

Section I
75 marks

Part A - 15 marks
Section I

- 1 W.L. Bragg and W.H. Bragg developed the theory and technique of X-ray diffraction by crystals in 1912- 1913.

What is another term for X-ray diffraction?

- (A) Chromotography
- (B) Crystallography
- (C) Fraunhofer diffraction
- (D) Fresnel diffraction

- 2 The temperature of a semiconductor is increased.

Which statement correctly identifies the change in this semiconductor's electrical resistance and the reason for this change?

- (A) Electrical resistance increases because the highest band containing electrons is completely filled.
- (B) Electrical resistance increases because the lowest band containing electrons is completely filled.
- (C) Electrical resistance decreases because more electrons will have enough energy to jump the energy gap.
- (D) Electrical resistance decreases because less electrons will have enough energy to jump the energy gap.

- 3 A proton is moving in a uniform magnetic field and feels a force toward the west when it moves vertically upward.

The same force, when moving horizontally in a northerly direction feels zero force.

What is the direction of the magnetic field in this instance?

- (A) North-south
- (B) East-west
- (C) South-west
- (D) North-east

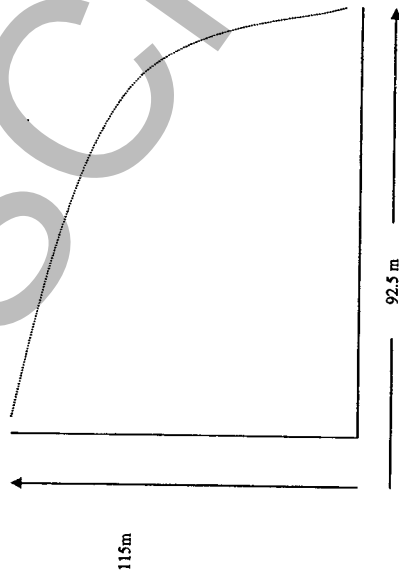
- 4 Photoelectrons are emitted by a metal surface only when the light directed at it exceeds a certain minimum _____.

- (A) wavelength
- (B) frequency
- (C) speed
- (D) charge

- 5 What is the main justification for assuming that the Law of Gravitation, as first proposed by Sir Isaac Newton, obtained from data on the Solar System, is valid for the entire Universe?

- (A) The Law of Gravitation was developed largely through work done by Newton, who was a scientist of high popular regard.
- (B) It is impossible to determine the universal gravitational constant from astronomical data alone.
- (C) It is unreasonable to suspect that there should be any objects in the Universe that do not obey Newton's Law of Gravitation.
- (D) Newton proposed this Law of Gravitation a long time ago.

- 6 A rock is thrown horizontally from a 115 m high vertical cliff and strikes the ground 92.5 m from the base of the cliff. The following diagram shows the rock's descent.



How long does it take to reach the ground?

- (A) 4.00 s
- (B) 8.00 s
- (C) 4.84 s
- (D) 6.36 s

- 7 Lenz's law is a consequence of the law of conservation of
- (A) charge
 - (B) momentum
 - (C) lines of force
 - (D) energy

- 8 The Michelson-Morley experiment was designed to measure the speed of the ether – the medium in which light was assumed to travel with respect to the Earth.

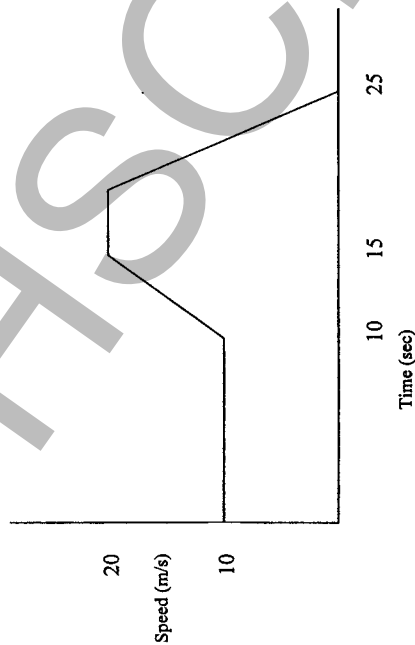
What did these experimenters hope to discover?

- (A) Confirmation of Maxwell's theory of electromagnetism.
- (B) Confirmation of Newton's third law of motion.
- (C) An absolute reference frame that could be considered at rest.
- (D) An absolute reference frame that could be considered unprimed.

- 9 A DC generator is much like an AC generator, except the slip rings are replaced by which components?

- (A) split-ring commutators
- (B) brushes
- (C) alternators
- (D) electromagnets

- 10 The motion of a car during 25 seconds of travel is plotted on the graph below.



What is the car's acceleration between 10 and 15 sec?

- (A) 2 m/s^2
- (B) 5 m/s^2
- (C) 10 m/s^2
- (D) 15 m/s^2

- 11 The magnetic flux through a wire loop in a magnetic field DOES NOT depend upon which variable?

