2003 HSC Notes from the Marking Centre Physics

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2003 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 2003 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 2003 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 2003, approximately 9501 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.

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Section I – Core

Part A – Multiple choice

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

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

Part B

General Comments

There is substantial evidence in responses to indicate that candidates are not following the instructions provided on the examination paper.

(a) Answer the question in the spaces provided.
A great number of responses contained irrelevant information, suggesting that answers had been rote-learnt to address specific areas of the syllabus, then written down regardless of what the question was actually asking. Candidates should, where possible, make use of clearly labelled diagrams to supplement a concise response. 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.

(b) 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.

Specific Comments

Question 16

On balance all parts of this question were well answered and presented few difficulties to the bulk of the candidature. A common error in part (b) was the placement of dependent and independent variables on the wrong axes.

Question 17

(a) Many candidates wrongly substituted 9.8 for G and others used Newton's very similar equation for gravitational force.

(b) Most candidates appreciated the equality of energies but then had trouble manipulating the equations to give v.

(c) Many candidates had a very poor understanding of the physics behind launching a satellite. Even those who knew that most are launched towards the east, were not sure why.

Question 18

(a) Most candidates did not correctly give two features of the aether model and instead gave two properties of aether.

(b) Good responses consisted of a series of succinct, sequential steps, with a description of the anticipated result and using key phrases such as 'interferometer' and 'interference pattern'. Neat, labelled diagrams of the interferometer were a feature of many responses. Weaker responses illustrated poor understanding of the apparatus or procedure used by Michelson and Morley, or of the theoretical concepts involved.

Question 19

The majority of responses included the substitution of correct values into the appropriate equation; however there were some errors in conversion of units and in recognising the correct length. Some candidates could not indicate the correct direction of the force on the wires.

Question 20

Many candidates failed to recognise the significance and purpose of the copper wire in the second figure or did not interpret the question correctly. Better candidates, having carefully considered the information given, were able to give a succinct and logically sequential response to the question to gain full marks. First-hand practical knowledge seemed to have assisted these candidates. The majority of the candidates displayed some knowledge of the theoretical aspects of electromagnetic induction.

Question 21

Many responses were longer than was indicated by the space provided.

(a) Superior responses provided the cause and effect relationship between number of turns in the coils, voltage and current. Incorrect responses included power transmission.

(b) The better responses linked the concept of changing magnetic flux to how a transformer worked, and identified the differences between AC and DC.

Question 22

A very significant proportion of candidates misinterpreted this question, despite it being a direct quote from the syllabus. They read the question so that 'generated current' became 'pre-existing current' and so dealt with the motor effect. From statements written by the candidates it was obvious that the question had been misinterpreted rather than the correct answer not being known. Many candidates knew that there was a relationship between induced current in a conductor and change in flux although many confused a change in flux with magnetic field strength.

Many candidates had no concept of controlled variables. They understood this to mean variables that the experimenter varied, or to repeat the experiment. A large number of candidates ignored this section of the question or simply listed variables without indicating 'how' they were controlled.

A large number of candidates had no idea of how ammeters and voltmeters are connected in circuits and many believe that current is measured on a voltmeter.

A disappointingly large number of candidates put a DC source of current into their sketched circuit.

Question 23

(a) Many candidates simply described the Meissner effect without explaining the balance between the weight force and the force of magnetic repulsion resulting from the interaction of the fields of the induced current and hovering magnet.

(b) Candidates knew a lot about conduction in metals and superconductors; however very few made comparisons between the two models. Very few responses consisted of tables to make comparisons, with the great majority of candidates simply listing features of both, and using no linking or comparative terms. Those responses including clearly labelled diagrams of electrons moving through both structures usually scored full marks.

Question 24

Many candidates were familiar with Thomson's experiment but a significant number were unable to outline both parts of it. Still fewer candidates were able to show how Thomson linked these two parts. Most candidates who used equations were able to use them to show the link between the two parts of Thomson's experiment.

A significant number of candidates confused Thomson's experiment with some other cathode ray experiment or with Millikan's oil drop experiment.

The better responses showed evidence of planning to use only the space provided. They included diagrams as an aid to their outline, although a significant number of these were confusing and misleading.

Question 25

(a) Most candidates were able to use the data given to calculate the energy of the photon, although some confused wavelength with frequency.

(b) Most candidates were able to cite the work function or the threshold frequency as an explanation for the observation described in the question, but many then went on to explain what would happen if the frequency was increased without explaining why it would happen in terms of photon energy.

Better responses contained reference to part (a) to provide information in a quantum explanation involving the energy of the photons.

Question 26

Many responses included some description of Einstein's contribution to Special Relativity and to Quantum Theory, but few successfully linked the contributions to how they changed the direction of scientific thought in the 20th century.

Question 27

The better responses connected the stimulus material with the question and made the appropriate link between centripetal force and the magnetic force. They then correctly identified mass dilation and described the appropriate change to the magnetic field.

Weaker responses made the link between centripetal force and magnetic force but then failed to take into account mass dilation or did not answer the question with respect to the magnetic field.

Section II – Options

Question 28 – Option Geophysics

In general candidates performed poorly on this question as it attracted many single student responses from large centres, where candidates apparently attempted the question without previously studying the option.

