2004 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: www.boardofstudies.nsw.edu.au

ISBN 1 7414 7223 7

2005086

Contents

2004 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 2004 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 2004 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 2004, 10 158 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.

Overall, the candidates' responses were appropriate and indicated a level of understanding of physics concepts that is appropriate for HSC candidates. Candidates need to be reminded that the answer space allocated is a guide 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. 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.

The space provided should be used as a guide to the length of the response required. Additional (blank) spaces may be used to plan or draft responses. By providing additional information beyond the requirements of the question, candidates may disadvantage themselves by introducing contradictions. Candidates should, where possible, make use of clearly labelled diagrams to answer and/or supplement a concise response.

Show all relevant working in questions involving calculations. An incorrect answer standing alone cannot score marks. Responses showing correct equations and substitutions but incorrect calculations may score some marks.

The use of formulae as supplied on the formulae sheet before substitution and rearrangement may be of benefit to candidates. Similarly candidates are advised to refer to the data sheet. Candidates are also reminded to be aware of the appropriate units used in formulae.

Section I – Core

Part A

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

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

Part B
Specific Comments

Question 16

A substantial number of candidates were able to gain full marks for this question.

Most responses correctly resolved the initial velocity vector into its vertical and horizontal components. Better responses used the vector components in the relevant equations and identified the direction of the acceleration.

Question 17

The better responses demonstrated a sound understanding of physics and were able to link the content drawn from several dot points, thus combining relevant equations to demonstrate the relationships involved.

(a) (i) Better responses converted time to seconds, rearranged terms successfully and made no arithmetical or transcription errors. A significant number of responses showed an incorrect selection of equations from the data.

(ii) Many responses incorrectly used the formula for escape velocity rather than calculating orbital velocity from the equations for centripetal and gravitational force.

(b) In the better responses, candidates demonstrated their understanding of the link between orbital velocity and altitude. They were then able to use this to support their argument.

Question 18

The better responses succinctly identified the two clear errors in the statement and used the centripetal force equation to support their judgement. Many candidates incorrectly interpreted the statement as being correct and therefore had difficulty as they tried to justify its elements.

Question 19

(a) The better responses recognised that Mars travelled approximately a third of a revolution in the time that Earth completed half a revolution. Many responses incorrectly showed both planets orbiting clockwise as viewed in the diagram. Poorer responses had trajectories that did not show the Sun at one focus of an elliptical path.

(b) Candidates are reminded that the gain in velocity due to the slingshot effect as a satellite passes by a planet does not provide velocity boost to the launch of a rocket from the Earth. Many responses clearly identified that both the Earth's rotation on its axis and revolution around the Sun contributed to the increased velocity of the rocket on launch but did not relate these to the effect of the Earth's motion on the trajectory.

Question 20

Candidates are reminded to identify and use the key word at the beginning of the question to construct an answer. A significant proportion of candidates could not identify the labelled parts.

Question 21

(a) Good responses clearly identified the mistakes in the motor's construction. Poorer responses described parts of the motor, but not mistakes in its construction. A significant number of candidates could identify two errors in the design but only a small proportion could identify three.

(b) A significant number of candidates did not recognise this as a question about back EMF and so offered explanations dealing with Ohm's law and the power equation. The better responses related the back EMF generated when the coil was spinning to the voltage supplied to the motor. Some weaker responses, in explaining the observation using back EMF, equated the back EMF to a current rather than a voltage.

Question 22

A significant number of candidates recognised the motor in the photographs. In weaker responses, candidates knew the names of the parts of the motor but some had trouble describing their functions. The operation of the motor was, in general, not well described.

In a large number of responses the features of different motors were mixed, adding features from a synchronous motor (slip rings) when describing an induction motor. Candidates are reminded to plan their response to directly address the question and present information logically.

Question 23

(a) Better responses showed understanding of the terms *thermionic devices*, *semiconductors* and *superconductors*.

(b) Better responses presented a scientifically accurate, coherent answer that provided the main features of one advantage with its respective applications. Many responses showed a lack of understanding of the distinction between the terms *advantages* and *applications*. Poorer responses showed limited understanding of the operation of maglev trains.

Candidates are reminded to address the question and present relevant information in an organised response. A significant number of candidates gave a detailed explanation of the BCS theory, which was not required.

Question 24

Most candidates demonstrated a familiarity with the competition between Westinghouse and Edison and were able to show an understanding of the differences between AC and DC generation and distribution.

A majority of responses proposed arguments that Westinghouse could have used to promote AC over DC with the better responses focused on both generation and distribution. A significant number of responses proposed arguments for distribution of AC but did not deal with generation at all.

Most candidates displayed a sound understanding of the function of the transformer in the process of distribution of AC but few candidates could explain the advantages of the AC generator over the DC generator.

Weaker responses gave a list of features and/or advantages of AC but were unable to link the advantages to the features to form arguments.

Question 25

Most candidates were able to sketch in general terms the main features of the solar cell. Better responses clearly identified the correct sequence of steps from the initial light being directed onto the solar cell until the light globe lights up.

Better responses related the electrical properties of the n-type and p-type layers to the creation of a potential difference in the solar cell.

Weaker responses confused the direction of electron flow in the circuit with that in the semiconductor layers.

Question 26

(a) Well answered by nearly all candidates. A significant number of candidates did not plot the first point (0,0).

(b) A significant number of responses did not include the correct order of magnitude for the value of force and consequently that of the gradient.

(c) Many responses identified the appropriate equation. Poorer responses showed a lack of skill in manipulating the equation to obtain the required expression. Some responses contained substitutions into the equation that indicated a lack understanding of the intent of the question.

(d) In a number of responses, the magnitude for the value of the gradient, although not stated in part (b), was correctly used in part (d).