- (A) the area of the loop
- (B) the shape of the loop
- (C) the angle between the plane of the loop and the direction of the magnetic field
- (D) the magnitude of the field

- 12 A current-carrying loop in a magnetic field always tends to rotate until the plane of the loop is

- (A) parallel to the field
- (B) perpendicular to the field
- (C) either parallel or perpendicular to the field depending on the direction of the current
- (D) at a 45 deg angle with the field

- 13 What is the magnetic field inside a 100-turn solenoid of length 2 cm which carries a 10 A current?

- (A) 0.00063 T
- (B) 0.00126 T
- (C) 0.063 T
- (D) 0.126 T

- 14 The two wires of a 2.0 m long appliance cord are 3.0 mm apart and carry 8.0 A DC.

Calculate the force between the wires.

- (A) $2.6 \times 10^{-3} \text{ N}$
 (B) $4.5 \times 10^{-3} \text{ N}$
 (C) $6.4 \times 10^{-3} \text{ N}$
 (D) $8.5 \times 10^{-3} \text{ N}$

- 15 The radius of the path of an object in uniform circular motion is doubled.

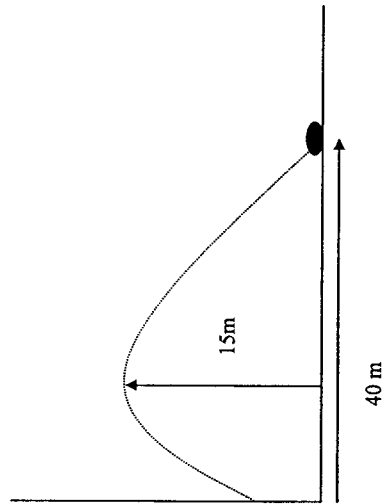
The centripetal force needed if its speed remains the same is

- (A) half as great as before
 (B) the same as before
 (C) twice as great as before
 (D) four times as great as before

Section I (continued)
Part B – 60 marks

Question 16 (5 marks)

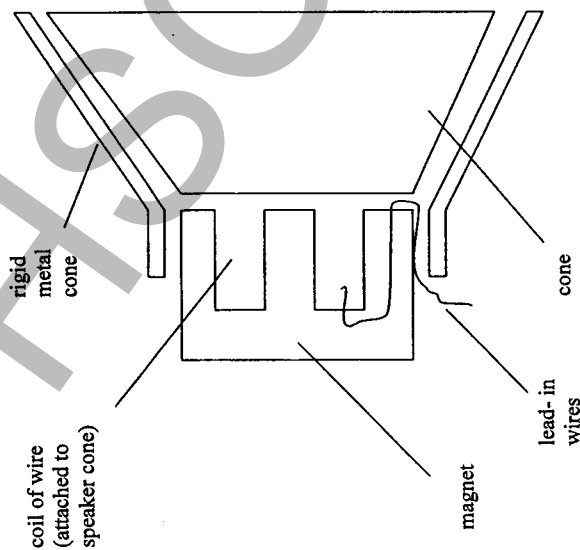
A footballer kicks a ball 40 metres. It rises to a maximum height of 15 metres.



- (a) What was the vertical component of the ball's velocity? 1
 (b) What was the time of flight? 1
 (c) What was the horizontal component of the ball's velocity? 1
 (d) At what angle to the horizontal was the ball kicked? 1
 (e) What was the initial velocity of the ball? 1

Question 17 (4 marks)

The diagram shows the structure of a loudspeaker.



Describe how the loudspeaker operates as an application of the motor effect. 4

Question 18 (4 marks)

Nuclear Physics had its beginnings in 1896. In that year, Henri Becquerel (1852-1908) made an important discovery. In his studies of phosphorescence, he found that a certain mineral would darken a photographic plate even when the plate was wrapped to exclude light.

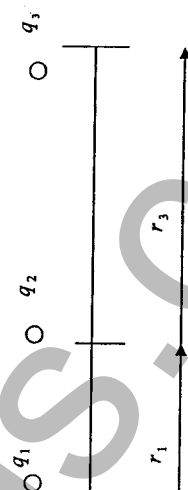
- (a) What was the radioactive element within this mineral and what radioactive particle did it emit? 2
- (b) Describe ONE potential hazard associated with performing experiments involving radioactive minerals, and outline ONE safe work practice which addresses this hazard. 2

Question 19 (3 marks)

