CATHOLIC SECONDARY SCHOOLS ASSOCIATION

2008 TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

PHYSICS – MARKING GUIDELINES

Section I
Part A
15 marks
Questions 1-15 (1 mark each)

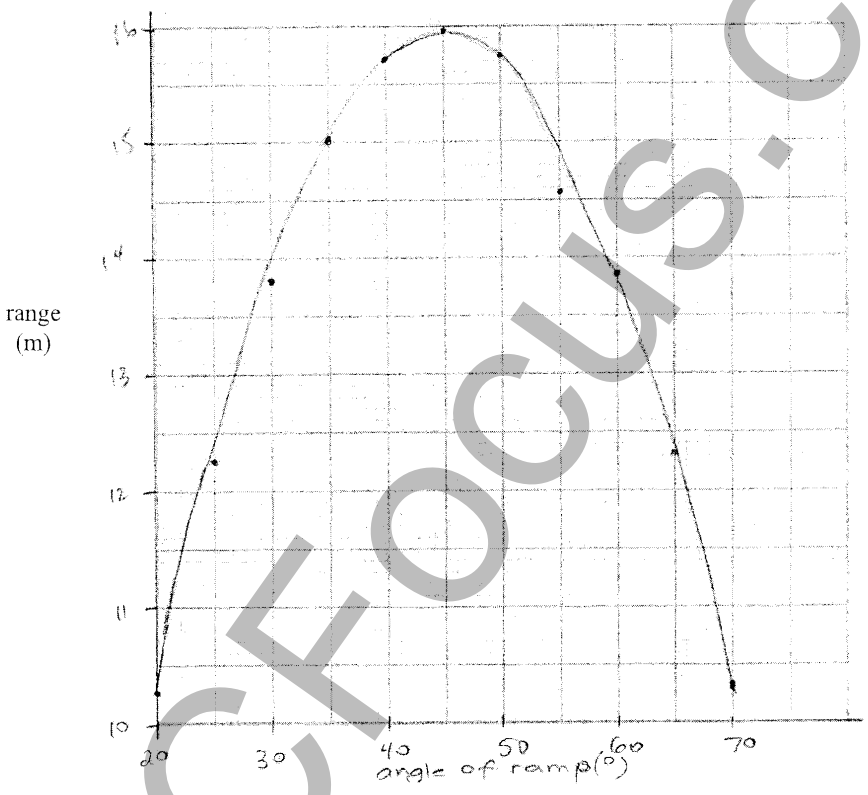
Question	Answer	Outcomes Assessed	Targeted Performance Bands
1	B	H6,H9	2-3
2	D	H6	3-4
3	A	H7	4-5
4	C	H6,H9	3-4
5	C	H6,H9,H13	4-5
6	C	H3,H7,H9	2-3
7	C	H6,H7,H9	4-5
8	B	H7,H9,H13	3-4
9	D	H7,H9	4-5
10	B	H8,H10	5-6
11	C	H9	2-3
12	A	H10	3-4
13	B	H9	2-3
14	C	H7,H9,H10	5-6
15	D	H7	4-5

Part B
60 marks
Questions 16-27

Question 16 (6 marks)
(a) (2 marks)
Outcomes Assessed: H13
Targeted Performance Bands: 2-3

Criteria	Marks
• Labels axis correctly AND • Plots point correctly AND • Correctly draws a curve-of-best-fit	2
• Labels axis correctly AND • Plots point correctly	1

Sample answer:



(b)(i) (1 mark)

Outcomes assessed: H14

Targeted Performance Bands: 3-4

Criteria	Mark
• correctly identifies outlying point and states correct range to fit on curve	1

Sample answer:

outlier is 55°, it should have a range of 15.0m

(b)(ii) (2 marks)

Outcomes assessed: H6, H9

Targeted Performance Bands: 4-5

Criteria	Marks
• calculates initial velocity of ball, includes units	2
• calculates initial horizontal component of velocity correctly OR • partially completes calculation of initial velocity	1

Sample answer:

Flight time = 1.64s

When angle is 40°, range is 15.70m

$\Delta x = u_x t$

$15.70 = u_x \times 1.64$

$u_x = 15.70/1.64 = 9.57$ m/s

$u_x = u \cos 40°$

$9.57 = u \cos 40°$

$u = 12.50$ m/s

Question 17 (4 marks)
(a) (2 marks)
Outcomes Assessed: H3, H6, H9
Targeted Performance Bands: 2-4

Criteria	Marks
• discusses BOTH orbital AND rotational motion of Earth and effect on the launch of a rocket	2
• discusses either orbital OR rotational motion of the Earth and its effect on the launch of a rocket OR • correctly identifies the orbital AND rotational motion of the Earth	1

Sample answer:
The Earth orbits the Sun and also spins on its axis, from west to east, the fastest velocity occurs at the equator. A rocket takes less energy to launch if the effect of these are taken into account. The launch must consider the position of the Earth in relation to the destination of the rocket, in which case it is best to launch when the Earth is in the closest location to the destination. To assist the rocket speed, the rocket is launched near the equator and towards the east, as in this location it gains the maximum assist from the rotational motion of the Earth.

(b) (2 marks)
Outcomes assessed: H6, H7
Targeted Performance Bands: 3-6

Criteria	Marks
• Calculates radius of orbit AND • Converts radius to metres AND • Correctly substitutes values into correct equation to calculate period, showing working and units	2
• Correctly substitutes some values into correct equation to calculate period OR • identifies correct equation	1

Sample answer:
$rE = 6400\ km$
$rs = 6500\ km$
$r = rE + rs$

$$\frac{r^3}{T^2} = \frac{GM}{4\pi^2}$$

$$T^2 = \frac{4\pi^2 r^3}{GM} = \frac{4\pi^2 \times (12900 \times 10^3)^3}{6.67 \times 10^{-11} \times 6.0 \times 10^{24}} = 2.12 \times 10^8\ s^2$$

$$T = 14552\ s$$

Question 18 (7 marks)
(a) (1 marks)
Outcomes Assessed: H2, H4
Targeted Performance Bands: 3-4

Criteria	Mark
• Correct states speed of light is constant for all observers	1

Sample answer:
The speed of light is the same for all observers, regardless of their relative motions.