Question 27

Most candidates recognised this as a projectile motion question. A large number of responses used the appropriate equations to carry out calculations but many of these responses contained errors in the substitution of data. In better responses, a valid judgement was made using appropriate calculations to support the arguments. An example of such a response follows.

> Now, $v_y = u_y + at$. If Jordan stayed in the air for 2.5 seconds,
> then by 1.25 seconds, he reaches maximum height.
> $\therefore 0 = u_y + 1.25 \times -9.8$, $\therefore u_y = 12.25$ m/s
>
> However, $\Delta y = u_y t + \frac{1}{2} a_y t^2$
>
> $$\therefore \Delta y = 12.25 \times 1.25 + \frac{1}{2} \times 9.8 \times 1.25^2$$
> $$= 7.66 \text{ m}$$
>
> This states that Jordan reaches a maximum height of 7.66m, which is impossible for a human with physical legs! Since the basket of the basketball is between 2 and 3 metres it would take less than 1 second overall to reach a height of 3 metres above the ground. Therefore the magazine is exaggerating TOO MUCH and the information stated in the information is not valid at all.

Section II – Options

Question 28 – Geophysics

(a) (i) Well answered by the majority of candidates.

(ii) Better responses linked magnetic mineral reversals with magnetic field reversals.

(b) (i) Most responses involved the correct determination of 'g' using the supplied equation, although many candidates had difficulty in selecting the appropriate equation to calculate the Earth's radius.

(ii) Good responses supplied reasons for the longer period by relating it to changes in the gravitational field due to properties of the underlying materials.

(c) Better responses contained descriptions of how satellites provide information in remote sensing, and included good comparisons for geostationary versus low earth orbit satellites. Poorer responses did not relate the types of data with types of satellite.

(d) (i) Good responses demonstrated an understanding of the investigation technique including experimental factors involved and evidence of reliability. Poorer responses gave partial descriptions of possible experiments.

(ii) Better responses answered the question with clear references to the supplied data.

(iii) Better responses contained references to the structures of the earth's interior.

Question 29 – Medical Physics

(a) (i) The better responses were short and referred to high frequency alternating potential difference being applied across the piezoelectric material. Many candidates confused AC with alternating potential difference and a significant few indicated that ultrasound was produced when current went through the crystal.

(ii) While most responses recognised that the image was an ultrasound and described the process of its production in general terms, better responses related reflections to differences in acoustic impedances of materials at boundaries between tissues. Many responses referred to differences in density rather than acoustic impedance and most did not relate the production of the image to time differences in the transducer receiving reflected ultrasound nor did they relate the brightness of the image to the amount of reflection.

(b) (i) Better responses provided clear descriptions of the physical processes and then made judgements based on them.

(ii) While most responses identified the process as Doppler ultrasound, and could describe the Doppler effect with examples, the better responses related specified changes in frequency or wavelength of ultrasound to the direction of blood flow. In some responses it seemed evident that some candidates thought that b (ii) was about PET.

(c) Many good responses demonstrated a sound knowledge of the physical process of MRI and linked this development to the development of semiconductors and superconductors.

A significant number of poorer responses either did not contain information about semiconductors or superconductors or did not refer to the MRI process or indicated a lack of understanding of what 'physical process' meant. Many candidates wrote unnecessarily long responses to this question.

(d) (i) Most of candidates demonstrated an understanding of the angle of incidence being equal to the angle of reflection when they drew a ray of light being totally internally reflected. However, a surprising number of candidates did not draw their incident ray with an incident angle greater than the critical angle. A significant number of candidates did not sketch the diagram faithfully into the answer booklet and subsequently did not convincingly draw the incident ray at an angle greater than the critical angle. It appeared that many candidates mistook the line in the diagram in the question, which represented the critical angle to be the actual incident ray, and they simply drew a reflection of this ray in their sketched answer.

(ii) This part of the question was generally well answered, with most candidates demonstrating clear understanding of the role of non-coherent fibres and coherent fibres in an endoscope. Better responses also showed a clear understanding of the role of the coherent fibre bundles in maintaining the integrity of the image delivered by the endoscope. Poorer responses simply described the role of total internal reflection in the transport of light within optical fibres.

(iii) The best responses described the incorporation of surgical tools into the endoscope, described the insertion of the endoscope and the procedure involved (colonoscopy) in taking the sample. These responses also outlined the suitability of endoscopes for the procedure in the question by giving reasons such as the avoidance of invasive surgery and the ability of endoscopes to provide the surgeon with a clear view during the procedure.

Question 30 – Option Astrophysics

(a) (i) A number of responses indicated that candidates had overlooked the words 'Main Sequence', and therefore their responses continued beyond the required hydrogen and helium. In some responses, the term *elements* seemed to be misunderstood, often resulting in involved descriptions of the total evolution of types of star.

(ii) Most responses identified that the Sun will initially change into a (Red) Giant after its hydrogen is exhausted. In some responses, however, the word *initially* was interpreted as referring to the initial stage of being a Red Giant, eliciting a different response.

(b) (i) The more successful responses included a calculation of colour index for each star and then related this to the blueness of a star. Reference to absolute magnitude was inappropriate to this section.

(ii) Most responses included an identification of the appropriate formula and correct substitutions. In weaker responses, there was some confusion as to which apparent magnitude to substitute and/or problems in manipulating the equation, including the log, to determine distance.

(c) The better responses recognised that the spectrum received from any star consists of both a continuous spectrum (similar to a blackbody) and a set of absorption lines. Candidates are advised to clarify their use of words such as *spectra* in contexts such as this. Some responses excelled by the use of appropriate labelled diagrams or graphs of various kinds, including the H–R diagram.