Three point charges:

$$q_1 = -4 \text{ nC} \quad q_2 = 5 \text{ nC} \quad \text{and} \quad q_3 = 3 \text{ nC}$$

are distributed according to the following figure



$$\text{If } r_1 = 0.5 \text{ m and } r_3 = 0.8 \text{ m}$$

Find the force on q_2 due to the other charges. 3

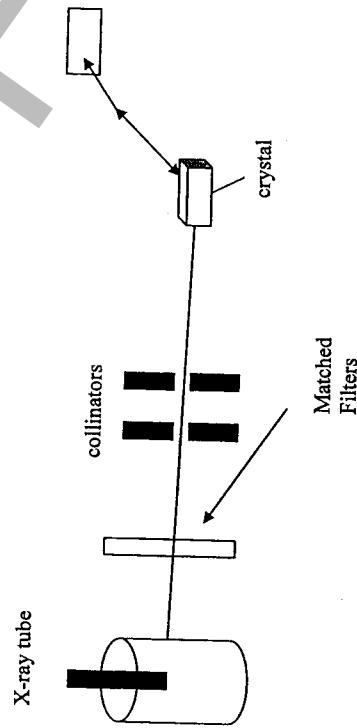
Question 20 (6 marks)

- (a) Describe the impact of Cooper pairs on BCS theory. 4
- (b) Describe the Meissner effect. 2

Question 21 (4 marks)

Much of our knowledge about crystal structure and the structure of molecules as complex as DNA in crystalline form comes from the use of X-rays in diffraction studies.

An instrument for such study is the Bragg spectrometer.



Briefly describe the function of the following with respect to the Bragg spectrometer

- (a) Matched filters 1
- (b) Collimators 1
- (c) Bragg's Law 2

Question 22 (2 marks)

- A quantum of electromagnetic radiation has an energy of 2.0 keV. What is the associated wavelength? 2

Question 23 (4 marks)

Red light of wavelength 670.0 nm produces photoelectrons from a certain metal which requires a stopping potential of 0.5 V to stop.

- (a) What is the work function of the metal? 2
- (b) What is the threshold wavelength of the metal? 2

Question 24 (4 marks)

Explain qualitatively Hertz's experiments in measuring the speed of radio waves and how they relate to light waves. 4

Question 25 (4 marks)

During your study of Physics you performed a first-hand investigation to demonstrate the production of an alternating current.

Describe your investigation. 4

Question 26 (5 marks)

According to April 2007 estimates of the International Superconductivity Industry Summit the worldwide market for superconductor products is projected to grow near AUS \$6 billion by the year 2010 and to AUS \$45 billion by 2020.

Discuss ONE possible application of superconductors in terms of electronics, energy, transportation, industrial and medical markets.

- a) electronics 1
- b) energy 1
- c) transportation 1
- d) industrial 1
- e) medical 1

Question 28 (5 marks)

With the use of a simple table compare low Earth and geo-stationary orbits. 5

Question 29 (3 marks)

Discuss the competition between Westinghouse and Edison to supply electricity to cities in the United States of America. 3

Question 30 (4 marks)

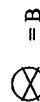
Describe the contribution of ONE of the following individuals to the development of space exploration.

Tsiolkovsky, Oberth, Goddard, Esnault-Pelterie, O'Neill, or von Braun. 4

End of Part B

Question 27 (3 marks)

Suppose a very long straight wire of linear mass density 20g/m is immersed in a constant magnetic field where $B=3\text{T}$



What is the current I that would be required so that the wire will be suspended? 3

Section II

25 marks

Attempt ONE question from Question 31-35

Question 31- Geophysics (25 marks)

Question 31 (a)

Describe the role that geophysics have played in

- (i) monitoring nuclear test ban treaties. 2
- (ii) natural hazard reduction. 2

Question 31 (b)

During your study of Geophysics you performed an investigation to demonstrate how the inclination of the Earth's magnetic field varies with latitude.

Describe your investigation. 5

Question 31 (c)

Discuss the reluctance of the scientific community to accept the mobility of the Earth's plates in the absence of a mechanism for plate movement. 5

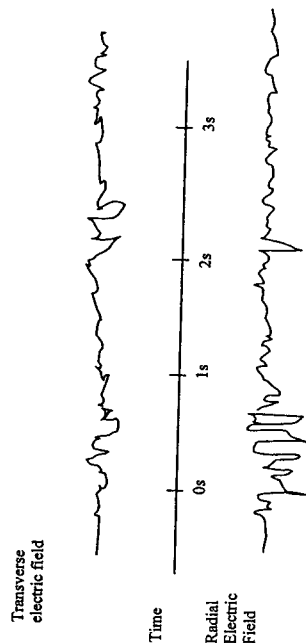
Question 31 (d)

- (i) Using a simple labelled sketch draw the main components of a gravimeter. 2
- (ii) Describe the purpose of data reduction in gravity surveys. 1

Question 31 (e)

A seismo-electric event was recorded following a completely contained underground detonation of a small nuclear device in Nevada, USA, with an energy yield in the order of two kilotonnes equivalent to TNT. The recording site was approximately 10 km from the point of detonation.

The following diagram shows two traces which indicate the voltages recorded between two pairs of electrodes oriented in the transverse and radial directions with respect to the detonation point and with an electrode separation of 1 km.



