



BOARD OF STUDIES
NEW SOUTH WALES

2011 HSC Physics Marking Guidelines

Section I, Part A

Multiple-choice Answer Key

Question	Answer
1	C
2	B
3	B
4	C
5	B
6	C
7	C
8	A
9	B
10	D
11	D
12	A
13	A
14	A
15	C
16	B
17	B
18	B
19	D
20	D

Section I, Part B**Question 21 (a)**

Criteria	Marks
<ul style="list-style-type: none">• Correctly plots points• Draws line of best fit with similar number of points above and below the line• Correctly estimates electrical resistance	3
<ul style="list-style-type: none">• Correctly plots points• Draws lines of best fit with similar numbers of points above and below the line OR <ul style="list-style-type: none">• Estimates electrical resistance appropriate for their line	2
<ul style="list-style-type: none">• Correctly plots points	1

Question 21 (b)

Criteria	Marks
<ul style="list-style-type: none">• Gives judgement about the validity of using the data and supports this with a reason	2
<ul style="list-style-type: none">• Gives judgement or reason	1

Question 22 (a)

Criteria	Marks
<ul style="list-style-type: none">• Identifies the aim of the experiment	1

Question 22 (b)

Criteria	Marks
<ul style="list-style-type: none"> • Draws a clearly labelled diagram that indicates: <ul style="list-style-type: none"> – path of light – key components of apparatus – rotation of apparatus 	4
<ul style="list-style-type: none"> • Draws a clearly labelled diagram that indicates TWO of the following: <ul style="list-style-type: none"> – path of light – key components of apparatus – rotation of apparatus OR <ul style="list-style-type: none"> • Draws a diagram that indicates: <ul style="list-style-type: none"> – path of light – key components of apparatus – rotation of apparatus 	3
<ul style="list-style-type: none"> • Draws a diagram correctly identifying some components and path of light 	2
<ul style="list-style-type: none"> • Draws a diagram correctly identifying some components 	1

Question 23 (a)

Criteria	Marks
<ul style="list-style-type: none"> • Gives a reason for weight change of the satellite 	1

Question 23 (b)

Criteria	Marks
<ul style="list-style-type: none"> • Selects correct equations • Correctly substitutes 	2
<ul style="list-style-type: none"> • Selects correct equations • Incorrectly substitutes 	1

Question 23 (c)

Criteria	Marks
<ul style="list-style-type: none"> • Identifies TWO effects and clearly relates TWO causes of these effects 	4
<ul style="list-style-type: none"> • Identifies TWO effects and relates ONE cause 	3
<ul style="list-style-type: none"> • Identifies TWO effects OR	2
<ul style="list-style-type: none"> • Identifies ONE effect and its cause 	2
<ul style="list-style-type: none"> • Identifies a cause or an effect 	1

Question 24

Criteria	Marks
<ul style="list-style-type: none"> Gives reasons why BOTH observations are correct Outlines the relativity of simultaneity 	4
<ul style="list-style-type: none"> Gives reasons why ONE observation is correct Relates this to special relativity 	3
<ul style="list-style-type: none"> Relates the observations to the concept of special relativity 	1–2

Question 25

Criteria	Marks
<ul style="list-style-type: none"> Identifies that magnet B will leave its tube first and supports this by identifying that the falling magnet results in a changing magnetic flux in the tube walls Identifies that this will result in eddy currents and braking effect for magnet A (Lenz's Law) Identifies that because of the slots, there will be smaller eddy currents and no braking for magnet B 	3–4
<ul style="list-style-type: none"> Outlines the production of eddy currents and braking OR <ul style="list-style-type: none"> Outlines that eddy currents will not occur in the slotted tube OR <ul style="list-style-type: none"> Identifies the correct magnet 	1–2

Question 26 (a)

Criteria	Marks
<ul style="list-style-type: none"> Draws a correctly labelled diagram that shows the key elements of the electrical distribution system and how they are connected 	3
<ul style="list-style-type: none"> Draws a labelled diagram that shows some of the key elements of the electrical distribution system and how they are connected 	2
<ul style="list-style-type: none"> Draws a labelled diagram that shows one of the key elements of the electrical distribution system 	1

Question 26 (b)