(d) (i) Candidates performed well in this part of the question. Good responses related features of the light curve to justify a binary system. In better responses candidates succinctly identified that the light curve had 'periodic dips in intensity'. In poorer responses a binary system was described rather than the features of the light curve necessary to identify the presence of a binary system.

(ii) Candidates are reminded that this part of the question required a change of units for period from days to seconds and then squaring it.

(iii) Candidates were challenged by this question, having difficulty using the relationship provided to determine the answer. Poorer responses indicated that there was some confusion in understanding of the terms luminosity, magnitude and intensity

Question 31 – Quantum to Quarks

(a) (i) Well answered. Most candidates could name two features of the strong nuclear force.

(ii) Well answered. Most candidates correctly identified the required laws. Conservation of mass was a common error.

(b) (i) Well answered. Most responses demonstrated that the correct answers could be deduced from the tabulated data.

(ii) Most responses indicated an understanding of the need to calculate a difference in the masses before and after the fission occurs. Better responses contained few arithmetic errors. Simple errors in addition and subtraction were common.

(c) Better responses provided a succinct description that considered both sides of the question, the standard model and particle accelerators, and particularly how they were linked together as asked in the question. Poorer responses contained the history of the atomic model but stopped short of the 'standard model'. There was also some confusion between neutron scattering and particle acceleration. Many candidates wrote unnecessarily long responses to this question.

(d) Candidates are reminded that practical experiences are a mandatory part of the course and are examinable.

(i) Better responses named the required equipment without describing the experiment.

(ii) Candidates tended to answer this part of the question better than other parts. Poorer responses did not contain the second calculation.

(iii) A majority of candidates successfully answered this question. Poorer responses named two limitations but did not describe them.

Question 32 – Age of Silicon

Most candidates attempted all sections.

(a) (i) Good responses clearly outlined the function of the parts of a relay, including the use of diagrams.
(ii) Good responses linked the cause and effect to explain how the relay works.

(b) (i) Well answered.
(ii) There was a wide variety of correct responses.

(c) Most responses provided good specific detail. Good responses contained details as to the specific advantages/disadvantages of each generation of devices and good closing summaries that made judgements about their impact on computers.

(d) Better responses clearly showed in parts (i) and (ii) the sequence of steps required to calculate and verify V_{out}.

Physics

2004 HSC Examination Mapping Grid

Question	Marks	Content	Syllabus Outcomes
Section I Part A			
1	1	9.2.2 Col 2 dot 1	H9
2	1	9.2.3 Col 2 dot 2 / Col 3 dot 2, 9.2.1 Col 3 dot 3	H9, H6, H12
3	1	9.2.3 Col 3 dot 2 / Col 2 dot 3	H9, H12
4	1	9.2.4 Col 3 dot 5	H6, H12
5	1	9.2.4 Col 2 dot 9	H6
6	1	9.2.4 Col 2 dot 4	H6, H14
7	1	9.3.4 Col 3 dot 6	H7, H13
8	1	9.3.4 Col 3 dot 2	H7, H12
9	1	9.3.1 Col 3 dot 4	H9, H12
10	1	9.3.1 Col 2 dot 4	H9, H12
11	1	9.3.2 Col 2 dot 5 / Col 3 dot 4, 9.3.5 Col 2 dot 1	H3, H9
12	1	9.4.1 Col 3 dot 1	H10
13	1	9.4.3 Col 2 dot 6, 7	H7
14	1	9.4.2 Col 3 dot 4	H10, H12
15	1	9.4.2 Col 2 dot 3	H10, H1
Section I Part B			
16	4	9.2.2 Col 3 dot 1	H6, H12.4
17 (a) (i)	2	9.2.2 Col 3 dot 5	H9, H6
17 (a) (ii)	2	9.2.2 Col 3 dot 4, 5, 9.2.3 Col 3 dot 2	H9, H6
17 (b)	2	9.2.2 Col 2 dot 10	H9, H6
18	4	9.2.2 Col 2 dot 8	H6, H13, H14
19 (a)	3	9.2.2 Col 2 dot 6, dot 10	H6, H13, H14
19 (b)	3	9.2.2 Col 2 dot 6	H6, H13
20	2	9.3.3 Col 3 dot4	H7, H13
21 (a)	3	9.3.1 Col 3 dot2	H9, H12, H14
21 (b)	3	9.3.2 Col 2 dot 5	H7, H9, H14
22	3	9.3.3 Col 2 dot 3	H9
23 (a)	3	9.4.3 Col 2 dot 8	H3, H1
23 (b)	3	9.4.4 Col 2 dot 7 / Col 3 dot 5	H3
24	6	9.3.3 Col 1 / Col 2 dot 3, 4, 5, Col 3 dot 2, 3	H1, H9, H13
25	6	9.4.2 Col 3 dot 3, 9.4.3 Col 2 dot 3	H7, H10
26 (a)	3	9.1. H13.1 (f)	H13, H14