(b) (3 marks)
Outcomes assessed: H7, H10
Targeted Performance Bands: 3-6

Criteria	Marks
• identifies features of the aether model of light AND • identifies consequences of constancy of speed of light AND • relates these to Michelson-Morley experimental results	3
• identifies features of the aether model of light AND • identifies consequences of constancy of speed of light OR • relates these to Michelson-Morley experimental results	2
• identifies features of the aether model of light OR • identifies consequences of constancy of speed of light	1

Sample answer:
The aether model claimed that the aether was the medium that carried light waves. The aether was invisible and completely elastic. Einstein's theory of relativity showed that distance and time are not fixed but that they are contracted or dilated in order to conform to the constant value of the speed of light. The Michelson-Morley experiment could not support the aether model and was discarded and replaced by Einstein's theory.

(c) (i) (1 mark)

Outcomes assessed: H6

Targeted Performance Bands: 5-6

Criteria	Marks
• correctly calculates the time for the journey in Earth-Angolis reference frame	1

Sample answer:

$v = d/t$

$\therefore t = d/v = 40 \times c / 0.8c = 50$ years

(c) (ii) (2 marks)

Outcomes assessed: H6

Targeted Performance Bands: 5-6

Criteria	Marks
• substitutes into correct equation AND • calculates time for journey in spacecraft reference frame	2
• substitutes into correct equation OR • correctly calculates time for journey in spacecraft reference frame without showing working	1

Sample answer:

$$t_o = t_v\sqrt{1-\frac{v^2}{c^2}} = 50\sqrt{1-\frac{(0.8c)^2}{c^2}} = 50\sqrt{1-0.64} = 50\sqrt{0.36} = 30\,years$$

Question 19 (6 marks)
Outcomes Assessed: H2, H6, H12, H13, H14
Targeted Performance Bands: 2-6

Criteria	Marks
• analysis includes a discussion of the dilemma in the TWO possible answers, and their implications AND • Einstein's reconciliation of the answer • clear discussion of the relationship between thought and reality	5-6
• discussion of the dilemma in the TWO possible answers, and their implications OR • Einstein's reconciliation of the answer OR • discussion of the relationship between thought and reality	3-4
• identifies ONE of the TWO possible answers OR • Einstein's reconciliation of the answer	1-2

Sample answer:
In this particular thought experiment there are two possible answers, both of which contained a dilemma for the scientific community of the time that believed in the aether model:

1. No, a reflection will not appear. This is the result predicted by the aether model, since light can only travel at a set speed through the aether. If the train is travelling at that speed then the light cannot catch the mirror and return as a reflection. Unfortunately, this violates the principle of relativity, which states that in an inertial frame of reference you cannot perform any experiment to tell that you are moving.
2. Yes, the reflection will be seen, because according to the principle of relativity, it would not be possible for the person in the train to do anything to detect the constant motion with which he or she is moving. However, a person watching this from the side of the track should see the light from your face travelling at faster than c.

Einstein decided that:
- the reflection will be seen as normal, because he believed that the principle of relativity should always hold true
- the person at the side of the track sees the light travelling normally. But this means that time passes differently for you on the train and for the person at the side of the track
- the aether model has nothing to do with it, Einstein decided it was superfluous.

A limitation of thought experiments is that what you imagine as the outcome is based upon your common sense, that is, your collective experiences of the way things normally happen. Einstein used thought experiments to investigate situations that could not be tested in reality. In some cases, that inability to test, stems from limitations in current technology.

Question 20 (4 marks)
Outcomes Assessed: H4, H7, H9
Targeted Performance Bands: 2-6

Criteria	Marks
• Identifies Westinghouse as having championed the cause of AC. • Identifies TWO impacts on the environment due to the AC generator. • Gives specific details of the impacts demonstrating an extensive knowledge and sound argument. • Makes a judgement about the impact on the environment and relates it to Westinghouse's happiness.	4
• Identifies Westinghouse as promoting AC. • Identifies TWO impacts on the environment and relates them to the AC generator. • Makes a judgement about the impact on the environment and relates it to Westinghouse's happiness.	3
• Makes a judgement OR relates to Westinghouse • Identifies at least ONE impact of AC electricity on the environment	1-2

Sample answer:
In his work Westinghouse fought and won a battle against Edison in a bid to make AC the main power supply. It has lead to the development of the electricity supply that we know today which uses AC generators. AC generators have mainly had a negative effect on the environment. As most generators are run on fossil fuels they impact on the environment by releasing greenhouse gases such as carbon dioxide which are commonly accepted as causing climate change, raising the Earth's temperature and harming the environment. The AC generator has made possible a cheap supply of electricity. This easy access to electricity has lead to industrialization, leading to waste. Eg It is cheaper to buy a new computer than repair an old one. This leads to not only the overuse of finite resources such as metals and petrochemicals but also to increased landfill. Further harming the Earth's environment. From an environmental point of view Westinghouse has little reason to be happy.

Question 21 (5 marks)

(a) (1 mark)

Outcomes Assessed: H6, H9

Targeted Performance Bands: 3-4

Criteria	Mark
• Identifies the apparatus as an AC motor and correctly attributes this to the slip rings	1

Sample answer:

It is an AC motor as it has slip rings.

(b) (2 marks)

Outcomes assessed: H6, H9

Targeted Performance Bands: 3-5

Criteria	Marks
▪ substitutes correctly into correct equation AND ▪ calculates maximum force on the longer side of coil	2
▪ calculates a force on ONE side of the coil OR ▪ identifies correct equation without substitution	1

Sample answer:

$n = 900$ turns
$B = 0.48T$
$I = 10A$
$L = 40cm$

$F = nBIL$
$= 900 \times 0.48 \times 10 \times 0.40$
$= 1728$ N perpendicular to magnetic field

(c) (2 marks)

Outcomes assessed: H3, H6, H9

Targeted Performance Bands: 3-6

Criteria	Marks
• substitutes correctly into correct equation AND • calculates torque required when rotating as shown	2
• substitutes correctly into correct equation OR • calculates torque required when rotating as shown, without showing working	1

Sample answer:

$\tau = nBIA = 900 \times 0.48 \times 10 \times 6.4 \times 10^{-2} = 276.5$ Nm clockwise as in diagram

Question 22 (4 marks)
Outcomes Assessed: H3, H6, H9, H10
Targeted Performance Bands: 2-4