Criteria	Marks
<ul style="list-style-type: none"> • Demonstrates coherence and logical progression and includes correct use of scientific principles and ideas • Demonstrates thorough knowledge and understanding of the effects on the environment of the development of AC generators • Provides the cause and effect of at least one significant positive effect and one significant negative effect OR <ul style="list-style-type: none"> • Provides the cause and effect of at least two significant positive effects OR <ul style="list-style-type: none"> • Provides the cause and effect of at least two significant negative effects 	5–6
<ul style="list-style-type: none"> • Communicates some scientific principles and ideas in a clear manner • Demonstrates sound knowledge and understanding of the effects on the environment of the development of AC generators • Describes the effects on the environment • Identifies the effects as either positive or negative 	3–4
<ul style="list-style-type: none"> • Communicates simple ideas • Demonstrates a basic knowledge of the effects on the environment of the development of AC generators • Identifies positive AND/OR negative effects 	1–2

Question 27 (a)

Criteria	Marks
<ul style="list-style-type: none"> • Selects correct equation • Correctly substitutes 	2
<ul style="list-style-type: none"> • Selects correct equation • Incorrectly substitutes 	1

Question 27 (b)

Criteria	Marks
<ul style="list-style-type: none"> • Identifies that the magnitude of the forces on either side of the coil is equal • Correctly relates the direction of the current in the coil to the direction of the forces experienced 	2
<ul style="list-style-type: none"> • Identifies the opposing forces on either side of the coil 	1

Question 28 (a)

Criteria	Marks
<ul style="list-style-type: none"> Identifies an appropriate investigation Clearly demonstrates how the results support the hypothesis 	3
<ul style="list-style-type: none"> Identifies an appropriate investigation Shows some understanding of how the results support the hypothesis 	2
<ul style="list-style-type: none"> Identifies an appropriate investigation 	1

Question 28 (b)

Criteria	Marks
<ul style="list-style-type: none"> Describes how the beam is produced, including the role of the: <ul style="list-style-type: none"> filament electrodes collimator/focusing system 	3
<ul style="list-style-type: none"> Outlines how the beam is produced, including the role of TWO of the following: <ul style="list-style-type: none"> filament electrodes collimator/focusing system 	2
<ul style="list-style-type: none"> Identifies the role of ONE of the following: <ul style="list-style-type: none"> filament electrodes collimator/focusing system in the production of an electron beam 	1

Question 29 (a)

Criteria	Marks
<ul style="list-style-type: none"> Selects correct equations Correctly substitutes 	3
<ul style="list-style-type: none"> Correctly substitutes to determine photon energy OR <ul style="list-style-type: none"> Selects correct equations but makes one error in substitution or incorrectly manipulates formulae 	2
<ul style="list-style-type: none"> Correctly calculates frequency of the photon OR <ul style="list-style-type: none"> Identifies two correct equations 	1

Question 29 (b)

Criteria	Marks
<ul style="list-style-type: none"> Correctly outlines TWO significant differences 	2
<ul style="list-style-type: none"> Correctly outlines ONE significant difference 	1

Question 30 (a)

Criteria	Marks
<ul style="list-style-type: none"> Identifies that higher temperature results in increased lattice vibrations Relates increased lattice vibrations to a greater number of collisions of the electrons with the lattice and therefore higher resistance 	2
<ul style="list-style-type: none"> Identifies that higher temperature results in increased lattice vibrations or a greater number of collisions of the electrons with the lattice 	1

Question 30 (b)

Criteria	Marks
<ul style="list-style-type: none"> Clearly outlines the BCS theory, including: <ul style="list-style-type: none"> formation of Cooper pairs critical temperature the role of the distortion of the lattice unimpeded movement of the Cooper pairs through the lattice, resulting in zero resistance 	4
<ul style="list-style-type: none"> Outlines the BCS theory, including MOST of the following: <ul style="list-style-type: none"> formation of Cooper pairs critical temperature the role of the distortion of the lattice unimpeded movement of the Cooper pairs through the lattice, resulting in zero resistance 	3
<ul style="list-style-type: none"> Outlines the BCS theory, including SOME of the following: <ul style="list-style-type: none"> formation of Cooper pairs critical temperature the role of the distortion of the lattice unimpeded movement of the Cooper pairs through the lattice, resulting in zero resistance 	1–2

Section II

Question 31 (a)