Question	Marks	Content	Syllabus Outcomes
26 (b)	1	9.1 H14.1 (f)	H14
26 (c)	2	9.3.1 Col 2 dot 2 / Col 3 dot 3	H14, H9
26 (d)	1	9.1 H14.1 (f)	H14
27	4	9.1 H12 (f), 9.2.2 Col 3 dot 1	H12, H9
Section II Question 28 — Geophysics			
28 (a) (i)	1	9.5.1 Col 2 dot, 9.5.4 Col 2 dot 2	H10
28 (a) (ii)	3	9.5.1 Col 2 dot 1	H9
28 (b) (i)	4	9.5.2 Col 3 dot 3	H2, H12
28 (b) (ii)	2	9.5.2 Col 3 dot 4, 8	H2
28 (c)	7	9.2.2 Col 2 dot 9, 9.5.2 Col 2 dot 3, 5, 9	H4
28 (d) (i)	3	9.5.1 Col 2 dot 2	H12, H14
28 (d) (ii)	2	9.5.1 Col 2 dot 1, Col 3 dot 2	H14
28 (d) (iii)	3	9.5.3 Col 2 dot 1, 2, 3, 5	H8
Section II Question 29 — Medical Physics			
29 (a) (i)	1	9.6.1 Col 2 dot 2	H7, H8
29 (a) (ii)	3	9.6.1 Col 2 dot 4, 6	H7, H8
29 (b) (i)	3	9.6.3 Col 2, dot 2, 3, 9.6.4 Col 3 dot 4, 5	H1, H13
29 (b) (ii)	3	9.6.1 Col 2, dot 8, 9	H4
29 (c)	7	9.6.4 Col 2 dot 3, 4, 5, 6, 9.4.4 Col 2 dot 7, Col 3 dot 5, 9.4.3 Col 3 dot 3	H3, H7, H9, H10
29 (d) (i)	2	9.6.2 Col 2 dot 5, Col 3 dot 3	H7, H8, H13
29 (d) (ii)	3	9.6.2 Col 2 dot 6, 7	H7, H8
29 (d) (iii)	3	9.6.2 Col 2 dot 7	H7, H8
Section II Question 30 — Astrophysics			
30 (a) (i)	2	9.7.6 Col 2 dot 4	H10, H7
30 (a) (ii)	2	9.7.6 Col 2 dot 2	H7
30 (b) (i)	3	9.7.4 Col 2 dot 4	H2, H14
30 (b) (ii)	3	9.7.4 Col 3 dot 1	H2, H14
30 (c)	7	9.4.2 Col 2 dot 3, 9.7.3 Col 2, dot 1, 5 / Col 3 dot 1	H2, H7, H10
30 (d) (i)	2	9.7.5 Col 3 dot 1	H14
30 (d) (ii)	3	9.7.5 Col 3 dot 2	H6
30 (d) (iii)	3	9.7.5 Col 3 dot 1, 2	H14
Section II Question 31 — From Quanta to Quarks			
31 (a) (i)	2	9.8.3 Col 2 dot 8	H10

Question	Marks	Content	Syllabus Outcomes
31 (a) (ii)	2	9.8.3 Col 2 dot 2	H6, H7
31 (b) (i)	2	9.8.4 Col 2 dot 5	H10
31 (b) (ii)	4	9.8.3 col 3 dot 2, Col 2 dot 9	H7, H10
31 (c)	7	9.8.4 Col 2 dot 4, 5, 9.4.1 Col 2 dot 5	H1, H2, H3, H6
31 (d) (i)	2	9.8.1 Col 3 dot 1	H11
31 (d) (ii)	4	9.8.1 Col 2 dot 5, Col 3 dot 3	H7, H12
31 (d) (iii)	2	9.8.1 Col 2 dot 6	H10
Section II **Question 32 — The Age of Silicon**			
32 (a) (i)	2	9.9.4 Col 3 dot 2	H9
32 (a) (ii)	2	9.9.4 Col 3 dot 1	H9
32 (b) (i)	2	9.9.5 Col 2 dot 1 / Col 3 dot 2	H2, H13
32 (b) (ii)	4	9.9.5 Col 2 dot 1 / Col 3 dot 2	H2, H13
32 (c)	7	9.9.3 Col 3 dot 8 / Col 3 dot 3, 9.9.1 Col 2 dot 1, 2, 3, 4 / Col 3 dot 1	H1, H3, H7, H9
32 (d) (i)	2	9.9.6 Col 2 dot 8	H7, H9, H14
32 (d) (ii)	3	9.9.6 Col 2 dot 8 / Col 3 dot 3, 4	H7, H9, H14
32 (d) (iii)	3	9.9.6 Col 2 dot 11, 12	H9

BOARD OF STUDIES
NEW SOUTH WALES

2004 HSC Physics
Marking Guidelines

Section I, Part B

Question 16

Outcomes assessed: H6, H12

MARKING GUIDELINES

Criteria	Marks
• Correct solution given (working shown) • Correct substitutions (both data and signs) into relevant formulae (arithmetic errors ignored)	4
• Relevant formulae used but u_x and u_y transposed consistently OR • All correct but time of flight value is halved OR • Lack of use of sign convention	3
• Relevant formulae used but u_x and u_y transposed inconsistently OR • Angle not taken into account but *+ve* and *–ve* convention used to determine answer OR • Initial velocity resolved into components correctly AND • Working data has value for 'g' and initial velocity in different directions (+ve and –ve)	2
• Initial velocity resolved into components correctly OR • Working data has value for '*g*' and initial velocity in different directions (*+ve* and *–ve*)	1

Question 17 (a) (i)

Outcomes assessed: H9, H6

MARKING GUIDELINES

Criteria	Marks
• Correctly calculates mass of the moon	2
• Uses correct formula but makes incorrect substitution	1

Question 17 (a) (ii)

Outcomes assessed: H9, H6

MARKING GUIDELINES

Criteria	Marks
• Correctly calculates the magnitude of the orbital velocity of the command module	2
• Uses correct relationship but makes incorrect substitution	1

Question 17 (b)

Outcomes assessed: H9, H6

MARKING GUIDELINES

Criteria	Marks
• Any valid reasoning that leads to the independence of the mass of an object and its orbital speed and altitude	2
• State period independent of mass or period only depends on radius/altitude OR • Orbital velocity depends on mass of central body not mass of orbiting body (statement only)	1