Criteria	Marks
• Identifies properties of cathode rays supporting electromagnetic nature AND • Identifies properties of cathode rays supporting the particles nature AND • States that the measurement of charge is to mass ratio of cathode ray as a key factor in reaching the conclusion of the debate AND ▪ A judgement is made on why it was difficult to identify cathode rays as particles.	4
• Identifies properties of cathode rays supporting electromagnetic nature AND • Identifies properties of cathode rays supporting the particles nature AND • States that the measurement of charge is to mass ratio of cathode ray as a key factor in reaching the conclusion of the debate	3
• Identifies properties of cathode rays supporting electromagnetic nature AND • Identifies properties of cathode rays supporting the particles nature	2
• Identifies properties of cathode rays supporting electromagnetic nature AND • Identifies properties of cathode rays supporting the particles nature	1

Sample answer:
When the scientists were experimenting with cathode rays, they discovered various properties of these rays. When the cathode rays cast a shadow (Maltese cross) they showed wave-like properties. But when the cathode rays had momentum (paddle wheel) they behaved like particles. When the cathode rays were deflected by magnetic or electric fields, they behaved like charged particles. Hence the behaviour of cathode rays was inconsistent, which caused debate among the scientists of the time, as to whether these rays were actually charged particles or waves. The answer was not easy to find, since these "particles" were very small and difficult to detect. When Thomson finally determined the charge/mass ratio of the cathode rays it was agreed they were charged particles.

Question 23 (4 marks)
(a) (1 mark)
Outcomes Assessed: H5, H7
Targeted Performance Bands: 3-4

Criteria	Mark
• correctly identifies another use of superconductors	1

Sample answer:
Superconductors are used in MRI machines to create a very strong magnetic field.

(b) (1 mark)
Outcomes assessed: H7, H8
Targeted Performance Bands: 2-4

Criteria	Mark
• correctly identifies ONE advantage of using superconductors	1

Sample answer:
When superconductors are used to transmit electricity, they have no resistance, hence there are no lines losses during transmission.

(c) (2 marks)
Outcomes assessed: H7, H9
Targeted Performance Bands: 4-6

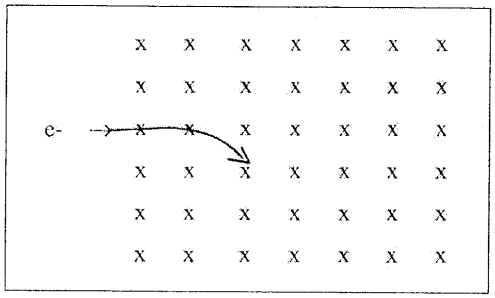
Criteria	Marks
• identifies a limitation of using superconductors AND • relates this limitation to using magnetic levitation in transport	2
• identifies a limitation of using superconductors	1

Sample answer:
Current superconductors need to be kept at very low temperatures, eg in liquid nitrogen, hence it is difficult to keep the superconductor cold so that it can be used in magnetic levitation over long distances, as would be required by transportation systems.

Question 24 (3 marks)
(a) (1 mark)
Outcomes Assessed: H9, H13
Targeted Performance Bands: 2-3

Criteria	Mark
• correctly sketches the path of the electron in the magnetic field	1

Sample answer:



(b) (2 marks)
Outcomes assessed: H9
Targeted Performance Bands: 3-6

Criteria	Marks
• correctly substitutes into correct equation AND • calculates force on electron, including direction	2
• substitutes into correct equation OR • calculates force on electron, without showing working	1

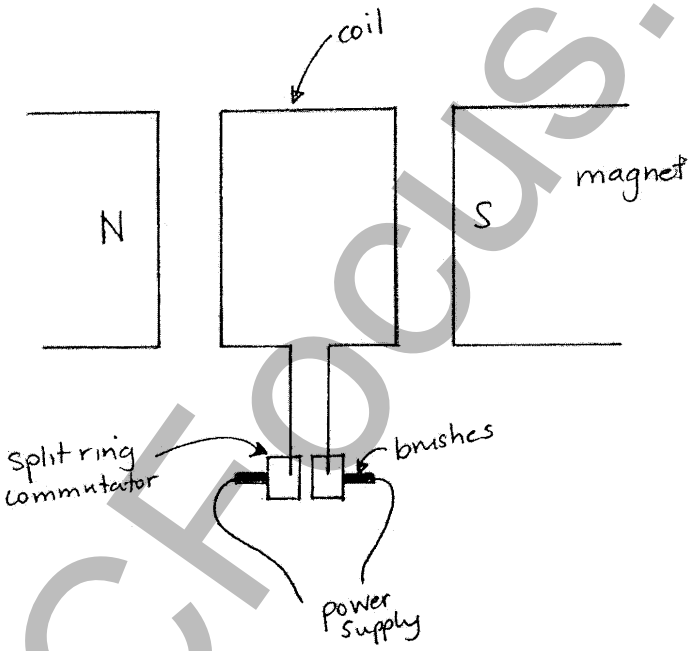
Sample answer:

$B = 0.05T$ $\quad F = qvB$
$v = 300\ m/s$ $\quad = 1.602 \times 10^{-19} \times 300 \times 0.05$
$q = 1.602 \times 10^{-19}\ C$ $\quad = 2.40 \times 10^{-18}\ N$ *downwards*

Question 25 (4 marks)
Outcomes Assessed: H3, H9, H13
Targeted Performance Bands: 2-4

Criteria	Marks
• explains factors affecting torque in DC motor AND • identifies back emf in DC motors AND • includes a correctly labelled diagram of simple DC motor	4
• explains factors affecting torque in DC motor AND • includes a correctly labelled diagram of simple DC motor	3
• explains factors affecting torque in DC motor OR • identifies back emf in DC motors AND • includes a mostly correct labelled diagram of simple DC motor OR • ONLY includes a correctly labelled diagram of simple DC motor	2
• includes a mostly correct labelled diagram of simple DC motor OR • identifies how torque is generated in a DC motor	1

Sample answer:



When a simple DC motor has a current applied to it, it starts to rotate, due to the motor effect, but this also generates a back emf, due to Lenz's law, which hinders the turning of the coil. When the motor is at maximum speed, then it has a maximum torque, but up until this stage the torque varies as angle between coil and magnetic field varies.