With reference to the above diagram, describe the principles of the reflection and refraction of seismic waves. 4

Question 31 (f)

Earthquake wave studies show that the Earth's core must be a liquid, and the existence of the Earth's magnetic field means that the liquid must be a metal in order to support the required electric currents.

- (i) Briefly describe of what form: element, compound or mixture that the Earth's core resembles. 1
- (ii) Describe the properties of the following Earth materials that are studied in geophysics: elasticity, thermal and electrical. 3

Question 32- Medical Physics (25 marks)

Question 32 (a)

Nuclear magnetic resonance (NMR) spectroscopy is a powerful and analytical tool. With NMR spectroscopy, experiments are performed on the nuclear atoms, not the electrons.

- (i) How many possible orientations do spin half nuclei have when they are located in an applied magnetic field? 1
- (ii) Describe the observed effect when radiation energy is absorbed by a spin half nucleus in a magnetic field. 1
- (iii) What is the name given to the relaxation process due to an interaction between an excited nucleus and the magnetic fields caused by nuclei in molecules moving around in the sample? 1

Question 32(b)

Position Emission Tomography (PET) produces images of the body by detecting the radiation emitted from radioactive substances.

- (i) What type of radiation is emitted during PET? 1
- (ii) Briefly describe TWO disadvantages that the PET technique has when compared to another scanning procedure. 2
- (iii) Using a simple labelled drawing or series of simple drawings describe the PET technique. 4

Question 32 (c)

When ultrasound passes into the human body it is reflected at boundaries between different tissues. The extent to which the ultrasound is absorbed or reflected is given by certain parameters that are specific to organ structures.

The table below gives some ultrasound properties of some human body tissues.

Material	Density (kg m^{-3})	Velocity (m/s)	Acoustic Impedance ($\text{Pa} \cdot \text{s/m}$)
Air	1.3	330	429
Water	1000	1500	1.50×10^6
Blood	1060	1570	1.59×10^6
Brain	1025	1540	1.58×10^6
Fat	925	1450	1.38×10^6
Muscle	1075	1590	1.70×10^6
Bones (varies)	1908	4080	7.78×10^6
PZT Transducer	7650	3791	29.0×10^6
Quartz transducer	2650	5736	15.2×10^6

- (i) What is the thickness of a slice of PZT material if its fundamental resonance frequency is 1.5 MHz? 1
- (ii) The time delay for a pulse going through fat is 0.133 ms. How deep is the fat? 1
- (iii) List TWO advantages for using ultrasound as a diagnostic tool and TWO disadvantages for using ultrasound as a diagnostic tool. 4

Question 32 (d)

During your study of Medical Physics you performed a first-hand investigation to demonstrate the transfer of light by optical fibres.

Describe your investigation.

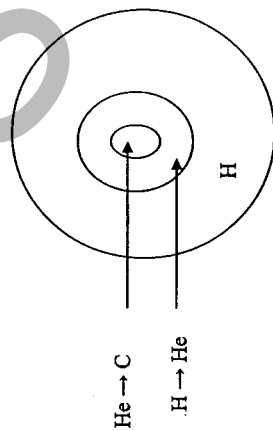
Question 32 (e)

Describe how a computed axial tomography (CAT) scan is produced.

Question 33 Astrophysics (25 marks)

Question 33 (a)

The following diagram shows the structure of a helium-burning supergiant.



During the life of the supergiant, there comes a time when the amount of helium available in the core for conversion into carbon diminishes remarkably.

As the nuclear reaction wanes and the pressure gradient diminishes due to the escaping energy, the core of the star once again contracts under gravity.

The core temperature increases, and at a temperature of about 3×10^8 K,

the reaction $^{12}_6\text{C} + ^4_2\text{He} \rightarrow ^{16}_8\text{O} + \gamma$ can commence.

The star then has three sources of energy from nuclear reactions.

- What are these THREE sources of energy? 3
- In each of the stages of a supergiant's life cycle, the conversion of hydrogen into helium has been taking place somewhere in the star.
Describe how the site of this reaction moves as the star evolves. 3

Question 33 (b)

Describe the key features of discrete, continuous and absorption spectra and describe how these are useful for star classification. 3

Question 33 (c)

Astronomers use parallax measurements to determine the distance to nearby stars. Once the distance is known, the luminosity and absolute magnitude of a star can be determined from the apparent magnitude using the Inverse Square Law.

- If the parallax angle for Sirius A is found to be 0.38 arc sec, what is the distance to Sirius A? 1
- The apparent magnitude is found to be -1.44. What is the absolute magnitude of Sirius A? 1
- Astronomers have classified Sirius A of Spectral Type A1 on the main sequence. Approximately where on the Hertzsprung – Russell diagram would Sirius A be located? 1

Question 33 (d)

Discuss the problems associated with ground-based astronomy in terms of resolution, absorption of radiation and atmospheric distortion. 3

Question 33 (e)

Explain the importance of the period-luminosity relationship for determining the distance of cepheids. 3

Question 33 (f)

During your study of Astrophysics you performed an investigation to demonstrate the use of filters for photometric measurements.