Question 18

Outcomes assessed: H6, H14, H13

MARKING GUIDELINES

Criteria	Marks
• Makes a correct judgement supported by arguments addressing horizontal forces and backed up by numerical data	4
• Makes a judgement insufficiently supported by argument and/or numerical data	2–3
• Makes correct statement about car moving in circular motion	1

Question 19 (a)

Outcomes assessed: H14, H6, H13

MARKING GUIDELINES

Criteria	Marks
• Appropriately locates the positions of Earth and Mars and shows the trajectory correctly	3
• Locates Earth and Mars appropriately OR • Locates Earth correctly and has a trajectory that forms part of a plausible ellipse (with the sun at a focus) passing through launch location of Earth and the incorrect location of Mars	2
• Locates Earth correctly OR • Shows a plausible trajectory between incorrectly located planets i.e. orbit is plausibly elliptical around the sun	1

Question 19 (b)

Outcomes assessed: H6, H13

MARKING GUIDELINES

Criteria	Marks
• Identifies that velocity imparted by rocket motors to satellite is augmented by Earth's motion and provides any two of the following supporting points: • Axial rotation of Earth augmenting launch towards east • Orbital motion of Earth (revolution) augmenting departure from Earth orbit to interplanetary trajectory • The launch window from this position on the Earth's orbit provides the shortest trajectory	3
• Identifies that the velocity imparted by rocket motors to satellite is augmented by Earth's motion and provides one of the following supporting points: • Axial rotation of Earth augmenting launch towards east • Orbital motion of Earth (revolution) augmenting departure from Earth's orbit to interplanetary trajectory • The launch window from this position on the Earth's orbit provides the shortest trajectory	2
Provides one of the following supporting points: • Axial rotation of Earth augmenting launch towards east • Orbital motion of Earth (revolution) augmenting departure from Earth's orbit to interplanetary trajectory • The launch window from this position on the Earth's orbit provides the shortest trajectory	1

Question 20

Outcomes assessed: H7, H13

MARKING GUIDELINES

Criteria	Marks
• Correctly clarifies the role of <u>both</u> structures A – protects the transmission line from lightning strikes B – insulates the wires from the supporting structures	2
• Only makes clear the role of one of the structures A or B	1

Question 21 (a)

Outcomes assessed: H9, H12, H14

MARKING GUIDELINES

Criteria	Marks
• Correctly identifies THREE mistakes in the construction of the motor	3
• Correctly identifies TWO mistakes in the construction of the motor	2
• Correctly identifies ONE mistake in the construction of the motor	1

Question 21 (b)

Outcomes assessed: H7, H9, H14

MARKING GUIDELINES

Criteria	Marks
• Identifies link between back emf and a motor operating normally (rotation) • Demonstrates understanding that back emf opposes supply emf • Concluding statement that when the coil stops rotating the net emf increases and so does the current	3
• Link between back emf and lower current made	2
• Back emf identified	1

Question 22

Outcomes assessed: H9

MARKING GUIDELINES

Criteria	Marks
• Identifies the rotor and the stator, (their relative positions) and describes one • States that induction is responsible for the movement of the rotor (or no current passes directly to rotor or similar statement) • States one other relevant feature (may be an expanded description relating to rotor and stator)	3
• Refers to terms rotor and stator OR • Describes the rotor or stator OR • States that induction is responsible for the movement of the rotor (or no current passes directly to rotor or similar statement) AND • States one other relevant feature	2
• At least one feature OR • Names rotor and stator	1

Question 23 (a)

Outcomes assessed: H3, H1

MARKING GUIDELINES

Criteria	Marks
• Lists THREE correct disadvantages	3
• Lists TWO correct disadvantages	2
• Lists ONE correct disadvantage	1

Question 23 (b)

Outcomes assessed: H3

MARKING GUIDELINES

Criteria	Marks
• Gives main features of ONE advantage with its respective applications	3
• ONE advantage and ONE relevant application	2
• ONE advantage only OR • ONE application	1

Question 24

Outcomes assessed: H1, H9, H13

MARKING GUIDELINES

Criteria	Marks
• Well presented arguments discussing the advantages of Westinghouse's AC system of generation and distribution • Refers to both generation and distribution over longer distances	5–6
• Outlines advantages of AC over DC • Makes references to generation and distribution • Provides some reasons to support argument	4
• Outlines advantages of AC and DC • Makes well presented arguments for generation or distribution • Provides some reasons to support argument	3
• Answer gives attributes of AC but no reference to advantages over DC • Supporting statements are lists only OR • Features of AC discussed with brief outline but no clear evidence of understanding why an advantage	1–2

Question 25

Outcomes assessed: H7, H10

MARKING GUIDELINES

Criteria	Marks
• Identifies the photo-electric effect on semiconductors, the generation of free electrons and holes, their diffusion, the creation of a potential difference, and the production of a current	6
• Identifies the photo-electric effect, the generation of free electrons and holes, the creation of a potential difference or electron diffusion and the production of a current	5
• Identifies the photo-electric effect, the generation of free electrons and holes, and of current flowing through the circuit	4
• Identifies the photo-electric effect and current flowing OR • Outlines properties of *p* and *n* type layers with reference to free electrons and holes	3
• Identifies that the current flows during the generation of free electrons/holes OR • Outlines properties of *p* and *n* type layers	2
• Identify that free electrons are generated OR • A simple energy transformation OR • Identifies the photo-electric effect	1

Question 26 (a)

Outcomes assessed: H13, H14

MARKING GUIDELINES

Criteria	Marks
• Correctly plots the 5 points • Correctly draws line of best fit that indicates an understanding of what this is	3
• Correctly plots the 5 points • Fails to draw line of best fit OR • Correctly draws a line of best fit through the plotted points of which at least two are correct	2
• At least two are correctly plotted and no line of best fit or wrong line	1

Question 26 (b)