Question 26 (46 marks)

(a) (2 marks)

Outcomes Assessed: H9

Targeted Performance Bands: 2-4

Criteria	Marks
• Identifies TWO reasons that transformers are used and relates it to the function of the transformer	2
• Identifies TWO reasons OR • Identifies ONE reason that transformers are used and relates it to the function of the transformer	1

Sample answer:

Transformers are used to step up the voltage so that there is less power loss during transmission. Transformers are also used to step down the voltage when near residential areas or for use so that it is safer to use.

(b) (2 marks)

Outcomes assessed: H9

Targeted Performance Bands: 3-5

Criteria	Marks
• Correctly calculates the power lost	2
• Substitutes correctly for power	1

Sample answer:

$power\ loss = Pp - Ps = VpIp - VsIs$

$= 12 \times 0.05 - 6 \times 0.2 \times 10^{-3}$

$= 0.5988W$

(c) (2 marks)

Outcomes assessed: H9

Targeted Performance Bands: 3-5

Criteria	Marks
• identifies a feature of transformer to reduce power loss AND • outlines the physics of the use of this feature	2
• identifies a feature of transformer to reduce power loss	1

Sample answer:

A laminated iron core in a transformer can be used to reduce power loss. The laminations reduce the size of the eddy currents induced in the core due to the fluctuating magnetic fields in the transformer, this leads to a decrease in the heat produced (and power lost).

Question 27 (8 marks)
(a) (2 marks)
Outcomes Assessed: H2, H7, H10
Targeted Performance Bands: 3-6

Criteria	Marks
• provides features of the experiment by Hertz which produced the photoelectric effect	2
• outlines the Hertz experiment which produced the photoelectric effect	1

Sample answer:
Hertz produced radio waves, which induced a spark across a gap in a metal conductor at some distance from his transmitter. He observed that when he illuminated the conductor with ultraviolet light, the rate of sparking increased. He recorded this observation but did not try to explain its cause.

(b) (3 marks)
Outcomes assessed: H1, H7, H8
Targeted Performance Bands: 4-6

Criteria	Marks
• identifies Planck's contribution to black body radiation AND • identifies Einstein's contribution to black body radiation AND • explains black body radiation using both ideas	3
• identifies Planck's contribution to black body radiation AND • identifies Einstein's contribution to black body radiation OR • explains black body radiation using ONE respective contribution	2
• identifies Planck's contribution to black body radiation OR • identifies Einstein's contribution to black body radiation	1

Sample answer:
Planck investigated black body radiation and found that the energy emitted by the black body was quantised and depended on the frequency of the radiation (E = hf). Planck applied his idea of quantisation to all light. Einstein confirmed Planck's ideas to formulate an explanation of black body radiation – the light travels in packets, called photons, which have an energy that depends on its frequency (E = hf) and the energy of the photon is completely given up in any collision. Einstein used this idea to explain the photoelectric effect.
Black bodies are those which absorb all radiation that falls on it, and only re-emits radiation via a small hole in the side of the black body. The energy comes in defined packets, the energy of the packet is determined by the frequency of the light emitted, Planck described this packet as a quantum of energy.

(c) (i) (2 marks)

Outcomes assessed: H13

Targeted Performance Bands:3- 4

Criteria	Marks
• substitutes into correct equation AND • calculates the energy of the photon	2
• substitutes some values into correct equation OR • calculates the energy of the photon, without showing working	1

Sample answer:

$\lambda = 300\ nm \qquad E = hf = hc/\lambda$

$$= \frac{6.626 \times 10^{-34} \times 3.00 \times 10^{8}}{300 \times 10^{-9}}$$

$$= 6.626 \times 10^{-19}\ J$$

(c) (ii) (1 mark)

Outcomes assessed: H6, H7, H14

Targeted Performance Bands: 4-6

Criteria	Mark
• explains how photon produces photoelectron	1

Sample answer:

When the packet of light hits an electron in the outer shells of the metal, it gives all of its energy to the electron. This electron then has enough energy to break away, and leave the surface of the metal atom and kinetic energy to move once released from the surface.

Section II
25 marks

Question 28 - Geophysics (25 marks)
(a) (5 marks)
(i) (2 marks)
Outcomes Assessed: H9
Targeted Performance Bands: 3-5

Criteria	Marks
• Correct substitution into correct answer AND • Correct calculation, showing working and units	2
• Correct substitution of some data into correct equation OR • identify correct equation	1

Sample answer:

$r^3/T^2 = GM/4\pi^2$

$(42200 \times 1000)^3/(24 \times 60 \times 60)^2 = (6.67 \times 10^{-11})\ M/4\pi^2$

$M = 5.96 \times 10^{24}\ kg$

(ii) (3 marks)
Outcomes Assessed: H8
Targeted Performance Bands: 2-6

Criteria	Marks
• Explains the recording of images of the surface of the Earth in specific ranges of wavelengths AND • identifies TWO examples of the type of information that would indicate changes in vegetation and climate.	3
• Explains the use of specific ranges of wavelengths reflected off the surface of the Earth AND • identifies ONE example	2
• Explains the use of images made by cameras OR • identifies an example of the type of information that indicates changes in vegetation or climate.	1

Sample answer:
Using a variety of wavelengths from blue to thermal red, cameras on board satellites are able to record reflected light to produce images that feature various aspects of the vegetation below. Specific wavelengths are chosen that reveal information such as tree height and vegetation density that may relate to the effects of climate change. Remote sensing can also identify variations in water temperature across oceans and monitor climate events, such as flooding.

(b) (6 marks)
(i) (2 marks)
Outcomes Assessed: H11, H12
Targeted Performance Bands: 2-4

Criteria	Marks
• Describes an investigation with details of both reflection and refraction	2
• Outlines an investigation	1

Sample answer:
One way of modelling the principles of reflection and refraction is to use a light box and a variety of glass and Perspex slabs. Light waves travelling through these media will reflect and refract at an interface between any two of the materials used. At the critical angle the light beam will travel along the interface. Shock waves will pass through rock and reflect and refract in the same way as light does.