A few responses included good use of diagrams and figures.

(a) Some candidates were unable to clarify 'principal' methods.
(b) A minority of candidates displayed a good understanding of the topic.
(c) Many candidates ignored the resources supplied with the question (picture and text), and gave a general discussion on remote sensing.
(d) In the better responses, candidates demonstrated a clear understanding of the components of a geophone and could relate it to other basic physics principles.
(e) Good responses linked physics theory to data collected in surveys and used it to demonstrate how this impacted on the greater understanding of Earth's structure. In the weaker responses, candidates struggled to apply principles of physics to their answer.

Question 29 – Option Medical Physics

Many candidates seemed to be confused and unable to adequately distinguish the five basic diagnostic procedures in the Medical Physics syllabus section.
A large number of candidates appeared to have general, not specific knowledge of medical imaging. It is important that candidates address the physics involved.

(a) (i) The majority of candidates responded well, with a broad range of possible correct answers being accepted.
(a) (ii) Better responses described both Bremsstrahlung and characteristic X-radiation. Most had some notion of braking radiation (Bremsstrahlung).

(b) This question was well answered by many candidates. The best responses described the manner in which attenuation of gamma rays by tissue was used to pinpoint the location of the radiopharmaceutical concentration within the body. Candidates often confused CAT or Technetium-based gamma scans with PET.

(c) (i) The better responses demonstrated the similarities and differences of these two scans. Poorer responses gave stand-alone descriptions of the two scanning techniques. A significant number confused PET scans with bone scans.
(c) (ii) The best responses identified that a radiopharmaceutical is tagged with an isotope and so can target and subsequently identify parts of the body, eg bone cancers, through following metabolic pathways. A significant number of responses did not address the question being asked.

(d) (i) This question was answered well.
(d) (ii) Most candidates realised the difference in acoustic impedance was needed to answer the question correctly. Some candidates made incorrect calculations.

(d) (iii) The few good responses linked the properties of ultrasound to the measurements made of variations in bone density. Poorer responses only stated general properties of ultrasound.

(e) The better responses included information to support statements about electrons in CAT and PET imaging production and detection. Poorer responses described CAT and PET scans in general and compared the techniques.

Question 30 – Option Astrophysics

(a) Most candidates could define the resolution of a telescope, and were able to identify a means by which the resolution of a ground-based telescope could be improved. Poorer responses included the description of a different method, or indicated minimal knowledge of how their chosen method functioned.

(b) Generally candidates performed well in this question but had difficulty manipulating the 'log d/10'.

(c) Responses indicated that candidates seemed confused by emission spectrum.
(c) (i) Most candidates did not notice the red shift and described the bands.
(c) (ii) (1) Many candidates described absorption correctly but did not relate it to a star.
(c) (ii) (2) The many poor responses often incorrectly referred to black body radiation or described emission spectrum.

(d) (i) Many candidates considered the cluster to be one star at the point it was labelled or assumed any star on the main sequence must be young.
(d) (ii) (1) Many candidates thought the CNO cycle resulted in heavier elements being produced rather than carbon as a catalyst.
(d) (ii) (2) Many candidates were able to give an evolutionary path but did not proceed to a corpse eg neutron star or black hole.

(e) In the best responses, candidates not only specified how the light spectrum has been used to interpret certain types of information, they continued on to define impacts this information has had upon the modern scientific view of stars, nebulae, galaxies, etc. The better responses identified at least one impact, and then gave a value judgement as to its significance.

Poorer responses used the phrase 'the visible spectrum of light', without defining precisely how it was being used. In the majority of cases the candidates meant the use of spectral lines, but if these were not clearly identified, or at least described, the properties of stars depending upon the absorption (or emission) spectra were simply a jumble of facts.

Question 31 – Option Quantum to Quarks

(a) This part was generally well answered though a minority of candidates confused Thompson's and Rutherford's models of the atom.

(b) This part was generally well answered.

(c) The better responses linked the isotope production to its parent reaction. In the poorer responses, candidates did not know the processes involved in generating radioactive isotopes, although they could explain the uses of the isotopes.

(d) (i) Generally well answered. Some candidates performed calculations for the forces when it would have been easier to read them from the graph.

(d) (ii) Some candidates did not interpret the question in sufficient depth. Their explanation of the importance of the strong nuclear force was not described adequately. Various groups of candidates mentioned gravitational and electrostatic forces and then talked of the repulsive force between the protons as if there was a third force.

(e) Many candidates had a good understanding of the basic differences between controlled and uncontrolled nuclear reactions.

While basic nuclear reactor design was reasonably well described many candidates had a poor understanding of the role of a moderator in sustaining a controlled reaction in a conventional reactor.

Question 32 – Option Age of Silicon

(a) There was considerable confusion about the difference between digital and analogue operation.

(b) Candidates who understood the question performed very well.

(c) A significant number of candidates failed to notice the logarithmic scale

(d) Some candidates commonly use symbols in their answers without defining the quantities the symbols represent, making their answers ambiguous. Most candidates were unfamiliar with the idea of voltage division in a series of resistors. Many candidates were not careful in reading the graph, and selected the nearest 'whole-number' along the curve, rather than making an appropriate approximation.