Describe your investigation. 7

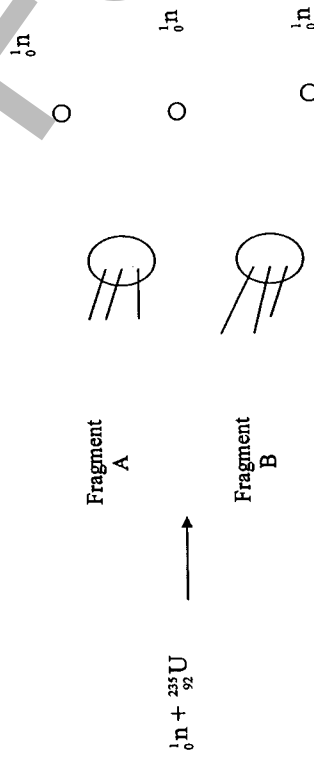
Question 34 From Quanta to Quarks (25 marks)

Question 34 (a)

- (i) Using a simple labelled sketch or series of simple labelled sketches, describe Bohr's explanation of the Balmer series. 3
- (ii) Discuss TWO limitations of the Bohr model of the hydrogen atom. 2

Question 34 (b)

The following sketch shows a possible nuclear fission of the isotope U-235.



- (i) If Fragment A produced in the above fission reaction is an isotope of barium write the nuclear equation for the reaction and identify Fragment B. 2

- (ii) A stable isotope of barium has 137 nucleons in its nucleus while the barium produced by this fission reaction has 141 nucleons and is very radioactive.

Explain what form of radioactive decay you would expect from this barium isotope produced by the fission reaction. 2

Question 34 (c)

Using a simple labeled sketch or series of simple labeled sketches describe controlled and uncontrolled nuclear chain reactions. 4

Question 34 (d)

The fission on one uranium-235 nucleus yields an average energy of about 200 MeV = 3.2×10^{-14} J.

Given that 1.0 kg of pure uranium 235 contains approximately 2.56×10^{24} uranium atoms, calculate the total energy released if the nucleus of every atom in the 1.9 kg of uranium undergoes fission.

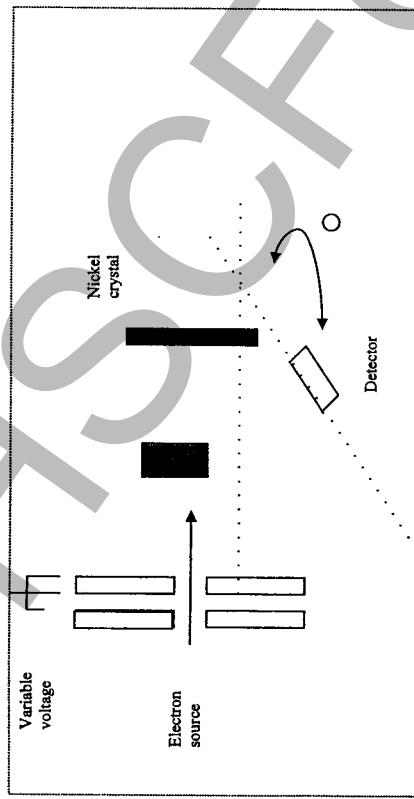
Question 34 (e)

During a PET scan, the positrons produced are almost immediately annihilated in a collision with an electron. This annihilation leads to TWO gamma rays being emitted which travel off in opposite directions.

Based on the mass defect, calculate the minimum energy of the photons of gamma radiation produced during this collision. 2

Question 34 (f)

In 1927, C.J. Davisson and L.H. Germer of the Bell Telephone Laboratory described an experiment that they conducted to observe the diffraction of electrons from the surface of a solid crystal.



Briefly describe the significance of this work for quantum physics.

3

Question 34 (g)

During your study from Quanta to Quarks you performed a first-hand investigation or gathered secondary information to observe the radium emitted from a nucleus using Wilson Cloud Chamber or a similar detection device, describe your investigation.

5

Question 35- The Age of Silicon

(25 marks)

Question 35 (a)

Using a simple table outline THREE similarities and differences between an integrated circuit and a transistor.

3

Question 35 (b)

Discuss the possibility that there may be a limit on the growth of computer power and the implications that this could have on computer design.

3

Question 35 (c)

(i) Briefly describe how an operational amplifier can be used as an inverting amplifier

1

(ii) What is the voltage range over which an operational amplifier circuit acts as a linear device.

1

(iii) If $R_a = 1000 \Omega$

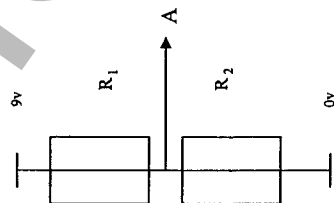
And $R_f = 100,000 \Omega$

What is the gain of the inverting amplifier?

1

Question 35 (d)

The following diagram shows a potential divider.