(ii) (4 marks)
Outcomes Assessed: H7, H8
Targeted Performance Bands: 2-6

Criteria	Marks
• Describes the use of a shot point and geophones (or hydraphones) • Explains that reflection and refraction will occur whenever there are changes in density in the rock structure • Explains how reflection of waves is used • Explains how refraction is used	3-4
• Describes the use of a shot point and geophones (or hydraphones) OR • Explains that reflection and refraction will occur whenever there are changes in density in the rock structure OR • Explains how reflection of waves is used OR • Explains how refraction is used	1-2

Sample answer:
A shot point is used to generate a shock wave, which penetrates the Earth. The interaction between the wave and the rock structures is recorded by a string of geophones embedded into the surface at varying distances. These geophones allow the time taken for the wave energy returning to the surface to be recorded at various points. Reflection and refraction will occur at any interface between rocks of different density. To collect reflected waves the geophones are placed near the shot point so that only waves that have travelled downward and been reflected on a near vertical line can be recorded. Waves striking an interface at the critical angle will move along the interface and cause a vibration to move outwards that can be recorded by sensors on the surface. This information is then downloaded to a computer where specially designed software is used to analyse the data and produce diagrams.

(c) (7 marks)
Outcomes Assessed: H9
Targeted Performance Bands: 2-6

Criteria	Marks
• States the use of gravimeters to obtain raw data • explains the need for data reduction • Analyses the THREE factors involved in data reduction • Describes how gravity data can be useful	6-7
• States the use of gravimeters to obtain raw data • Understands the need for data reduction • Analyses the TWO factors involved in data reduction • Describes how gravity data can be useful	4-5
• States the use of gravimeters to obtain raw data • Understands the need for data reduction • describes ONE factor involved in data reduction • Describes how gravity data can be useful	2-3
• identifies the use of gravimeters to obtain raw data OR • Understands the need for data reduction OR • identifies ONE factor involved in data reduction OR • identifies how gravity data can be useful	1

Sample answer:
Gravity is measured using an instrument called a gravimeter, which can be mounted on board a plane and used to gather data over a wide area, or individual meters can be located at fixed points forming a grid. Gravity varies because of a number of factors including the changing radius of the Earth as well as other factors such as the presence of large relatively high density masses such as rock or low density areas such as ocean trenches.
In order to obtain reliable data useful over a larger area, data reduction techniques are used to remove factors affecting gravimeter readings that are caused by extraneous effects. Such factors influence readings but are not part of the gravitational pull of the Earth itself. One of the data reduction techniques employed is 'latitude correction'. This is used to remove the effects of the centripetal motion of the Earth, which are greater at the equator and reduce to zero at the Poles. 'Free air correction' is used to account for the varying elevations at which readings are taken. Small changes can cause significant variations in readings and need to be eliminated. For this purpose all readings are recalculated to a common datum level, usually sea level. The 'Bouguer correction' is included to account for the effect of a mass between the point at which the measurement is taken and the datum level. It is calculated as the product of the density and height of the rock between these two levels.
The final data can be recorded on maps and used for a variety of purposes such as the search for deposits containing ore bodies for metals. These exert a slightly increased gravitational pull compared to the surrounding area, which can be detected and used as an indicator of the usefulness of further exploration.

(d) (7 marks)
(i) (2 marks)
Outcomes Assessed: H7, H8
Targeted Performance Bands: 2-3

Criteria	Marks
• Explains that S-waves are transverse waves • Transverse waves or shear waves cannot travel through the liquid outer core of the Earth	2
• States that S-waves cannot travel through the liquid outer core of the Earth	1

Sample answer:
S-waves are transverse (shear) waves and are not able to pass through the liquid magma of the outer core. This creates a shadow region on the opposite side of the Earth to an epicenter where S-waves cannot be detected.

(ii) (2 marks)
Outcomes Assessed: H9
Targeted Performance Bands: 2-6

Criteria	Marks
• States that the Earth's magnetic field changes over time • As a result the magnetic orientation of iron traces in the cooling magma is affected • Shows how such patterns support the theory of plate tectonics	2
• Describes how the pattern is formed OR • States how such patterns support the theory of plate tectonics	1

Sample answer:
As magma emerging from the ridge axis cools the magnetic iron present will orient itself with the Earth's magnetic field at that time. As the oceanic plates spread more magma can rise to the surface. Over time the Earth's magnetic field changes in direction and strength and so the magnetic iron will align along a different set of field lines.
The theory of plate tectonics states that the Earth's crust is divided into plates that interact with each other. The pattern shown in the diagram justifies this theory by showing evidence of two plates spreading apart and new plate material being formed

(iii) (3 marks)
Outcomes Assessed: H1, H2
Targeted Performance Bands: 2-6

Criteria	Marks
• States that data was collected from pendulum experiments • Describes Newton's analysis of the data and his conclusion • Mentions Newton's use of the law of universal gravitation	3
• States that data was collected from pendulum experiments • Describes Newton's analysis of the data and his conclusion	2
• States that data was collected from pendulum experiments OR • Describes Newton's analysis of the data OR his conclusion OR • States Newton's Law of Gravitation	1

Sample answer:
Picard and Richer collected data about the period of a pendulum in Paris and Cayene. The data suggested that the period recorded was longer nearer to the equator and shorter as one approached the Poles. Using the universal law of gravitation, Newton concluded that a longer period was possible if the pendulum was further from the centre of the Earth. He concluded that the Earth was flattened at the Poles.

Question 29 – Medical Physics (25 marks)

(a) (5 marks)

(i) (2 marks)

Outcomes Assessed: H8

Targeted Performance Bands: 3-5

Criteria	Marks
• substitutes correctly into correct equation AND • calculates acoustic impedance, including units	2
• substitutes into correct equation OR • calculates acoustic impedance without showing working	1

Sample answer:

$v = 1520\ m/s$ $\qquad Z = \rho v$

$\rho = 1.00 \times 10^3\ kg/m^3$ $\qquad Z = 1.00 \times 10^3 \times 1520$

$= 1.52 \times 10^6\ kgm^{-2}\ m^{-1}$

$= 1.52\ rayl$

(ii) (3 marks)

Outcomes Assessed: H7, H8

Targeted Performance Bands: 2-6

Criteria	Marks
• relates cause and effect of difference in acoustic impedance and transmission of ultrasound waves for imaging	2-3
• identifies large acoustic impedance difference between air and skin OR • identifies large percentage of reflection of ultrasound occurs when there is a large difference in acoustic impedance OR • identifies the use of the gel allows more ultrasound waves to be transmitted	1

Sample answer:

There is a large difference in acoustic impedance between air and skin. This large difference in acoustic impedance causes a large degree of reflection of the ultrasound wave, hence not much of the ultrasound would pass through the skin for imaging. The gel reduces this acoustic impedance difference as its acoustic impedance is close to that of the skin and the majority of the ultrasound waves then pass through for imaging to occur.