Criteria	Marks
<ul style="list-style-type: none"> Identifies natural hazard and risks Identifies appropriate instrument Links use of instrument to reduction of risk 	3
<ul style="list-style-type: none"> Identifies hazard and instrument OR	2
<ul style="list-style-type: none"> Identifies hazard and describes how risk is reduced 	
<ul style="list-style-type: none"> Identifies hazard 	1

Question 31 (b) (i)

Criteria	Marks
<ul style="list-style-type: none"> Identifies magnetic anomaly profile as indicating reversals of magnetic field and radiometric dating as techniques used to date reversals Provides a method of how this is used to determine spreading rate 	3
<ul style="list-style-type: none"> Links radiometric dating to anomaly profile but fails to provide description of method 	2
<ul style="list-style-type: none"> Outlines radiometric dating OR	1
<ul style="list-style-type: none"> Outlines reversal of magnetic fields 	

Question 31 (b) (ii)

Criteria	Marks
<ul style="list-style-type: none"> Draws correct graph with time axis labelled 	2
<ul style="list-style-type: none"> Draws correct graph shape 	1

Question 31 (c) (i)

Criteria	Marks
<ul style="list-style-type: none"> Describes a plausible investigation which includes the use of different wavelengths Identifies items of apparatus 	4
<ul style="list-style-type: none"> Describes a plausible investigation but fails to include the use of a second wavelength Identifies items of apparatus 	3
<ul style="list-style-type: none"> Describes investigation but fails to give details of apparatus 	2
<ul style="list-style-type: none"> Lists relevant apparatus 	1

Question 31 (c) (ii)

Criteria	Marks
<ul style="list-style-type: none"> • Outlines method of observation and links observed property to state of vegetation 	2
<ul style="list-style-type: none"> • Outlines method of observation and observed qualities without linking property to state of vegetation 	1

Question 31 (d) (i)

Criteria	Marks
<ul style="list-style-type: none"> • Identifies at least one cause • Relates this to the effect 	2
<ul style="list-style-type: none"> • Identifies one or more causes but fails to relate any effect 	1

Question 31 (d) (ii)

Criteria	Marks
<ul style="list-style-type: none"> • Provides features of survey • Identifies the primary distinction between resource deposit and other surface features • Links this distinction to observed property 	3
<ul style="list-style-type: none"> • Any TWO of the above 	2
<ul style="list-style-type: none"> • Any ONE of the above 	1

Question 31 (e)

Criteria	Marks
<ul style="list-style-type: none"> • Identifies types of waves • Provides a detailed description of wave properties and Earth structure • Links wave properties to deductions regarding Earth structure in a logical and coherent way 	6
<ul style="list-style-type: none"> • Identifies wave properties and relates these to observation • Describes structure of Earth but does not link 	4–5
<ul style="list-style-type: none"> • Provides limited information about each of wave properties and Earth's structure OR	2–3
<ul style="list-style-type: none"> • Provides detailed information about only one 	
<ul style="list-style-type: none"> • Provides limited information about one only of wave properties and Earth structure 	1

Question 32 (a) (i)

Criteria	Marks
• Correctly identifies the type of scan AND the information that can be obtained from it	2
• Correctly identifies the type of scan OR the information that can be obtained from it	1

Question 32 (a) (ii)

Criteria	Marks
• Identifies that the proportion of ultrasound reflected is determined by the difference in acoustic impedance of the tissues at the boundary • Relates this to the specific scan	2
• Makes a correct, relevant statement about the reflection of ultrasound at a boundary	1

Question 32 (a) (iii)

Criteria	Marks
• Substitutes correctly into both equations to determine the percentage of ultrasound reflected	3
• Uses the two equations correctly but makes an error in substitution	2
• Uses one formula correctly in an attempt to calculate the percentage reflected	1

Question 32 (b) (i)

Criteria	Marks
• States that the production of X-rays involves the conversion of kinetic energy of electrons with the target during the collision • Outlines the TWO ways this occurs	3
• States that the production of X-rays involves the conversion of kinetic energy of electrons • Outlines ONE way this occurs	2
• States that the production of X-rays involves the conversion of kinetic energy of electrons	1

Question 32 (b) (ii)