(e) Essay answers were generally concise and well-written.

Physics

2003 HSC Examination Mapping Grid

Question	Marks	Content	Syllabus outcomes
1	1	9.2.1	H9
2	1	9.2.2	H6
3	1	9.2.2, 9.2.3	H6, H9
4	1	9.2.2	H9
5	1	9.2.4	H6
6	1	9.3.3	H12
7	1	9.3.5	H9
8	1	9.3.4	H9
9	1	9.3.1	H9
10	1	9.3.1	H9
11	1	9.4.4	H1
12	1	9.4.1	H8, H13, H14
13	1	9.4.3	H7
14	1	9.4.2	H8
15	1	9.4.1	H9
16 (a)	1	9.1	H14
16 (b)	3	9.1	H14
16 (c)	2	9.2.2	H14, H9
17 (a)	1	9.2.1	H9, H14
17 (b)	3	9.2.2	H9, H14
17 (c)	2	9.2.2	H9, H14
18 (a)	2	9.2.4	H8
18 (b)	4	9.2.4	H8, H1
19	3	9.3.1	H9, H14
20	4	9.3.2	H6, H9

Question	Marks	Content	Syllabus outcomes
21 (a)	3	9.3.4	H7
21 (b)	2	9.3.4	H7
22	5	9.3.2	H9
23 (a)	3	9.3.2, 9.4.4	H6, H7, H9
23 (b)	3	9.4.2	H2, H9
24	4	9.4.4	H9
25 (a)	2	9.4.2	H8
25 (b)	3	9.4.2	H8
26	6	9.2.4, 9.4.2	H1
27	4	9.2.2, 9.2.4, 9.4.1	H7
28 (a) (i)	1	9.5.1	H10
28 (a) (ii)	2	9.5.5	H3
28 (b)	3	9.5.4	H6
28 (c) (i)	2	9.5.2	H8, H10
28 (c) (ii)	3	9.5.2	H8, H10, H14
28 (d) (i)	2	9.5.3	H8, H13
28 (d) (ii) (1)	2	9.5.3	H8, H13
28 (d) (ii) (2)	2	9.5.3	H8, H13
28 (e)	8	9.2.3, 9.5.2	H4, H8
29 (a) (i)	1	9.6.4	H9
29 (a) (ii)	2	9.6.2	H7
29 (b)	3	9.6.3	H7
29 (c) (i)	3	9.6.3	H7, H8, H10, H11
29 (c) (ii)	2	9.6.3	H7, H11
29 (d) (i)	1	9.6.1	H7, H8, H13
29 (d) (ii)	2	9.6.1	H7, H8, H13
29 (d) (iii)	3	9.6.1	H7, H8, H13
29 (e)	8	9.6.2, 9.6.3, 9.6.4	H4, H7, H8

Question	Marks	Content	Syllabus outcomes
30 (a) (i)	1	9.7.1	H8
30 (a) (ii)	2	9.7.1	H8
30 (b)	3	9.7.4	H8, H14
30 (c) (i)	1	9.7.3	H8, H14
30 (c) (ii) (1)	2	9.7.3	H8, H14
30 (c) (ii) (2)	2	9.7.3	H10, H14
30 (d) (i)	1	9.7.6	H9
30 (d) (ii) (1)	2	9.7.6	H7, H13
30 (d) (ii) (2)	3	9.7.6	H7
30 (e)	8	9.7.1, 3, 4, 5, 6	H4, H8
31 (a) (i)	1	9.8.1	H7
31 (a) (ii)	2	9.8.1	H7
31 (b)	3	9.8.4	H10
31 (c) (i)	2	9.8.3	H7, H13
31 (c) (ii)	3	9.8.3, 9.8.4	H7, H13
31 (d) (i)	2	9.8.3	H6, H9, H13
31 (d) (ii)	2	9.8.3	H9, H13
31 (d) (iii)	2	9.8.3	H9, H13
31 (e)	8	9.8.3, 9.8.4	H4, H7
32 (a) (i)	1	9.9.2	H7
32 (a) (ii)	2	9.9.2	H7
32 (b)	3	9.9.5	H9
32 (c) (i)	3	9.9.7	H9, H14
32 (c) (ii)	2	9.9.7	H9, H14
32 (d) (i)	3	9.9.3, 9.9.2	H7, H13
32 (d) (ii)	3	9.9.6	H7, H13
32 (e)	8	9.9.3, 9.9.4	H4, H7

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2003 HSC Physics
Marking Guidelines

Question 16 (a)
Outcomes assessed: H14

MARKING GUIDELINES

Criteria	Marks
• Students can read the gradient of the line from the content of the box on the graph gradient = velocity OR • Student correctly calculates gradient from data taken from the graph	1

Question 16 (b)