If R_1 is $250\ \Omega$ and R_2 is $500\ \Omega$ what is the voltage at A?

1

Question 35 (e)

(i) Using a simple sketch or series of simple sketches explain the relationship in a light-dependent-resistor (LDR) between resistance and the amount of light falling on it.

3

(ii) Describe the role of LDRs in cameras.

1

Question 35 (f)

A sawmill has two switches, any one will allow the cutter to run. The first switch is on the side of the machine and the second is a foot operated switch.

However, the machine has two micro-switches that are used as safety devices, and, if any of these are released the cutter will stop. The first micro-switch is on a guard, if this is opened the machine will stop. The second micro-switch is on a door which allows access to the moving mechanism of the milling machine. If this is opened the machine will stop.

The micro-switches are normally logic "1" (true, high, on) when pressed.

(i) Draw the logic diagram for this machine.

3

(ii) What moving parts would you expect to see behind the door leading to the internal mechanism of the milling machine?

1

(iii) Why would access be dangerous if the machine is working at the same time?

1

(iv) How would you improve the design of the switch to make the machine safer to use.

2

Question 35 (g)

Describe the role of transducers as an interface between the environment and an electronic system.

4

Section 1 – Core
Part A – Multiple Choice

Question	Correct response
1	B
2	C
3	A
4	B
5	C
6	C
7	D
8	C
9	A
10	A
11	B
12	B
13	C
14	D
15	A

Section 1, Part B

Question 16 (a)
Marking Guidelines

Criteria	Marks
• Gives correct answer (17.1 m/s)	1

Question 16 (b)
Marking Guidelines

Criteria	Marks
• Gives correct answer (3.5s)	1

Question 16 (c)
Marking Guidelines

Criteria	Marks
• Gives correct answer (11.43 m/s)	1

Question 16 (d)
Marking Guidelines

Criteria	Marks
• Gives correct answer (56.3 deg)	1

Question 16 (e)
Marking Guidelines

Criteria	Marks
• Gives correct answer (20.6 m/s)	1

Question 17
Marking Guidelines

Criteria	Marks
• Describes how the components interact to enable the loudspeaker to operate including reference to the motor effect	3-4
• Correctly describes purpose of some components	2
• Describes function of only ONE component	1

Question 18 (a)
Marking Guidelines

Criteria	Marks
• Gives correct answers ($^{23}_{11}\text{U}$, α particle)	2
• Gives ONE correct answer	1

Question 18 (b)
Marking Guidelines

Criteria	Marks
• Gives ONE potential hazard and ONE safe work practice	2
• Gives ONE of the above	1

Question 19

Marking Guidelines

Criteria	Marks
• Demonstrates appropriate problem solving techniques to completion with correct answer ($9.31 \times 10^{-7} \text{ N}$ directed to the left)	3
• Demonstrates appropriate problem solving techniques to near completion	2
• Demonstrates appropriate problem solving techniques to partial completion	1

Question 20 (a)

Marking Guidelines

Criteria	Marks
• Correctly explains BCS theory and describes Cooper pairs including the assumption that there is some attraction between electrons which can overcome the Coulomb repulsion	3-4
• Provides a partial explanation both BCS theory and Cooper pairs	2
• Correctly describes either BCS theory or Cooper pairs	1

Question 20 (b)

Marking Guidelines

Criteria	Marks
• Provides a thorough description of the Meissner effect	2
• Provides a partial description of the Meissner effect	1

Question 21 (a)

Marking Guidelines

Criteria	Marks
• Correctly describes the function of the matched filters	1

Question 21 (b)

Marking Guidelines

Criteria	Marks
• Correctly describes the function of the collimators	1

Question 21 (c)

Marking Guidelines

Criteria	Marks
• Provides a thorough description of Bragg's law	2
• Provides a partial description of Bragg's law	1

Question 22

Marking Guidelines

Criteria	Marks
• Identifies the correct equation and provides correct answer (0.62 nm)	2
• Identifies the correct equation and partially solves for the correct answer	1

Question 23 (a)

Marking Guidelines

Criteria	Marks
• Identifies the correct equation and provides correct answer (1.36 eV)	2
• Identifies the correct equation and partially solves for the correct answer	1

Question 23 (b)

Marking Guidelines

Criteria	Marks
• Identifies the correct equation and provides correct answer (917.2 nm)	2
• Identifies the correct equation and partially solves for the correct answer	1

Question 24

Marking Guidelines

Criteria	Marks
• Correctly outlines Hertz's experiments and relates these measurements to light waves	3-4
• Demonstrates a partial knowledge of Hertz's experiments and their relation to light waves	2
• Provides a description of Hertz's radio wave experiments	1

Question 25

Marking Guidelines

Criteria	Marks
• Provides a thorough description of an investigation of the production of an alternating current	3-4
• Provides a partial description of an investigation of the production of an alternating current	1-2

Question 26 (a)