Outcomes assessed: H14

MARKING GUIDELINES

Criteria	Marks
• Gradient correctly determined from the line of best fit	1

Question 26 (c)

Outcomes assessed: H14, H9

MARKING GUIDELINES

Criteria	Marks
• Answer demonstrates an understanding of relationship between k and gradient	2
• Correctly identifies the formula required	1

Question 26 (d)

Outcomes assessed: H14

MARKING GUIDELINES

Criteria	Marks
• Correctly determines k using the (value of the) gradient from part (b) and the equation in part (c)	1

Question 27

Outcomes assessed: H12, H9

MARKING GUIDELINES

Criteria	Marks
• Correctly determines the take off speed and recognises that this is impossible OR correctly determines that the height to which the athlete jumps is impossible AND hence the information is not accurate	4
• Correctly determines the take off speed and recognises that this is impossible OR correctly determines that the height to which the athlete jumps is impossible BUT does NOT make an assessment of the article	3
• Makes a correct calculation but does not recognise the answer as being impossible nor the flawed nature of the article OR • Makes a conclusion based on incorrect value for the time of flight OR • Makes an incorrect substitution into a correct equation with conclusion and assessment of the article consistent with the calculated values	2
• States that staying in the air for 2.5 seconds is impossible, with no justification OR • Makes a correct statement OR • Substitutes incorrect time of flight	1

Section II

Question 28 (a) (i)

Outcomes assessed: H10

MARKING GUIDELINES

Criteria	Marks
• TWO properties of earth materials listed	1

Question 28 (a) (ii)

Outcomes assessed: H9

MARKING GUIDELINES

Criteria	Marks
• Description of alignment of magnetic minerals in rocks related to Earth's magnetic field at times of formation • Observation of reversals indicates magnetic field reversal occurring on a regular basis	3
• As above, but talk about rocks rather than magnetic minerals OR • Describes alignment reversals but does not link to magnetic field (or vice versa)	2
• Mention that Earths magnetic field has been reversed in the past OR • Magnetic minerals in rocks align with Earths magnetic field	1

Question 28 (b) (i)

Outcomes assessed: H2, H12

MARKING GUIDELINES

Criteria	Marks
• Correct value for radius determined	4
• Correct value of '*g*' obtained through correct substitution • Attempt at finding '*r*' made using calculated value of '*g*'	3
• Correct value of '*g*' obtained through correct substitution OR • Data sheet value of '*g*' used and correct substitution into determining '*r*'	2
• Attempt to find '*g*' OR • Attempt made at finding '*r*' using '*g*' from data sheet	1

Question 28 (b) (ii)

Outcomes assessed: H2

MARKING GUIDELINES

Criteria	Marks
• Links longer period to smaller value of '*g*' (may be inferred) • Provides a correct reasoning for variation consistent with strength of gravitational field	2
• Indicates that 'g' is smaller OR • Links a value of '*g*' with strength of gravitational field	1

Question 28 (c)

Outcomes assessed: H4

MARKING GUIDELINES

Criteria	Marks
• Describes how satellites provide information about the Earth by remote sensing using geostationary and low Earth orbit satellites. Puts forward valid reasons for the preference of one type of satellite for the collection of specific data	6–7
• Describes the type of information provided by satellites • Makes some comparisons of geostationary and low Earth orbit satellites • Outlines reasons for preferring one type of satellite over the other	5
• Outlines the type of information provided by satellites • Makes some comparisons of geostationary and low Earth orbit satellites • Outlines reasons for preferring one type of satellite over the other	4
• Outlines the type of information provided by satellites • Outlines some features of geostationary and/or low Earth orbit satellites	3
• Identifies the type of information provided by satellites • Identifies some features of geostationary and/or low Earth orbit satellites	2
• Identifies a correct fact about satellites OR • Identifies at least two types of information that can be obtained from remote sensing	1

Question 28 (d) (i)

Outcomes assessed: H12, H14

MARKING GUIDELINES

Criteria	Marks
• Outline of experimental method used which shows familiarity with doing experiments • Evidence of reliability from experimental method	3
• Outline of experimental method used which shows familiarity with experiments but no clear links to reliability	2
• Outline of experimental method only	1

Question 28 (d) (ii)

Outcomes assessed: H14

MARKING GUIDELINES

Criteria	Marks
• Discontinuity indicates changes in composition of rock type and or effects of temperature and pressure on structures OR • Relate above answer to specific layer of Earth's internal structure	2
• Recognition of reason for discontinuity at either of named points	1

Question 28 (d) (iii)

Outcomes assessed: H8

MARKING GUIDELINES

Criteria	Marks
• Link velocity changes in P & S waves to variation in density as shown on graph • Identify 50km as site of change in structure / density therefore refraction occurring (may relate to 2895 instead) • Identify 2895km as change of state to liquid due to loss in velocity of P waves and stopping of S waves	3
• TWO of above points	2
• ONE of above points	1

Question 29 (a) (i)

Outcomes assessed: H7, H8

MARKING GUIDELINES

Criteria	Marks
• Alternating potential difference (or voltage) applied to piezoelectric crystal	1

Question 29 (a) (ii)

Outcomes assessed: H7, H8

MARKING GUIDELINES

Criteria	Marks
• Reflection of ultrasound at tissue boundary • Distances calculated from time for signal to return to ultrasound transducer • The brightness difference is greater if the difference between acoustic impedance is greater such as, flesh / bone showing up the skulls clearly	3
• Reflection of ultrasound at skull boundary and mentions the differences in acoustic impedence or an indication that this is an ultrasound	2
• Sound waves reflect off the heads/skulls OR indicates that this is an ultrasound	1

Question 29 (b) (i)