Outcomes assessed: H14

MARKING GUIDELINES

Criteria	Marks
• Mark correctly labelled axes (includes units) • Straight line indicating a linear relationship between horizontal velocity and range and approaching the origin • Point (1.85, 0.6) must be clearly identified as being on the line. (The point 1.85, 0.6) may be implied by numerical divisions on the axes)	3
• Mark correctly labelled axes (includes units) AND • Straight line approaching origin or point (1.85, 0.6) identified OR • Straight line approaching origin and point (1.85, 0.6) identified, no axes labelled	2
• Correctly labelled axes (units not required) OR • Straight line approaching origin OR • Point (1.85, 0.6) identified	1

Question 16 (c)

Outcomes assessed: H14, H9

MARKING GUIDELINES

Criteria	Marks
• Range on the planet is longer because of the acceleration due to gravity (g) on the planet is smaller OR • Since g is smaller on the planet the time of flight is longer OR • Longer time of flight means that the ball travels a longer horizontal distance before it reaches the ground	2
• Longer because gravity on the planet is smaller OR • Longer because time of flight is longer	1

Question 17 (a)

Outcomes assessed: H14, H9

MARKING GUIDELINES

Criteria	Marks
• Identify correct equation • Correct substitution	1

Question 17 (b)

Outcomes assessed: H14, H9

MARKING GUIDELINES

Criteria	Marks
• Relationship given in question hence equating $\left\|E_p\right\| = E_k$ is given AND • Correct expression for v, or inferred AND • Correct substitution, note that the answer (even if wrong) from (a) can be substituted	3
• Relationship given in question hence equating $\left\|E_p\right\| = E_k$ is given AND • Mark given for correct expression for v, or inferred	2
• $\left\|E_p\right\| = E_k$	1

Question 17(c)

Outcomes assessed: H9, H14

MARKING GUIDELINES

Criteria	Marks
• An issue and relationship to direction of launch	2
• An issue such as assistance to motion or fuel usage	1

Question 18 (a)

Outcomes assessed: H8

MARKING GUIDELINES

Criteria	Marks
• Aether is medium for propagation of light/EM radiation and one other feature	2
• Aether is medium for propagation of light/EM radiation OR another feature	1

Question 18 (b)

Outcomes assessed: H8, H1

MARKING GUIDELINES

Criteria	Marks
• Constructed an interferometer which splits a single beam of light and sent them on perpendicular paths and reflected them back • Observed an interference pattern when light beams returned • The arms of apparatus rotated through 90° and experiment repeated • It was expected that the two interference patterns would be different since the earth's passage through the aether would affect the velocity of light	4
• Includes three points from above	3
• Includes two points from above OR • Correct diagram of interferometer	2
• Used an interferometer or description of interferometer OR • Use of interference patterns OR • Any other one correct point from above	1

Question 19

Outcomes assessed: H9, H14

MARKING GUIDELINES

Criteria	Marks
• Correct calculation • Correct direction	3
• Correct formula and correct substitution or correct direction	2
• Correct formula identified	1

Question 20

Outcomes assessed: H6, H9

MARKING GUIDELINES

Criteria	Marks
• Fully explains both investigations which could include – Investigation 1: Since the solenoid is not in a circuit, no current can be induced by the magnetic field. No current → no induced magnetic field → no motion. – Investigation 2: The circuit is closed, so magnet induces current in solenoid. Lenz's law says the current will produce a magnetic field opposing the changing field that induced it. So direction of induced field is opposite to field of magnet. They repel, and solenoid moves to the LEFT. Includes both a description of Lenz's law and gets direction of motion correct	4
• Explains both investigations • Mentions Lenz's law OR gets direction of motion correct	3
• Briefly explains both investigations OR • Full explanation of either investigation	2
• Solenoid moves in investigation 2 but not in investigation 1 OR • Brief explanation of investigation 1 (no circuit, no motion) OR • Brief explanation of investigation 2 OR • EMF induced in coil 1 because of the motion of the magnet • OR • No current produced in coil 1 but is in coil 2	1

Question 21 (a)

Outcomes assessed: H7

MARKING GUIDELINES

Criteria	Marks
• Conservation of energy requires $E = V_p I_p t = V_s I_s t$ hence $V_p I_p = V_s I_s$ • If stepdown $V_p > V_s$ • which means that $I_p < I_s$	3
• Any two of the above	2
• Any one of the above	1

Question 21 (b)

Outcomes assessed: H7

MARKING GUIDELINES

Criteria	Marks
• A changing magnetic flux through the secondary coil is needed to induce a voltage/current AND • An AC current in the primary coil produces a changing flux AND • A DC current in the primary coil produces a constant magnetic flux	2
• One of the above points	1

Question 22

Outcomes assessed: H9

MARKING GUIDELINES

Criteria	Marks
• Labelled diagram connected to CRO or meter and magnet nearby AND • Description of how magnetic field varied AND • Description of how two variables are controlled	5
• Failed to adequately describe either magnetic field variation or control of variables or draw complete diagram or to completely label the diagram	4
• Failed to describe both magnetic field variation and control of variable OR • Failed to provide adequate description of experimental setup or a fully labelled diagram OR • Failed to provide labelled diagram or experimental set-up	3
• Inadequately labelled OR • Incomplete diagram AND • Description of how magnetic field varied OR • How two variables are controlled	2
• A magnet was pushed into coil connected to a meter OR • Control of variables mentioned OR • Mention of variation of magnetic field	1

