantised energy levels	2
• Limited answer – one correct statement about Bohr or Balmer that is not given in the question ie energy quantisation $n = 2$ energy level $E = hf$ Absorption/Emission spectrum Bohr's mathematical model Electrons moving between energy levels	1

Question 31 (c) (ii)

Outcomes assessed: H7, H8, H10

MARKING GUIDELINES

Criteria	Marks
• Correct calculation below	3
• Correct calculation using $\frac{1}{\lambda} = R_h\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$ substituting 2 for n_f, and any other value for n_i OR • Failure to invert $\frac{1}{\lambda}$ at end of calculation	2
• Select correct equation	1

Question 31 (d)

Outcomes assessed: H2, H5, H9, H10, H13

MARKING GUIDELINES

Criteria	Marks
• Provides a succinct and logical discussion of use of neutron scattering and one other process in understanding the structure of matter	7
• Provides a thorough assessment of neutron scattering and one other process and applies it to our understanding of matter	6
• Provides a thorough assessment of neutron scattering and a basic assessment of one other process and applies it to our understanding of matter OR • Provides a thorough assessment of one other process and a basic assessment of neutron scattering and applies it to our understanding of matter	4–5
• Provides a basic assessment of neutron scattering AND/OR one other process and applies it to our understanding of matter	2–3
• States what neutron scattering is OR • Describes another process	1

Question 32 — Age of Silicon

Question 32 (a) (i)

Outcomes assessed: H3, H7

MARKING GUIDELINES

Criteria	Marks
• Provides a detailed description of an LED	2
• Provides basic description of an LED	1

Question 32 (a) (ii) (4 marks)

Outcomes assessed: H4, H7

MARKING GUIDELINES

Criteria	Marks
• Describes four advantages of an LED over an ordinary source	4
• Three advantages described	3
• Two advantages described	2
• Only one advantage described	1

Question 32 (b) (i) 1 (1 mark)

Outcomes assessed: H7, H14

MARKING GUIDELINES

Criteria	Marks
• Correct dependence	1

Question 32 (b) (i) 2 (1 mark)

Outcomes assessed: H7, H14

MARKING GUIDELINES

Criteria	Marks
• Correct value from graph	1

Question 32 (b) (ii) (4 marks)

Outcomes assessed: H3, H7, H14

MARKING GUIDELINES

Criteria	Marks
• Correctly calculates R_{Coil}	4
• Recognise series circuit	3
• Apply Ohm's Law to calculate R_{total}	2
• Read correct value of LDR at 2 LUX	1

Question 32 (c) (i)

Outcomes assessed: H3, H7, H14

MARKING GUIDELINES

Criteria	Marks
• Describes properties of an ideal amplifier	2
• States only two properties of an ideal amplifier	1

Question 32 (c) (ii)

Outcomes assessed: H7, H14

MARKING GUIDELINES

Criteria	Marks
• Correct method used to obtain value and sign of the gain	2
• Uses correct method, but has incorrect sign OR exponent of input voltage	1

Question 32 (c) (iii)

Outcomes assessed: H7, H14

MARKING GUIDELINES

Criteria	Marks
• Links the two factors that limit use of the amplifier at these input signals	2
• Identifies one factor which limits the use of the amplifier at these input signals	1

Question 32 (d)

Outcomes assessed: H4, H5, H7, H13

MARKING GUIDELINES

Criteria	Marks
• Provides a succinct and logical discussion of the impact and limitations of each of the types of devices and links the developments to the older technology	6–7
• Provides a well structured response of – Impacts of three and limitations of one – Impacts of two and limitations of two – Impacts of one and limitations of three	4–5
• Provides the limitations and impacts of at least one device and attempts to link it to another	2–3
• Gives a list of limitations or impacts of one without making any references to the other devices	1