Outcomes assessed: H1, H13

MARKING GUIDELINES

Criteria	Marks
• Makes a clear judgement based on the functional nature of PET providing information about the location and level of activity and location of areas (structure and function) in the brain associated with tasks such as seeing and learning or other brain functions AND • States that glucose concentrates more in areas of greater metabolic activity • Tagged glucose produces positrons which interact with electrons to produce gamma rays • These gamma rays can be used to indicate areas of activity	3
• States that glucose concentrates more in areas of greater metabolic activity • Tagged glucose produces positrons which interact with electrons to produce gamma rays • These gamma rays can be used to indicate areas of activity OR • Makes a judgement and states any two of the points above	2
• PET is functional OR • F-18 is a gamma-source or positron source OR • PET shows active areas OR • Glucose is used in greater amounts by more active areas	1

Question 29 (b) (ii)

Outcomes assessed: H4

MARKING GUIDELINES

Criteria	Marks
• Identifies the process as Doppler ultrasound AND • Describes the movement of blood towards transducer (or Ultrasound head or observer) as increasing the frequency and movement away decreases frequency AND • States that the magnitude (or amount) of the change depends on the relative speed	3
• Identifies the process as Doppler ultrasound and states that movement of blood produces a frequency change of the ultrasound	2
• Identifies the process as being Doppler ultrasound OR • Description of the Doppler effect	1

Question 29 (c)

Outcomes assessed: H3, H7, H9, H10

MARKING GUIDELINES

Criteria	Marks
• Makes a judgement supported by evidence linked to identified advances in knowledge about both semiconductors and superconductors which substantiates their impact on MRI development • Describes the physical basis of MRI	6–7
• Describes the physical basis of MRI and • Makes a judgment about the impact/advances of semiconductors and superconductors but does not support the assessment with clear, specific facts OR • Makes a judgement about the impact/advances of semiconductors or superconductors with evidence substantiating their impact on MRI development	5
• Describes the physical basis of MRI • Makes a judgement about the impact/advances of semiconductors and superconductors with limited support for one technology	4
• Outline the physical basis of the MRI OR • Outlines parts of the MRI process with parts omitted AND • Identifies advances in semiconductor or superconductor technology	3
• Outlines parts of the MRI process with parts omitted OR • Identifies advances in semiconductor or superconductor technology	2
• Identifies a correct fact about MRI or semiconductor or superconductor technology	1

Question 29 (d) (i)

Outcomes assessed: H7, H8, H13

MARKING GUIDELINES

Criteria	Marks
• Ray of light strikes P at an angle greater than I_c as measured from the normal AND • Angle of reflection = angle of incidence	2
Any • Reflected ray with angle of incidence = angle of reflection	1

Question 29 (d) (ii)

Outcomes assessed: H7, H8

MARKING GUIDELINES

Criteria	Marks
• Describes the transmission of light to the area being imaged by non-coherent fibre bundles and the return of the image via coherent fibres including a description of the role of coherent fibres in maintaining the integrity of the image	3
Any two of the following points: • Describes the transmission of light to the area being imaged by non-coherent fibre bundles • Describes the return of the image via coherent fibre bundles • Describes the role of the coherent fibres in maintaining the integrity of the image	2
• Describes the role of the total internal reflection in the transmission of light to the optical fibres OR • Describes the light returning from the object being viewed via coherent bundle of fibre OR • Describes the overall process of transmission, reflection and return of the light creating the image	1

Question 29 (d) (iii)

Outcomes assessed: H7, H8

MARKING GUIDELINES

Criteria	Marks
• Describes the incorporation of tissue sampling instruments into the endoscope AND • TWO reasons for use (eg real time, real colour, minimally invasive cost effective)	3
• Describes the incorporation of tissue sampling instruments into the endoscope AND • ONE reason for use	2
• ONE reason for use OR • One description of use	1

Question 30 (a) (i)

Outcomes assessed: H10, H7

MARKING GUIDELINES

Criteria	Marks
• Identifies both elements correctly	2
• Identifies ONE element correctly	1

Question 30 (a) (ii)

Outcomes assessed: H7

MARKING GUIDELINES

Criteria	Marks
• Identifies type of star and mode of nuclear burning	2
• Identifies either the type of star or the mode of nuclear burning	1

Question 30 (b) (i)

Outcomes assessed: H2, H14

MARKING GUIDELINES

Criteria	Marks
• Calculates correctly the colour index of each of the THREE stars • Identify that the bluest star has the smallest value of the colour index	3
• Calculates correctly the colour index of least one star and • Identifies that bluest star has smallest colour index OR • Calculates correctly the colour index of each of the THREE stars but identifies the wrong star	2
• Shows understanding of the concept of colour index, but incorrectly determines its value OR • Correctly calculates one value of the colour index OR • Identifies the correct star	1

Question 30 (b) (ii)

Outcomes assessed: H2, H14

MARKING GUIDELINES

Criteria	Marks
• Identifies correct formula to apply, rearranges equation correctly, substitutes the appropriate values from the table	3
• Identifies correct formula, but either rearrange equation incorrectly, substitutes in a wrong value OR • Makes a substitution error	2
• Identifies correct formula, but makes two mistakes in rearranging or substituting	1

Question 30 (c)

Outcomes assessed: H2, H7, H10

MARKING GUIDELINES

Criteria	Marks
• Correctly describes at least one feature of the spectrum of a star, and links these to determine the temperature, chemical composition, rotational and transitional velocity of the star	6–7
• Describes or outlines at least one feature of the spectrum, and correctly describes how it/they may be used to determine 2 characteristics or outlines all three characteristics	4–5
• Outlines at least one feature and correctly outlines how to determine two of the characteristics	3
• Outlines a feature of a star and outlines how one characteristic is determined OR • Outlines how two or more characteristics are determined	2
• Identifies features of the spectrum of a star OR • Identifies how ONE characteristic is determined	1