Question 23 (a)

Outcomes assessed: H6, H7, H9

MARKING GUIDELINES

Criteria	Marks
• The magnetic field of the superconductor interacts with/excludes/opposes the field of the magnet and when in the superconducting state, current in the superconductor produces a magnetic field AND • Force due to magnetic effect = force due to gravity in the opposite direction	3
• Any two of the above	2
• Any one of the above	1

Question 23 (b)

Outcomes assessed: H2, H9

MARKING GUIDELINES

Criteria	Marks
• Comparison of one similarity and two differences OR • Three similarities OR • Three differences OR • One difference and two similarities	3
• Comparison with one similarity and one difference or two differences OR • Two similarities	2
• One similarity or one difference	1

Question 24

Outcomes assessed: H9

MARKING GUIDELINES

Criteria	Marks
• Clear outline of relationship between electric and magnetic fields and radius of curvature/in order to determine $\frac{q}{m}$ (diagrams and equations may be used to support answer)	4
• Outline of experimental set-up AND • Uses electric and magnetic fields to balance forces on electron beam • And centripetal force/radius of curvature/displacement	3
• Uses electric and magnetic fields to balance forces on electron beam • And centripetal force/radius of curvature/displacement OR • Outline of experimental set-up	2
• Uses electric and magnetic fields to balance forces on electron beam OR • Uses only one field and notes position	1

Question 25 (a)

Outcomes assessed: H8

MARKING GUIDELINES

Criteria	Marks
• $E = 1.28 \times 10^{-19}$ J OR • With correct substitution	2
• $E = \frac{hc}{\lambda}$ OR • f correctly calculated	1

Question 25 (b)

Outcomes assessed: H8

MARKING GUIDELINES

Criteria	Marks
All 3 of the following bullet points: • The photon needs to have a minimum energy/frequency to excite an electron to leave the surface • For these photons the energy is too low OR • An increase in energy is required • Increasing the intensity (number of photons) does not increase the energy of the photons	3
• Any two bullet points in ‘full answer’	2
• Any one bullet point in ‘full answer’	1

Question 26

Outcomes assessed: H1

MARKING GUIDELINES

Criteria	Marks
• Describes a contribution to each field and how each contribution changed scientific thinking in the 20^{th} Century	6
• Description of a contribution to each field and how at least one contribution changed scientific thinking in the 20^{th} Century	5
• Describes a contribution to each field • OR • Describes a contribution to one field and how the contribution changed scientific thinking in the 20th century	4
• Description of contribution to one field and mentions a point from another	3
• Any relevant points from each field OR • Description of a contribution to one field	2
• Any one relevant point from either field	1

Question 27

Outcomes assessed: H7

MARKING GUIDELINES

Criteria	Marks
• Clear description of why B must increase as v increases, and that as v approaches c, relativistic mass increases (with or without mass dilation equation) Using $F = \frac{mv^2}{r} = qvB$	4
• Relates $F = qvB$ to $F = \frac{mv^2}{r}$ and states that B increases OR • Relates $F = qvB$ to $F = \frac{mv^2}{r}$ and states the relativistic effects on the mass OR • States $F = qvB$ <u>or</u> $F = \frac{mv^2}{r}$ and states the relativistic effect on mass and B gets larger	3
• Same as three (3) marks but does not relate the equations OR • States two points from (1) mark	2
• As electron goes faster, mag field must be larger OR • Accounts for relativistic mass/time OR • Faster the electron goes greater force is required	1

Question 28 (a) (i)

Outcomes assessed: H10

MARKING GUIDELINES

Criteria	Marks
• Must name any three of the following: seismic, gravitational, magnetic, palaeomagnetic, electrical, electromagnetic, radiometric, geothermal methods	1

Question 28 (a) (ii)

Outcomes assessed: H3

MARKING GUIDELINES

Criteria	Marks
• Compare possible tests against records of known geophysical activity or an answer covering similar ideas AND one of: • Worldwide network of monitoring stations • Variety of geophysical data to record possible nuclear tests,	2
• Need to mention ONE of the above points	1

Question 28 (b)

Outcomes assessed: H6

MARKING GUIDELINES

Criteria	Marks
• Outlines three (or more) main pieces of evidence linking to plate tectonics OR • Discusses two in depth	3
• Outlines two pieces of evidence, linked to plate tectonics OR • Discusses one in depth	2
• Outlines one piece of evidence, linked to plate tectonics	1

Question 28 (c) (i)

Outcomes assessed: H8,H10

MARKING GUIDELINES

Criteria	Marks
• Describe that different surfaces absorb/reflect different amounts of radiation, and that observing at different frequencies (or wavelengths) give more information about the object	2
• Describe ONE point from above	1

Question 28 (c) (ii)

Outcomes assessed: H8, H10,H14

MARKING GUIDELINES

Criteria	Marks
• Spread of fire – smoke plume and blackened ground AND • Changes in images over time to indicate regrowth	3
• Spread of fire – either of two points AND • Changes in vegetation shown by different images	2
• Any one from above	1

Question 28 (d) (i)