Marking Guidelines

Criteria	Marks
• Correctly outlines an application of superconductors in electronics	1

Question 26 (b)

Marking Guidelines

Criteria	Marks
• Correctly outlines an application of superconductors in energy	1

Question 26 (c)

Marking Guidelines

Criteria	Marks
• Correctly outlines an application of superconductors in transportation	1

Question 26 (d)

Marking Guidelines

Criteria	Marks
• Correctly outlines an application of superconductors in industry	1

Question 26 (e)

Marking Guidelines

Criteria	Marks
• Correctly outlines an application of superconductors in medicine	1

Question 27

Marking Guidelines

Criteria	Marks
• Demonstrates appropriate problem-solving techniques to completion (0.065 A)	3
• Identifies the correct equation and partially solves	2
• Identifies the correct equation	1

Question 28

Marking Guidelines

Criteria	Marks
• Provides a table that demonstrates coherence and logical progression of differences and similarities between low Earth and geo-stationary satellites	4-5
• Provides a table that shows one or two differences and similarities between low Earth and geo-stationary satellites	2-3
• Provides a table that shows one difference or one similarity between low Earth and geo-stationary satellites	1

Question 29

Marking Guidelines

Criteria	Marks
Correctly describes the competition between Westinghouse and Edison to supply electricity to cities	2-3
Provides an account of either Westinghouse's or Edison's contribution to the development of electricity	1

Question 30

Marking Guidelines

Criteria	Marks
Demonstrates a thorough knowledge of the contribution of the chosen individual to the development of space exploration	3-4
Demonstrates a partial knowledge of the contribution of the chosen individual to the development of space exploration	1-2

Section 11

Question 31 (a)(i)

Marking Guidelines

Criteria	Marks
Provides a complete account of the role that geophysicists have played in monitoring nuclear test ban treaties	2
Provides a partial account of the role that geophysicists have played in monitoring nuclear test ban treaties	1

Question 31 (b)
Marking Guidelines

Criteria	Marks
Provides a complete and logical description of the investigation	4-5
Provides a partial description of the investigation	2-3
Provides a statement that is relevant to how the Earth's magnetic field varies with latitude.	1

Question 31 (c)

Marking Guidelines

Criteria	Marks
Provides a complete and logical argument	4-5
Provides a partial argument	2-3
Provides a statement that describes the difficulties in persuading scientific paradigms.	1

Question 31 (d)(i)

Marking Guidelines

Criteria	Marks
Completely describes a gravimeter	2
Partially describes a gravimeter	1

Question 31 (d)(ii)

Marking Guidelines

Criteria	Marks
Provides a complete description of the purpose of data reduction in gravity surveys	2
Provides a partial description of the purpose of data reduction in gravity surveys	1

Question 31 (e)
Marking Guidelines

Criteria	Marks
• Provides a complete and logical description including reflection and refraction of seismic waves	3-4
• Provides a partial description of reflection and refraction of seismic waves	2-3
• Provides a description of either reflection or refraction of seismic waves	1

Question 31 (f)(i)
Marking Guidelines

Criteria	Marks
• Describes a liquid inner core and a solid outer core of the Earth	1

Question 31 (f)(ii)
Marking Guidelines

Criteria	Marks
• Provides a brief description of THREE of the properties of Earth materials	3
• Provides a brief description of TWO of the properties of Earth materials	2
• Provides a brief description of ONE of the properties of Earth materials	1

Question 32 (a)(i)
Marking Guidelines

Criteria	Marks
• Provides correct answer (2)	1

Question 32 (a)(ii)
Marking Guidelines

Criteria	Marks
• Provides correct answer (The axis of rotation will precess around the magnetic field, then absorption of radiation flips the magnetic moment so that it opposes the applied field)	1

Question 32 (a)(iii)
Marking Guidelines

Criteria	Marks
• Provides correct answer (spin-lattice relaxation)	1

Question 32 (b)(i)
Marking Guidelines

Criteria	Marks
• Provides correct answer (gamma rays)	1

Question 32 (b)(ii)
Marking Guidelines

Criteria	Marks
• Correctly describes TWO disadvantages that PET has over another diagnostic tool	2
• Correctly describes ONE disadvantage that PET has over another diagnostic tool	1

Question 32 (c)(i)
Marking Guidelines

Criteria	Marks
• Provides correct answer (1.27mm)	1

Question 32 (c)(ii)
Marking Guidelines

Criteria	Marks
• Provides correct answer (9.6cm)	1

**Question 32 (c)(iii)
Marking Guidelines**

Criteria	Marks
• Lists TWO advantages and TWO advantages of using ultrasound over another diagnostic tool	4
• Lists TWO advantages and ONE disadvantage or vice versa	3
• Lists ONE advantage and ONE disadvantage	2
• Lists ONE advantage or ONE disadvantage	1