(b) (6 marks)
(i) (2 marks)
Outcomes Assessed: H12
Targeted Performance Bands: 3-5

Criteria	Marks
• uses at least TWO features for comparison	2
• identifies ONE feature used for comparison OR • identifies how the scan would be different	1

Sample answer:
Bone scan and x-ray images can be compared using the following criteria:
(i) detail shown in image – is the image clear and sharp?, does it show bone edges/outline or internal structure?
(ii) anatomical vs functional – does image show anatomy or function of area?

(ii) (4 marks)
Outcomes Assessed: H14
Targeted Performance Bands: 2-6

Criteria	Marks
• gives at least TWO reasons for bone scan to be used in preference to x-ray • comparison of long-term sports injury to recent injury	3-4
• gives at least ONE reason for bone scan to be used in preference to x-ray • identifies long term sports injury likely to be fracture and not a clean break, which would not show clearly on x-ray	1-2

Sample answer:
A bone scan is better at showing stress fractures, or similar injuries, than an x-ray, whereas the x-ray would be better for showing a clean break in the bone. A long term sports injury would most likely be a bone fracture or stress fracture, rather than a clean break in the bone because the clean break is easier to detect quickly and cheaply. The bone scan gives information about the functioning of the bone, or area of injury. The increased blood flow is detected, which shows and area in rapid growth compared to the neighbouring areas.

(c) (7 marks)

Outcomes Assessed: H

Targeted Performance Bands: 2-6

Criteria	Marks
• discusses at least THREE developments in technology/physics that were necessary for the development of MRI AND • gives reasons for MRI being a useful medical technology AND • uses concise and scientific language	6-7
• discusses TWO developments in technology/physics that were necessary for the development of MRI AND • gives ONE reason for MRI being a useful medical technology	4-5
• discusses ONE development in technology/physics that was necessary for the development of MRI OR • gives ONE reason for MRI being a useful medical technology	2-3
• identifies ONE development in technology/physics that was necessary for the development of MRI OR • identifies ONE use of MRI	1

Sample answer:

MRI is a useful medical technology because it can produce precise anatomical images of the inside of the body without invasive surgery. This enables medical practitioners to diagnose and treat disease in the earliest of stages, which makes the treatment more successful, allowing these people to lead longer and more productive lives as members of our community.

There have been several advances in the technology that have enabled MRI to develop. The production of superconductors, which have zero resistance at their critical temperature, allows a very strong magnetic field to be produced, which is the basis for the MRI technique. The external magnetic field is used to align the spinning protons in the body, which are manipulated and produce the great images of MRI.

MRI relies heavily on computer technology. The development of the silicon chip and integrated circuit have enabled computers to become smaller and process information faster , which enables the image from the gathered data to produce and image quickly – almost in real time.

The image is formed on the screen attached to the computer. The screen resolution has increased markedly in recent years – from CRT to LED – due to an increase in physics knowledge and application of this knowledge.

Therefore without these developments in technology and physics, MRI would not be as useful as it is today as a medical tool.

(d) (7 marks)
(i) (2 marks)
Outcomes Assessed: H8
Targeted Performance Bands: 2-4

Criteria	Marks
• explanation includes most of the following: optic fibres, various instruments, use of endoscopes, total internal reflection	2
• identifies total internal reflection as used by endoscopes OR • identifies use of endoscope	1

Sample answer:
An endoscope is used to obtain real-time images and tissue samples (or perform surgery) from the insides of a patient. A couple of small incisions are made into the patient, one incision for light and the other for the video and/or tools used. The light travels down optical fibres by total internal reflection to illuminate the area of interest, so video data can be transmitted out of the patient for the doctors to see.

(ii) (2 marks)
Outcomes Assessed: H8
Targeted Performance Bands: 2-6

Criteria	Marks
• identifies the difference between coherent and incoherent bundles of optic fibres • justifies the use of coherent optic fibres in endoscopes	2
• identifies the difference between coherent and incoherent bundles of optic fibres OR • justifies the use of coherent optic fibres in endoscopes	1

Sample answer
Coherent bundles of optic fibres keep the same relative position all the way along the length of the bundle, so an image can be transmitted for one end of the bundle to the other. This is useful in endoscopes because the doctors want to be able to see the real-time image of the inside of the body. An incoherent bundle of optic fibres does not keep the same relative position along its length, and cannot be used for images, only for light, or to illuminate the area of interest inside the body.

(iii) (3 marks)
Outcomes Assessed: H8
Targeted Performance Bands: 2-6

Criteria	Marks
• provides features of the process used by an endoscope to obtain a tissue sample of an internal organ	2-3
• identifies the use of instruments in the endoscope OR • identifies the use of optical fibres in the endoscope	1

Sample answer:
When the two small incisions (key-holes) are made into the patient on either side of the area of interest, one incision has an optical fibre inserted to illuminate the area, while the other has an optic fibre for video feed and the cutting/sucking instruments attached to retrieve the tissue sample.
When the video shows the doctor that they are in correct location, the doctor then inserts the cutting instruments in the incision with the video feed, cutting the tissue and sucking up the sample to be collected outside the body. This sample is then sent to a lab for further testing. The endoscope is then removed and the small incision sutured.

Question 30 - Astrophysics (25 marks)
(a) (5 marks)
(i) (2 marks)
Outcomes Assessed: H6, H9
Targeted Performance Bands: 3-5

Criteria	Marks
• correct substitution into correct equation • calculates distance, including units	2
• correct substitution into correct equation OR • calculates distance, without showing working	1

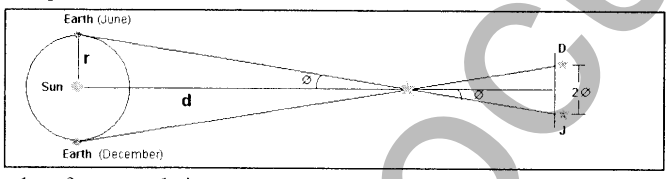
Sample answer:

$D = 1/p = 1/(0.25/2) = 4\ pc$

(ii) (3 marks)
Outcomes Assessed: H
Targeted Performance Bands: 2-6

Criteria	Marks
• includes all of the following: diagram, explanation of parallax, how to obtain it and how to calculate the distance	2-3
• includes ONE of the following: diagram, explanation of parallax, how to obtain it and how to calculate the distance	1

Sample answer:



Θ = annual parallax angle
d = distance to 'near' star being measured

taken from a website: *http://www.wonderquest.com/parallax-example.htm)*

Looking at a star in June will position it close to star J (a distant star) . When viewed in December, the star now appears to be closer to D. The apparent shift of the star in relation to the background stars is known as parallax. If a photo was taken at both these times and then a scaled picture was used to measure the shift, the parallax angle could be measured and then using the relation d =1/p the distance to the star can be calculated.