Outcomes assessed: H8, H13

MARKING GUIDELINES

Criteria	Marks
• Magnet or spring, coil and both: relative motion produces current, and seismic waves cause relative motion, causes current in coil OR • Similar details for other type geophone OR • Suitable labelled diagram	2
• Magnet or spring, coil and relative motion produces current in coil OR • Similar detail for type of geophone OR • Similar diagram	1

Question 28 (d) (ii) (1)

Outcomes assessed: H8,H13

MARKING GUIDELINES

Criteria	Marks
• Refracted wave travels faster than direct wave AND • Refracted wave initially arrives at geophones after the direct wave as it has further to travel, but overtakes it	2
• Refracted wave travels faster than direct wave	1

Question 28 (d) (ii) (2)

Outcomes assessed: H8, H13

MARKING GUIDELINES

Criteria	Marks
• Correct calculation	2
• For incorrect use of slope (time/distance) OR • Incorrect substitution	1

Question 28 (e)

Outcomes assessed: H4, H8

MARKING GUIDELINES

Criteria	Marks
• Well constructed, extensive answer on both the application of Newton's theory to geophysics, and the understanding of Earth's structure • Should include – Statement of Newton's theory – Geophysicists measure local gravitational force/acceleration through surveys with gravimeters (and/or satellite motion) – Gravitational anomaly profiles give information about structure of Earth (density of material underground) – Can get info about hidden structure not easily observed by other methods	7–8
• Sound knowledge outline of application of Newton's theory to geophysics and in discussion of how it leads to understanding of structure Earth • Should include: – Geophysicists measure local gravity – Gives info about density (structure) of Earth nearby – Gravitational anomaly profiles shown landforms, structure etc	5–6
• Limited answer to both application of Newton's theory and understanding of Earth's structure OR • More extensive description of either application of Newton's theory or use in understanding Earth's structure	3–4
• Limited outline of application of gravity to geophysics OR • Limited discussion of how it leads to understanding of Earth's structure • Any of the following could be included: – Local measurement of gravity – Gravity shows hidden structure – Local changes in gravity show structure – Gravity depends on density of material	1–2

Question 29 (a) (i)

Outcomes assessed: H9

MARKING GUIDELINES

Criteria	Marks
• Hydrogen nucleus behaves like a small magnet, magnetic property • OR • Hydrogen nuclei have a spin	1

Question 29 (a) (ii)

Outcomes assessed: H7

MARKING GUIDELINES

Criteria	Marks
• Conversion of electrons kinetic energy to X-rays • Excitation and subsequent emission electrons	2
• One of the points above	1

Question 29 (b)

Outcomes assessed: H7

MARKING GUIDELINES

Criteria	Marks
• Radio–pharmaceutical produces positrons • Pairs of _–rays are produced by electron/positron annihilation • Detectors paired on opposite sides of body detect gamma rays • The attenuation of which depends on the depth of tissue the γ–rays have to pass through to reach the detectors	3
• Gamma rays are produced by electron/positron annihilation • Pairs of gamma rays are detected on opposite sides of the body	2
• One of the above	1

Question 29 (c) (i)

Outcomes assessed: H7, H8, H10, H11

MARKING GUIDELINES

Criteria	Marks
• Compare location and nature of radiation source and production of image (different brightness due to: brightness of X-rays for X-ray image, different concentration of γ source in organs for bone scan)	3
• Must mention both location of radiation source and brightness of X-rays/concentration of γ source, and must compare one of these points	2
• Basic comparison (X-ray source outside body γ source inside body) or (simple statement about X-ray brightness vs γ source concentration OR • Good description of how radiation is used in X-ray or bone scans	1

Question 29 (c) (ii)

Outcomes assessed: H7, H11

MARKING GUIDELINES

Criteria	Marks
• Radio-pharmaceutical targets the bone due to selective uptake • Hence the bone scan detects function (or physiology) due to the metabolic uptake of the radio-pharmaceutical rather than anatomy as do X-rays	2
• Radioisotopes are tagged to a molecule that targets/binds to the bone OR • Gamma radiation shows sites of detailed structure change where X-rays may not	1

Question 29 (d) (i)

Outcomes assessed: H7, H8, H13

MARKING GUIDELINES

Criteria	Marks
• Correct substitution into formula	1

Question 29 (d) (ii)

Outcomes assessed: H7, H8, H13

MARKING GUIDELINES

Criteria	Marks
• Identification of fat • Because of its greatest difference in acoustic impedance compared to kidney	2
• One of the above	1

Question 29 (d) (iii)

Outcomes assessed: H7, H8, H13

MARKING GUIDELINES

Criteria	Marks
• Ultrasound can be passed through the (heel) bone from one side to the other (emitter/detector on opposite sides) • Variations in bone density result in the bone having a different acoustic impedance • Reflection from healthy bone/flesh boundary is different from reflection from abnormal bone/flesh boundary, therefore transmitted intensity is different • The speed of ultrasound is different in bones of different density	3
• Two of the points above	2
• One of the points above	1

Question 29 (e)