Question 30 (d) (i)

Outcomes assessed: H14

MARKING GUIDELINES

Criteria	Marks
• Identifies TWO features which provide evidence for an eclipsing binary system	2
• Identifies ONE of the features	1

Question 30 (d) (ii)

Outcomes assessed: H6

MARKING GUIDELINES

Criteria	Marks
• Determines orbital period from graph • Correct substitution into correct formula	3
• Determines orbital period from graph • Identifies correct formula or • Makes one incorrect substitution into the correct formula	2
• Identifies the correct equation OR • Determines orbital period from graph	1

Question 30 (d) (iii)

Outcomes assessed: H14

MARKING GUIDELINES

Criteria	Marks
• Relates amount of dip in light curve to fraction blocking light from star • Calculates area blocked by the star (or intensity ratios) to determine the fractional ratio	3
• Identifies that dip in light curve is due to blocking of star; but incorrectly calculates the relationships	2
• Identifies that dip in light curve is related to blocking of light OR • Identifies a relevant mathematical relationship	1

Question 31 (a) (i)

Outcomes assessed: H10

MARKING GUIDELINES

Criteria	Marks
• Two features correctly identified	2
• One feature correctly identified	1

Question 31 (a) (ii)

Outcomes assessed: H6, H7

MARKING GUIDELINES

Criteria	Marks
• Names the two laws	2
• Names one law	1

Question 31 (b) (i)

Outcomes assessed: H10

MARKING GUIDELINES

Criteria	Marks
• Correctly states the quark composition of the neutron AND the negative pion	2
• Correctly states the composition of either	1

Question 31 (b) (ii)

Outcomes assessed: H7, H10

MARKING GUIDELINES

Criteria	Marks
• Correctly substitutes data in the correct equation to determine energy released	4
• Identifies correct energy equation AND • Mass defect	3
• Calculate the mass defect	2
• Calculate the sums of the masses of reactants OR products	1

Question 31 (c)

Outcomes assessed: H1, H2, H3, H6

MARKING GUIDELINES

Criteria	Marks
• Description of the key features and components of the standard model of matter and • Links these to the ways accelerators are used as probes	6–7
• Describes key features and components of the standard model of matter • Outlines how accelerators are used as probes	4–5
• Outlines the key features or components of the standard model of matter • Outlines way accelerators have been used as probes	2–3
• Identifies a correct feature of the standard model of matter OR • Outlines the way accelerators are used as probes	1

Question 31 (d) (i)

Outcomes assessed: H11

MARKING GUIDELINES

Criteria	Marks
• Correctly identifies the two pieces of equipment used	2
• Correctly identifies one piece of equipment used	1

Question 31 (d) (ii)

Outcomes assessed: H7, H12

MARKING GUIDELINES

Criteria	Marks
• Correctly identify appropriate equations and correct substitution	4
• Correct substitution into Balmer/Rydberg equation AND • Identification of additional equations required	3
• Identifies relevant equations OR • Correct substitution into Balmer/Rydberg equation to determine wavelength	2
• Identifies one of the correct equations required	1

Question 31 (d) (iii)

Outcomes assessed: H10

MARKING GUIDELINES

Criteria	Marks
• Two limitations described	2
• One limitation described	1

Question 32 (a) (i)

Outcomes assessed: H9

MARKING GUIDELINES

Criteria	Marks
• Correctly outlines role of both components	2
• Correctly outlines role of ONE	1

Question 32 (a) (ii)

Outcomes assessed: H9

MARKING GUIDELINES

Criteria	Marks
• Links cause and effect	2
• States cause or effect	1

Question 32 (b)

Outcomes assessed: H2, H13

MARKING GUIDELINES

Criteria	Marks
• Identify gate correctly AND • Determine output correctly	2
• Identify gate incorrectly but match output correctly to this identification	1

Question 32 (b) (ii)

Outcomes assessed: H2, H13

MARKING GUIDELINES

Criteria	Marks
• Correctly determines that the gate should be an 'OR' and correctly determines the truth table	4
• Correctly determines the truth table but chooses wrong gate OR • Chooses wrong gate due to one mistake in truth table	3
• Makes more than one error in truth table	2
• Correctly states output of *C* OR • States the correct gate	1

Question 32 (c)

Outcomes assessed: H1, H3, H7, H9

MARKING GUIDELINES

Criteria	Marks
• Makes a judgement supported by a description of the properties of the three types of devices and the affect on the computing power due to a higher concentration of components on a chip	6–7
• Describes the properties of the three types of devices and makes unsupported statements on the effect on computing power	4–5
• Outlines properties of the three types of devices	3
• Outlines properties of at least two devices OR • Outlines developments in computers	2
• Identifies one correct property of a device or a development in computers	1

Question 32 (d) (i)

Outcomes assessed: H7, H9, H14

MARKING GUIDELINES

Criteria	Marks
• Correctly determines V_{out}	2
• Uses correct formula but makes a mistake in substitution	1

Question 32 (d) (ii)

Outcomes assessed: H7, H9, H14

MARKING GUIDELINES

Criteria	Marks
• Correctly calculates and verifies V_{out}	3
• Correctly calculates V_{out} OR • Correctly verifies V_{out}	2
• Attempts to calculate V_{out} using the results from part (a) and Diagram 2	1

Question 32 (d) (iii)

Outcomes assessed: H9

MARKING GUIDELINES

Criteria	Marks
• States input resistors provide summed input current • Identifies the 300k resistor as the negative feedback resistor • Explains amplifier output provides exactly opposing feedback current through the feedback resistor	3
• Two of the above points	2
• One of the above points	1