(b) (6 marks)
(i) (2 marks)
Outcomes Assessed: H12
Targeted Performance Bands: 2-4

Criteria	Marks
• identify the instruments needed AND • identifying at least TWO types of spectra AND • provides an example of each spectral type	2
• identify the instruments needed OR • identify the ONE types of spectra OR • provides an example of ONE spectral type	1

Sample answer:
Using a spectroscope, aim it at an incandescent light globe, reflected light from clouds and a fluorescent light. Observe and draw the pattern. Respectively you see a continuous, absorption and emission spectra.

(ii) (4 marks)
Outcomes Assessed: H8, H10
Targeted Performance Bands: 2-6

Criteria	Marks
• defines all THREE spectral types AND • identifies key differences between all spectra	3-4
• defines ONE spectral types AND • identifies key differences between TWO spectral types	1-2

Sample answer:
Continuous spectra is one that an object emits every wavelength of the electromagnetic spectra. Emission spectra is created when only select wavelengths are excited and emit light. An absorption spectra shows as dark lines on a coloured background of an otherwise continuous spectrum. It is a continuous spectra with some missing wavelength corresponding to chemicals in the atmosphere of the star that are absorbing the missing wavelengths.

(c) (7 marks)
Outcomes Assessed: H1, H2, H3, H8, H10
Targeted Performance Bands: 2-6

Criteria	Marks
• Concise information about technologies that helped developed astronomy. • Correct scientific terminology used • At least THREE different technologies identified AND discussed with relevant examples of increase in understanding	6-7
• Some correct scientific terminology used • At least TWO different technologies identified AND discussed, with at least an example of increased understanding	4-5
• At least TWO different technologies identified OR • ONE technology identified AND discussed	2-3
• ONE technology identified	1

Sample answer:
Originally, astronomy was done with the naked eye and theories developed based on these observations. When telescopes were turned to the skies, theories had to change in order to accommodate observations. Examples of this include Galileo's observations on the moon having mountains. The moon is quite close in comparison to some distance stars in the universe and until better telescopes were invented, knowledge was limited.

The greater the apperture of the telescope, the greater the sensitivity and resolution so the more detail in the universe you can see.

In order to capture these images and be able to study them later, photography gave astronomy greater power. Colours could be shown in true colour and recording of images and spectra for an extended period of time means study of dim objects is possible. Of course, CCD cameras changed everything yet again with computerised images, that could be manipulated and stacked for greater sensitivity and effective resolution.

Disturbances in the atmosphere due to heat or pollution can blur images even from these great telescopes - methods to fix this and create clearer images include adaptive and active optics.

The greater understanding resulting from recording, for example, the dim spectra from stars and galaxies has helped determine the nature and evolution of stars and the expansion of the universe.

(d) (7 marks)
(i) (2 marks)
Outcomes Assessed: H7
Targeted Performance Bands: 2-3

Criteria	Marks
• Explain what p-p chain and c-n-o cycle are. • Identify that the temperature and therefore the mass of the star will dictate which is employed.	2
• Difference identified but the difference between the methods not made clear.	1

Sample answer:
Both PP chain and the CNO cycle is the fusing of 4 H atoms to produce a He atom. The difference is in the path that is taken to the end result. PP chain occurs in stars of mass of the Sun or lower and occurs at core temperature of the sun or lower. In stars that are more massive, there is greater gravitational force and therefore greater temperatures. At higher temperatures the faster CNO cycle predominates.

(ii) (2 marks)
Outcomes Assessed: H6
Targeted Performance Bands: 2-6

Criteria	Marks
• identifies THREE of the FOUR groups of binary stars AND • state some characteristics of different groups • identifies reason for grouping	2
• identifies TWO groups of binary stars OR explains ONE type OR • identifies a reason for grouping stars	1

Sample answer:
There are 4 groups of binary stars. Each is characterised by how it is observed from Earth. The characteristics of each, also allows astronomers to generalise about all binaries that show the observed characteristics and tells them how exactly to observe them and obtain the greatest amount of information.
Visual binaries are stars that can be visual resolved as two stars.
Spectroscopic binaries are visually seen as one but common spectral lines split and combines periodically.
Eclipsing binaries are identified as the intensity of light from this system increases and decreases periodically, characteristically, Astrometric binaries are stars that appear as one but have a periodic wobble, in their motion through space.

(iii) (3 marks)

Outcomes Assessed: H6

Targeted Performance Bands: 2-6

Criteria	Marks
• Full list of steps to determine the distance to a Cepheid variable	2-3
• some of the steps to determine the distance to a Cepheid variable	1

Sample answer:

1. Determine the average apparent magnitude from its light curve.
2. Determine the light period of the variable.
3. Use the conversion graph to convert the period of the Cepheid to the absolute magnitude
4. Use the distance modulus equation to determine distance, ie $M = m - 5\log_{10}\frac{d}{10}$ where d is the distance in parsecs, etc.