Criteria	Marks
<ul style="list-style-type: none"> • Outlines THREE relevant similarities and/or differences between the information provided by the two scans 	3
<ul style="list-style-type: none"> • Outlines TWO relevant similarities and/or differences between the information provided by the two scans 	2
<ul style="list-style-type: none"> • Outlines ONE relevant similarity or difference between the information provided by the two scans 	1

Question 32 (c)

Criteria	Marks
<ul style="list-style-type: none"> • Identifies that a tumour is a region with a greater water (hydrogen nuclei) content than normal tissue. • MRI scans measure hydrogen (proton) density AND therefore an MRI scan is effective in detecting the increased water content of brain tumours 	3
<ul style="list-style-type: none"> • Identifies that a tumour is a region of different water content to the surrounding tissue • MRI scans measure hydrogen density 	2
<ul style="list-style-type: none"> • Identifies that a tumour is a region of high different water content OR <ul style="list-style-type: none"> • MRI scans measure hydrogen density OR <ul style="list-style-type: none"> • Relevant information about MRI 	1

Question 32 (d)

Criteria	Marks
<ul style="list-style-type: none"> • Outlines the structure of coherent and incoherent optical fibre bundles • Identifies that an incoherent bundle transmits light to illuminate the internal organ • Identifies that a coherent bundle transmits the image of the organ to the observer 	3
<ul style="list-style-type: none"> • Outlines the structure and/or function of coherent bundles • Outlines the structure and/or function of incoherent bundles 	2
<ul style="list-style-type: none"> • Outlines the structure and/or function of coherent bundles OR <ul style="list-style-type: none"> • Outlines the structure and/or function of incoherent bundles 	1

Question 32 (e)

Criteria	Marks
<ul style="list-style-type: none"> • Demonstrates a thorough understanding of the properties of radioactive isotopes • Describes the use of radioactive isotopes in two scanning techniques • Outlines at least two scanning techniques that use radioactive isotopes to produce an image • Correctly uses scientific principles and ideas to support the given statement • Demonstrates coherence and logical progression 	5–6
<ul style="list-style-type: none"> • Demonstrates a sound understanding of the relevant properties of radioactive isotopes AND EITHER <ul style="list-style-type: none"> • Identifies TWO relevant scanning techniques OR <ul style="list-style-type: none"> • Outlines one relevant scanning technique 	3–4
<ul style="list-style-type: none"> • Demonstrates a basic understanding of radioactive isotopes • Identifies at least one relevant scanning technique 	1–2

Question 33 (a) (i)

Criteria	Marks
<ul style="list-style-type: none"> • Provides correct diagram as part of correct definition 	2
<ul style="list-style-type: none"> • Provides correct definition without diagram OR <ul style="list-style-type: none"> • Provides diagram with incomplete definition 	1

Question 33 (a) (ii)

Criteria	Marks
<ul style="list-style-type: none"> • Relates a reason to sensitivity and a reason to resolution and links the reasons to relevant observations 	3
<ul style="list-style-type: none"> • Relates a reason to sensitivity and a reason to resolution OR <ul style="list-style-type: none"> • Distinguishes between sensitivity and resolution 	2
<ul style="list-style-type: none"> • Relates a reason to sensitivity or resolution OR <ul style="list-style-type: none"> • Outlines sensitivity or resolution 	1

Question 33 (a) (iii)

Criteria	Marks
• Describes features of a new technology that allow resolution to be improved	2
• Identifies a new technology related to resolution	1

Question 33 (b) (i)

Criteria	Marks
• Correctly identifies the key process in both stars • Provides a similarity between them and a characteristic of the differences between them	3
• Identifies the two processes and relates them to the correct star OR • Identifies characteristics of the differences between the processes OR • Correctly identifies the process in one star and one feature or characteristic	2
• Identifies a difference between the processes	1

Question 33 (b) (ii)

Criteria	Marks
• Correct substitution into the correct formula	2
• Incorrect substitution into correct formula	1

Question 33 (b) (iii)

Criteria	Marks
• Correctly identifies brighter star and correct substitution into correct formula	2
• Correct substitution into correct formula OR • Correctly identifies equation and which star is brighter	1

Question 33 (c)