Outcomes assessed: H4, H7, H8

MARKING GUIDELINES

Criteria	Marks
• Answer demonstrates extensive knowledge of the properties of electrons and the ability to control their behaviour and relates these to medical technologies including CAT and PET imaging technologies; • Points, which should link charge of electrons to their control in these technologies, could include – Electrons accelerated in an X-ray tube to produce X-rays – In PET, electrons controlled through their interaction with positrons to produce *y* rays through particle/antiparticle annihilation (or matter/antimatter) – Any of the technologies used involves electronic circuits in which electrons are controlled (by voltages/microunits) OR imaging technologies use cathodes ray tubes as a display device, which require electron control by electric and magnetic fields – The electron has a negative charge and hence it can be deflected by electric and magnetic fields	7–8
• Answer demonstrates substantial knowledge of the properties of electrons and the ability to control them and relates these to both PET and CAT imaging technology OR • Answer demonstrates substantial knowledge of the properties of electrons and the ability to control them and relates these to PET or CAT and at least one other medical technology	5–6
• Description of at least one property of electrons or the ability to control electrons and relates this to PET and/or CAT imaging technology	2–4
• One property of electrons OR • A way electrons can be controlled	1

Question 30 (a) (i)

Outcomes assessed: H8

MARKING GUIDELINES

Criteria	Marks
• Definition showing understanding of distinguishing fine detail/separation	1

Question 30 (a) (ii)

Outcomes assessed: H8

MARKING GUIDELINES

Criteria	Marks
• One method named • Brief description of the method	2
• Method named only	1

Question 30 (b)

Outcomes assessed: H8, H14

MARKING GUIDELINES

Criteria	Marks
• Correct identification of *M* and *m* • Correct substitution into correct formula	3
• Correct identification of *M* OR *m* • Correct substitution using values chosen into the correct formula	2
• Correct identification of either *M* OR *m*	1

Question 30 (c) (i)

Outcomes assessed: H8, H14

MARKING GUIDELINES

Criteria	Marks
• Identifies that redshift has occurred	1

Question 30 (c) (ii) (1)

Outcomes assessed: H8, H14

MARKING GUIDELINES

Criteria	Marks
• Hotter gases in interior produce spectrum and cooler outer gases absorb radiation resulting in dark lines	2
• Radiation absorbed resulting in dark lines OR • Spectrum produced by hot interior gases or core OR • Describes how an absorption spectrum is produced but not related to a star	1

Question 30 (c) (ii) (2)

Outcomes assessed: H10, H14

MARKING GUIDELINES

Criteria	Marks
• Presence of spectral lines associated with hotter or cooler temperatures • Specific example of an element/spectrum that demonstrates this	2
• Specific example only OR • Presence of spectral lines associated with hotter or cooler temperatures	1

Question 30 (d) (i)

Outcomes assessed: H9

MARKING GUIDELINES

Criteria	Marks
• High turn off point OR • Still has B class stars	1

Question 30 (d) (ii) (1)

Outcomes assessed: H13, H7

MARKING GUIDELINES

Criteria	Marks
• Star *X* – CN, C-N-O cycle dominates • Star *Z* – proton-proton chain is main process	2
• Only information on one star given or only information on one star correct • OR • Faster reactions in *X*	1

Question 30 (d) (ii) (2)

Outcomes assessed: H7

MARKING GUIDELINES

Criteria	Marks
• Distinction between mass left after becomes supernova to give two pathways	3
• Short life on main sequence, diagram without masses of cores OR • Two paths but no core mass identified OR • One path with core mass identified	2
• Diagram only without masses OR • One path with no mass	1

Question 30 (e)

Outcomes assessed: H4, H8

MARKING GUIDELINES

Criteria	Marks
• Extensive knowledge of information obtained from light • At least three different ideas that have learnt about celestial objects from studying them using light spectrum	7–8
• Thorough knowledge of information obtained from light spectrum • At least three different ideas considered	5–6
• Sound knowledge of information obtained from light spectrum • At least two different ideas considered	3–4
• Basic knowledge of information obtained from light spectrum • At least two different ideas considered	1–2

Question 31 (a) (i)

Outcomes assessed: H7

MARKING GUIDELINES

Criteria	Marks
• Electrons orbit a nucleus	1

Question 31 (a) (ii)

Outcomes assessed: H7

MARKING GUIDELINES

Criteria	Marks
• Electrons orbit the nucleus/instable orbits at discrete radii OR particular energy levels OR quantised energy levels AND • Electrons can move between levels by absorbing or emitting energy	2
• One of the points listed above	1

Question 31 (b)

Outcomes assessed: H10

MARKING GUIDELINES

Criteria	Marks
• Protons have + 1 charge, while neutrons have 0 charge • Protons are *uud* • Neutrons are *udd*	3
• Two point above	2
• One point above	1

Question 31 (c) (i)

Outcomes assessed: H13, H7

MARKING GUIDELINES

Criteria	Marks
• Reaction 2 because part of radioactive decay series OR • U-238 is naturally occurring OR • No energy has been put in OR • No neutrons are added to it OR • Reaction 3 — geological evidence in Africa	2
• Reaction 2 OR • Reaction 3	1

Question 31 (c) (ii)