**Question 32 (d)
Marking Guidelines**

Criteria	Marks
• Provides a thorough description of an investigation into optical fibre technology	4-5
• Provides a partial description of an investigation into optical fibre technology	2-3
• Provides a correct statement pertaining to optical fibre technology	1

**Question 32 (e)
Marking Guidelines**

Criteria	Marks
• Provides a thorough description of how a CAT scan is produced	4-5
• Provides a partial description of how a CAT scan is produced	2-3
• Provides a correct statement pertaining to the production of a CAT scan	1

**Question 33 (a)(i)
Marking Guidelines**

Criteria	Marks
• Provides THREE correct sources of energy	3
• Provides TWO correct sources of energy	2
• Provides ONE correct source of energy	1

**Question 33 (a)(ii)
Marking Guidelines**

Criteria	Marks
• Provides a complete description of the relocation of the reaction	2-3
• Provides a partial description of the relocation of the reaction	1

**Question 33 (b)
Marking Guidelines**

Criteria	Marks
• Provides a complete description of the key features of the spectra used to classify stars	2-3
• Provides a partial description of the key features of the spectra used to classify stars	1

**Question 33 (c)(i)
Marking Guidelines**

Criteria	Marks
• Provides correct answer (2.63158 pc)	1

**Question 33 (c)(ii)
Marking Guidelines**

Criteria	Marks
• Provides correct answer (1.46)	1

Question 33 (c)(iii)

Marking Guidelines

Criteria	Marks
• Provides correct answer (top LHS)	1

Question 33 (d)

Marking Guidelines

Criteria	Marks
• Provides a complete discussion of the problems associated with ground-based astronomy	2-3
• Provides a partial description of the problems associated with ground-based astronomy	1

Question 33 (e)

Marking Guidelines

Criteria	Marks
• Provides a complete explanation of the relationship between period-luminosity and distance to cepheids	2-3
• Provides a partial explanation of the relationship between period-luminosity and distance to cepheids	1

Question 33 (f)

Marking Guidelines

Criteria	Marks
• Provides a thorough description of the investigation	6-7
• Provides a partial description of the investigation	4-5
• Demonstrates some knowledge of the use of filters for photometric measurements	2-3
• States the function of filters in photometric measurement	1

Question 34 (a)(i)

Marking Guidelines

Criteria	Marks
• Provides a thorough explanation of Bohr's model of the Balmer series	2-3
• Provides a partial explanation of Bohr's model of the Balmer series	1

Question 34 (a)(ii)

Marking Guidelines

Criteria	Marks
• Describes TWO limitations of Bohr's model	2
• Describes ONE limitation of Bohr's model	1

Question 34 (b)(i)

Marking Guidelines

Criteria	Marks
• Provides TWO correct answers	2
• Provides ONE correct answer	1

Question 34 (b)(ii)

Marking Guidelines

Criteria	Marks
• Provides a thorough explanation of radioactive decay	2
• Provides a partial explanation of radioactive decay	1

Question 34 (c)

Marking Guidelines

Criteria	Marks
• Provides a thorough explanation of controlled and uncontrolled nuclear chain reactions	3-4
• Provides a partial explanation of controlled and uncontrolled nuclear chain reactions	1-2

Question 34 (d) Marking Guidelines	
Criteria	Marks
• Demonstrates appropriate problem-solving techniques to completion	2
• Identifies correct equation	1

Question 34 (e) Marking Guidelines	
Criteria	Marks
• Demonstrates appropriate problem-solving techniques to completion	2
• Identifies correct equation	1

Question 34 (f) Marking Guidelines	
Criteria	Marks
• Provides a thorough explanation of the significance of this investigation for quantum physics	2-3
• Provides a partial explanation of this investigation for quantum physics	1

Question 34 (g) Marking Guidelines	
Criteria	Marks
• Provides a thorough description of the investigation	4-5
• Provides a partial description of the investigation	2-3
• Provides a correct statement pertaining to the observation of radiation emitted from a Wilson Cloud Chamber or similar detection equipment	1

**Question 35 (a)
Marking Guidelines**

Criteria	Marks
• Provides THREE similarities and/or differences between an integrated circuit and a transistor	3
• Provides TWO similarities and/or differences between an integrated circuit and a transistor	2
• Provides ONE similarities and/or differences between an integrated circuit and a transistor	1

**Question 35 (b)
Marking Guidelines**

Criteria	Marks
• Provides a thorough discussion on the possibility that there may be a limit on the growth of computer power and the possible implications for computer design	2-3
• Provides a partial discussion on the possibility that there may be a limit on the growth of computer power and the possible implications for computer design	1

**Question 35 (c)(i)
Marking Guidelines**

Criteria	Marks
• Provides a correct description for how an operational amplifier can be used as an inverting amplifier	1

**Question 35 (c)(ii)
Marking Guidelines**

Criteria	Marks
• Provides a correct description of the range	1

**Question 35 (c)(iii)
Marking Guidelines**

Criteria	Marks
• Provides correct answer (-100)	1