Criteria	Marks
<ul style="list-style-type: none"> Distinguishes between an intrinsic and extrinsic variable Names a Cepheid as an intrinsic variable star and names a type of extrinsic variable star Links the properties of the stars to the type of variable 	3–4
<ul style="list-style-type: none"> Distinguishes between an intrinsic and extrinsic variable AND EITHER <ul style="list-style-type: none"> Names a Cepheid as an intrinsic variable star and names a type of extrinsic variable star OR <ul style="list-style-type: none"> Links the properties of the stars to the type of variable OR <ul style="list-style-type: none"> Names an intrinsic or extrinsic variable star and links its properties to the type of variable 	2
<ul style="list-style-type: none"> Distinguishes between intrinsic and extrinsic variables OR <ul style="list-style-type: none"> Gives a definition of an intrinsic OR extrinsic variable OR <ul style="list-style-type: none"> Names a Cepheid as an intrinsic variable and names another type of variable star 	1

Question 33 (d)

Criteria	Marks
<ul style="list-style-type: none"> Shows extensive knowledge of the type of information obtained by spectroscopy and photometry Shows limitations of using spectroscopy by itself Gives examples of when spectroscopy and photometry combined lead to a much greater understanding of stars Shows a coherent and logical progression 	6–7
<ul style="list-style-type: none"> Describes the information obtained by spectroscopy and the type of information that can be found by photometry 	4–5
<ul style="list-style-type: none"> Identifies some information found by spectroscopy and some information that is found by photometry 	3
<ul style="list-style-type: none"> Identifies some information about stars that can be found from spectroscopy or photometry 	1–2

Question 34 (a)

Criteria	Marks
<ul style="list-style-type: none"> Names a radioisotope that is used in agriculture Describes its use 	2
<ul style="list-style-type: none"> Names a radioisotope OR <ul style="list-style-type: none"> Identifies a use 	1

Question 34 (b) (i)

Criteria	Marks
<ul style="list-style-type: none"> Describes the relationship between neutrons, their exposure to a moderator and the number of control rods in the reactor vessel and the resulting rate of reaction 	4
<ul style="list-style-type: none"> Outlines any TWO of the above factors AND describes their relationship to the reaction rate OR <ul style="list-style-type: none"> Outlines all THREE factors 	3
<ul style="list-style-type: none"> Outlines ONE factor and its relationship to the reaction rate OR <ul style="list-style-type: none"> Outlines TWO factors 	2
<ul style="list-style-type: none"> Outlines ONE factor 	1

Question 34 (b) (ii)

Criteria	Marks
<ul style="list-style-type: none"> States that the mass of products is less than the mass of reactants States the relationship to $E = mc^2$ 	2
<ul style="list-style-type: none"> States either one of the above 	1

Question 34 (c)

Criteria	Marks
<ul style="list-style-type: none"> Completes the table correctly 	3
<ul style="list-style-type: none"> Completes 2/3 or more of the table correctly 	2
<ul style="list-style-type: none"> Completes between 1/3 and 2/3 correctly 	1

Question 34 (d)

Criteria	Marks
<ul style="list-style-type: none"> Selects correct formula Correct substitution 	2
<ul style="list-style-type: none"> Selects correct formula 	1

Question 34 (e)

Criteria	Marks
• Correctly states the number of up and down quarks and leptons	2
• Correctly calculates the number of TWO of the above three amounts	1

Question 34 (f)

Criteria	Marks
• Clearly and accurately outlines the important contributions made by Heisenberg and Pauli	4
• Clearly and accurately outlines ONE contribution and identifies another	3
• Accurately outlines two contributions	2
• Outlines one contribution	1

Question 34 (g)

Criteria	Marks
• Clearly describes and justifies examples of mathematical models that have been validated by experimental evidence which relate to Bohr and/or de Broglie	5–6
• Describe Bohr's and de Broglie's models	3–4
• Describes one mathematical model and/or one example of experimental evidence	2–3
• Demonstrates some knowledge of models of the atom	1

Question 35 (a)

Criteria	Marks
• Constructs a valid truth table for the situation • Correctly enters all elements in the table	3
• Constructs a valid truth table for the situation • Correctly enters the majority of the elements in the table	2
• Constructs a valid truth table for the situation OR • Shows some understanding of the correct elements in the table	1

Question 35 (b)

Criteria	Marks
<ul style="list-style-type: none"> Explains that no feedback circuit is present Shows understanding that this implies an open loop only 	2
<ul style="list-style-type: none"> Explains that no feedback circuit is present OR <ul style="list-style-type: none"> Shows understanding that the circuit configuration is open loop 	1