Outcomes assessed: H13, H7

MARKING GUIDELINES

Criteria	Marks
• Reaction 3 • Used nuclear reactors • For power or weapons or radioisotope production or electrical energy production • Plus details of named application OR • Reaction 1 • Artificial transmutation • Production of radioisotopes OR • Production of plutonium or fast breeder reaction	3
• Correctly names reaction 1 or 3 • Identifies one application OR • Describes a feature	2
• Names one reaction (1 or 3)	1

Question 31 (d) (i)

Outcomes assessed: H6, H9, H13

MARKING GUIDELINES

Criteria	Marks
• $F_G = -2 \times 10^{-34} N (\pm 0.1 \times 10^{-34} N)$ and $F_E = 230N$	2
• One result	1

Question 31 (d) (ii)

Outcomes assessed: H9, H13

MARKING GUIDELINES

Criteria	Marks
• The electrostatic force is greater than the gravitational force • Therefore the electrostatic force would blow the nucleus apart Both points below OR • The strong nuclear force is needed to overcome the electrostatic force	2
• One of the points above	1

Question 31 (d) (iii)

Outcomes assessed: H9, H13

MARKING GUIDELINES

Criteria	Marks
Any two of the following: • The strong nuclear force holds all nuclear particles together, whether charged or uncharged • It is much stronger than the electrostatic force • Is attractive only over a very small distance ($\sim 10^{-15}$ m) • Becomes repulsive at small distances — less that the diameter of a nucleon	2
• Any one of the points above	1

Question 31 (e)

Outcomes assessed: H4, H7

MARKING GUIDELINES

Criteria	Marks
• Well constructed extensive answer describing the requirements for a controlled nuclear chain reaction AND • Well constructed extensive answer describing the requirements for an uncontrolled nuclear reaction • Must show linkage between factors involved in controlled and uncontrolled reactions	7–8
• Sound answer describing the requirements of a controlled nuclear chain reaction in a fission reactor AND • Sound answer describing requirements for an uncontrolled nuclear reaction • No linkages between factors involved in the two types of reactions	5–6
• Sound answer which describes the requirements for a controlled nuclear chain reaction AND • Sound answer which describes the requirements for an uncontrolled chain reaction OR • A limited answer describing the requirements of a controlled nuclear chain reaction AND • A limited answer describing the requirements of an uncontrolled nuclear chain reaction	3–4
• Limited answer which describes • The control of the reaction OR • Compares a similarity or difference	1–2

Question 32 (a) (i)

Outcomes assessed: H7

MARKING GUIDELINES

Criteria	Marks
• One correct example for each	1

Question 32 (a) (ii)

Outcomes assessed: H7

MARKING GUIDELINES

Criteria	Marks
• Two correctly identified graphs	2
• One is correct but not both	1

Question 32 (b)

Outcomes assessed: H9

MARKING GUIDELINES

Criteria	Marks
• Each of the steps listed below (P = not A, Q = P or B, R = Q and A) is worth 1 mark	3
• Two of (P = not A, Q = P or B, R = Q and A) correct	2
• One of (P = not A, Q = P or B, R = Q and A)	1

Question 32 (c) (i)

Outcomes assessed: H9, H14

MARKING GUIDELINES

Criteria	Marks
• Computers become faster AND • Density increase so size of circuit elements decrease OR • Density increases (by factor of 10^5)	3
• Computers become faster AND • Density increases OR • Size of circuit elements decrease	2
• Computers become faster OR • Density increase OR • Size of circuit elements decrease	1

Question 32 (c) (ii)

Outcomes assessed: H9, H14

MARKING GUIDELINES

Criteria	Marks
• Graph is not valid at 2060 (1 mark) AND one of: – reduction in size – more components – heat dissipation – connection problems • Quantum effects may cause changes in way computers operate	2
• 1 of the above points	1

Question 32 (d) (i)

Outcomes assessed: H13, H7

MARKING GUIDELINES

Criteria	Marks
• Resistance at 15°C = 1400Ω (1 mark) • Voltage divider algebra (1 mark) • Final answer including units (1 mark)	3
• Any 2 of above points	2
• Any 1 of above points	1

Question 32 (d) (ii)

Outcomes assessed: H13, H7

MARKING GUIDELINES

Criteria	Marks
• Gain equation $\dfrac{V\text{coil}}{V_A} = \dfrac{-R}{10^5}$ • Relationship between gain equations correct • Correct substitution	3
• Gain = $\dfrac{V\text{coil}}{V_A} = \dfrac{-10^5}{R}$ (Identifies gain relationship but fails to equate correctly) OR • Fails to substitute correctly	2
• Gain = $\dfrac{V\text{coil}}{V_A}$ OR • $\dfrac{-R}{10^5}$ OR in words	1

Question 32 (e)

Outcomes assessed: H4, H7

MARKING GUIDELINES

Criteria	**Marks**
• Well constructed and extensive answer which both describes and compares the physical principles and relates them to the operation of the transducers	7–8
• Describes the physical principles underlying the operation of both transducers but does not compare these OR • Describes one and has a comparison	5–6
• Correct identification of both input and output transducers AND • Describes the physical principles of one transducers OR • A statement of comparison	3–4
• Correctly identifies the input transducer (solar cell) and/or output transducer (ammeter)	1–2