Question 35 (c)

Criteria	Marks
<ul style="list-style-type: none"> Identifies correct formula Correctly substitutes variable to arrive at algebraic answer 	2
<ul style="list-style-type: none"> Identifies correct formula Incorrectly substitutes variables 	1

Question 35 (d)

Criteria	Marks
<ul style="list-style-type: none"> Correctly identifies that the LED lights up when $O_{\emptyset} = 0$ Correctly identifies that $O_{\emptyset} = 0$ for a range of V_{in} values set by the potential divider in Question 35 (c) AND <ul style="list-style-type: none"> Correctly connects this to a range of V_{batt} values through the potential divider in Question 35 (c) 	3
<ul style="list-style-type: none"> Correctly identifies that the LED lights up when $O_{\emptyset} = 0$ Shows understanding that this corresponds to a range of V_{batt} voltages through the potential dividers in Question 35 (c) 	2
<ul style="list-style-type: none"> Shows understanding that the state of output O_{\emptyset} is related to the value of V_{batt} or V_{in} 	1

Question 35 (e) (i)

Criteria	Marks
<ul style="list-style-type: none"> Draws a clear labelled diagram that describes all the key elements of an LED 	3
<ul style="list-style-type: none"> Draws a clear labelled diagram that describes the majority of the elements of an LED OR <ul style="list-style-type: none"> Draws an unclear diagram that describes all the key elements of an LED 	2
<ul style="list-style-type: none"> Draws a diagram that demonstrates an understanding of the construction of an LED 	1

Question 35 (e) (ii)

Criteria	Marks
<ul style="list-style-type: none"> Identifies one advantage Identifies one disadvantage 	2
<ul style="list-style-type: none"> Identifies one advantage OR <ul style="list-style-type: none"> Identifies one disadvantage 	1

Question 35 (f)

Criteria	Marks
<ul style="list-style-type: none"> Identifies in clear language three key optical properties that are desirable 	3
<ul style="list-style-type: none"> Identifies at least two key optical properties that are desirable 	2
<ul style="list-style-type: none"> Shows understanding of the desirable optical properties 	1

Question 35 (g)

Criteria	Marks
<ul style="list-style-type: none"> Provides a clear and concise explanation of the fundamental physics limitations that restrict the reduction in size and speed of digital integrated circuits Makes a clear connection between these size/speed limitations and the operation of computers Makes a clear connection between the limitations and the need to fundamentally change the way computers are designed 	6–7
<ul style="list-style-type: none"> Provides an explanation of the key physics limitations of size reduction and speed increase on digital circuits AND <ul style="list-style-type: none"> Connects these limitations to the operation of computers OR <ul style="list-style-type: none"> Makes a connection between the limits and the need to change the design of computers 	4–5
<ul style="list-style-type: none"> Shows some understanding of the limitations that physics places on the operation and the design of computers 	1–3

Physics

2011 HSC Examination Mapping Grid

Section I Part A

Question	Marks	Content	Syllabus outcomes
1	1	9.2.2.2.11	H9
2	1	9.2.1.2.3, 9.2.3.3.2	H9
3	1	9.4.4.2.2	H10
4	1	9.4.3.2.2	H9, H10
5	1	9.3.4.2.4	H7
6	1	9.3.2.2.4	H9
7	1	9.4.1.3.3	H9
8	1	9.2.2.2.7, 9.2.2.2.5	H9
9	1	9.2.4.2.9	H6
10	1	9.3.1.2.2	H9, H11
11	1	9.3.2.3.2, 9.3.2.3.3	H9
12	1	9.3.1.2.4, 9.3.1.2.5	H9
13	1	9.4.3.2.6	H10
14	1	9.3.2.2.3	H9
15	1	9.2.2.3.1	H6
16	1	9.2.2.2.10	H9
17	1	9.4.2.2.5	H10, H13, H14
18	1	9.3.1.3.4	H9
19	1	9.4.2.1.6, 9.4.2.1.7	H6, H9
20	1	9.2.1.2.3, 9.2.3.3.2	H9

Section I Part B

Question	Marks	Content	Syllabus outcomes
21 (a)	3	9.4.4.2.4	H13, H14
21 (b)	2	9.4.4.2.4	H12, H14
22 (a)	1	9.2.4.2.2, 9.2.4.2.3	H8
22 (b)	4	9.2.4.2.2, 9.2.4.2.3	H13
23 (a)	1	9.2.1.2.1	H9
23 (b)	2	9.2.2.2.10, 9.2.2.3.4	H9
23 (c)	4	9.2.2.2.10, 9.2.2.2.11, 9.2.2.3.5	H9
24	4	9.2.4.2.9	
25	4	9.3.2.2.7	H9
26 (a)	3	9.3.3	H7, H9
26 (b)	6	9.3.3.2.5	H4
27 (a)	2	9.3.1.3.3	H9, H12

27 (b)	2	9.3.1.2.5	H6, H9
28 (a)	3	9.4.1.3.2	H2, H10
28 (b)	3	9.4.1.2.9	H9
29 (a)	3	9.4.2.3.4	H7, H10, H12
29 (b)	3	9.4.2.2.5	H10
30 (a)	1	9.4.4.2.4	H10
30 (b)	4	9.4.4.2.6	H9

Section II

Question	Marks	Content	Syllabus outcomes
Question 31 — Geophysics			
31 (a)	3	9.5.5.2.2	H4, H7, H9
31 (b) (i)	3	9.5.4.3.2	H9, H14
31 (b) (ii)	2	9.5.4.3.2	H9, H14
31 (c) (i)	4	9.5.2.3.1, 9.5.2.2.1	H3, H8, H14
31 (c) (ii)	2	9.5.2.2.2	H3, H8, H14
31 (d) (i)	2	9.5.2.2.4, 9.5.1.3.1	H9
31 (d) (ii)	3	9.5.2.2.9	H9
31 (e)	6	9.5.3.2.1, 9.5.3.2.2, 9.5.3.2.3, 9.5.3.2.5, 9.5.3.2.6	H8
Question 32 — Medical Physics			
32 (a) (i)	2	9.6.1.2.7	H8
32 (a) (ii)	2	9.6.1.2.3, 9.6.1.2.4, 9.6.1.2.5	H7, H8
32 (a) (iii)	3	9.6.1.3.5	H7, H8
32 (b) (i)	3	9.6.2.2.1	H9, H10
32 (b) (ii)	3	9.6.2.3.2	H10
32 (c)	3	9.6.4.3.2	H9
32 (d)	3	9.6.2.2.5, 9.6.2.2.6, 9.6.2.2.7	H3, H10
32 (e)	6	9.6.3.all	H3, H4
Question 33 — Astrophysics			
33 (a) (i)	2	9.7.2.2.1	H13.1d
33 (a) (ii)	3	9.7.1.2.3, 9.7.2.1.2.1	H3, H10
33 (a) (iii)	2	9.7.1.2.5	H3, H10
33 (b) (i)	3	9.7.6.2.3, 9.7.6.3.3	H7
33 (b) (ii)	2	9.7.4.3.1	H12
33 (b) (iii)	2	9.7.4.3.1	H12
33 (c)	4	9.7.5.2.3	H12
33 (d)	7	9.7.4.2.2, 9.7.5.2.4, 9.7.5.2.2, 9.7.6.2.5, 9.7.6.3.2, 9.7.2.2.3	H10

Question 34 — From Quanta to Quarks			
34 (a)	2	9.8.4.3.2	H3
34 (b) (i)	4	9.8.4.2.1, 9.8.3.2.11	H7
34 (b) (ii)	2	9.8.3.2.9	H7
34 (c)	3	9.8.4.2.5	H9
34 (d)	2	9.8.2.3.1	H8
34 (e)	2	9.8.4.2.5, 9.8.3.2.1	H12
34 (f)	4	9.8.2.3.2	H2
34 (g)	6	9.8.1, 9.8.2	H2
Question 35 — The Age of Silicon			
35 (a)	3	9.9.5.3.1	H12
35 (b)	2	9.9.6.2.5	H9
35 (c)	2	9.9.2.3.3	H9, H12
35 (d)	3	9.9.6.3.1, 9.9.2.3.3, 9.9.6.3.5	H12
35 (e) (i)	3	9.9.4.2.3	H9
35 (e) (ii)	2	9.9.4.3.3	H9
35 (f)	3	9.9.1.3.2	H10
35 (g)	7	9.9.7.2.2, 9.9.7.3.1	H3, H4, H5, H8