Question 31 – From Quanta to Quarks (25 marks)

(a) (5 marks)

(i) (2 marks)

Outcomes Assessed: H10

Targeted Performance Bands: 3-5

Criteria	Marks
• Correctly calculates the wavelength of the electron.	2
• Identifies the correct formula from the data sheet and makes a substitution into the formula.	1

Sample answer:

$\lambda = \frac{h}{mv}$ *,where* $h = 6.626 \times 10^{-34}$ Js, $m = 9.109 \times 10^{-31}$ kg *and* $v = 6.2 \times 10^{6}$ ms^{-1}

Thus,

$$\lambda = \frac{6.626 \times 10^{-34}}{9.109 \times 10^{-31} \times 6.2 \times 10^{6}} =, 1.2 \times 10^{-10} \text{ m}$$

(ii) (3 marks)

Outcomes Assessed: H10, H8

Targeted Performance Bands: 2-6

Criteria	Marks
• Explains how the results of the Davisson and Germer Experiment gave evidence for the De Broglie hypothesis • Describes the results of the Davisson and Germer • Outlines the experimental procedure	3
• Describes the results of the Davisson and Germer Experiment • Outlines the experimental procedure	2
• Outlines the procedure of the Davisson and Germer Experiment	1

Sample answer:

In Davisson and Germer's experiment, electrons from a hot filament were accelerated towards a smooth nickel target. This was done in vacuum so that the electron scattering from the surface could be observed. The nickel target could be rotated so that the angular dependence of the scattering could be observed. The scattered electrons were observed to have diffraction maxima and minima which could be interpreted by the Bragg equation. The Bragg equation was successfully applied to the diffraction of X-Rays which were electromagnetic waves. If the electrons were being diffracted this meant that they must have wave-like properties as hypothesised by de Broglie.

(b) (6 marks)
(i) (2 marks)
Outcomes Assessed: H12
Targeted Performance Bands: 3-5

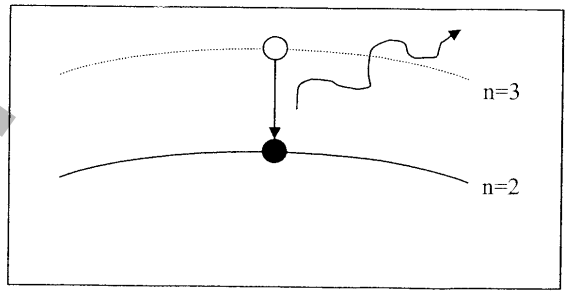
Criteria	Marks
• An extensive description of the experiment performed which accurately identifies apparatus AND a description of what is recorded.	2
• An elementary description of the experiment performed with some apparatus omitted.	1

Sample answer:
A Hydrogen discharge tube was excited with high voltage current. The resulting emitted light was observed using a hand held spectroscope. Observations were recorded on a wavelength scale using coloured pencils.

(ii) (4 marks)
Outcomes Assessed: H7, H10
Targeted Performance Bands: 2-6

Criteria	Marks
• Explains that the Rydberg equation gives the wavelength of light emitted when an electron moves from orbit n_f to n_i. • States that n_f and n_i can only take integer values and relates this to Bohr's postulates. • Presents an appropriately labelled diagram showing the relative positions of orbitals n_f and n_i.	3-4
• Presents an appropriately labelled diagram showing the relative positions of orbitals n_f and n_i. AND • Describes ONE feature of the Bohr model	2
• Presents an appropriately labelled diagram showing the relative positions of orbitals n_f and n_i. OR • Describes ONE feature of the Bohr model	1

Sample answer:
Bohr proposed that electrons exist in stable orbits about the nucleus. An electron may lose energy only if it falls from a higher allowed orbit to a lower allowed orbit. These orbits correspond to integers (1, 2, 3…) in the equation. If an electron moves from n_i to n_f it releases a photon of wavelength λ as given by Rydberg's equation, is emitted.



(c) (7 marks)

Outcomes Assessed: H3, H7

Targeted Performance Bands: 2-6

Criteria	Marks
• Analyses ONE implication of neutron scattering experiments for society AND ONE implication of neutron scattering experiments for the environment AND • Presents ONE correctly balanced nuclear reaction showing the fission of Uranium AND • Presents a well constructed extensive explanation of the requirements for a controlled nuclear chain reaction	7
• Analyses ONE implication of neutron scattering experiments for society or the environment AND • Presents ONE correctly balanced nuclear reaction showing the fission of Uranium AND • Presents a well constructed extensive explanation of the requirements for a controlled nuclear chain reaction	6
• Analyses ONE implication of neutron scattering experiments for society or the environment AND • Presents a nuclear reaction showing the fission of Uranium (with error) AND • Presents a well constructed explanation of the requirements for a controlled nuclear chain reaction	5
• Describes an implication of neutron scattering experiments for society or the environment AND • Presents a nuclear reaction showing the fission of Uranium (with error) AND • Presents an explanation of the requirements for a controlled nuclear chain reaction OR • Presents a well constructed extensive explanation of the requirements for a controlled nuclear chain reaction OR • Analyses ONE implication of neutron scattering experiments on society AND ONE implication of neutron scattering experiments on the environment.	3-4
• Describes an implication of neutron scattering experiments for society or the environment OR • Presents a correctly balanced nuclear reaction showing the fission of Uranium OR • Presents an explanation of the requirements for a controlled nuclear chain reaction	1-2

Sample answer:
At its core, OPAL has a small nuclear fission reactor (about the size of a washing machine). Enriched uranium fuel rods are arranged in a rectangular array in its core and the core is immersed in a heavy water (D_2O) moderator for slowing neutrons. After fission is initiated, the moderator slows the neutrons released so that they more readily cause more fissions. An example of a uranium fission reaction is:

$$^{235}_{92}U + ^{1}_{0}n \rightarrow ^{89}_{36}Kr + ^{144}_{56}Ba + 3^{1}_{0}n$$

Control rods absorb excess neutrons so that an equilibrium neutron flux is established in the core, providing for a controlled chain reaction. Surrounding the reactor core is a reflector material and radiation shielding to protect the environment surrounding the reactor. Excess heat is removed from the reactor core by piping cooled water through the core.
Some of the neutron flux produced is piped out of the reactor core in 'beam ports'. These beam ports channel the neutrons away from the reactor core into other parts of the installation where they irradiate targets in neutron scattering experiments.
Neutron scattering experiments are particularly important because they allow the structure of materials, including metals, polymers, and biochemicals to be determined. This has implications for society and the environment. For example, as a direct result of neutron scattering experiments, society benefits by the faster development of new pharmaceuticals or more efficient building materials. There are implications for the environment also. One negative implication is the need to dispose of radioactive waste as a direct result of the operation of the fission reactor core and the need to store this waste indefinitely in ecologically sound storage facilities. However, the environment also benefits in positive ways in that by determining the structure of compounds (by neutron scattering research) this leads to more efficient production methods or new production methods which help to remove the heavy burden of raw material supply from natural sources.

(d) (7 marks)
(i) (2 marks)
Outcomes Assessed: H7
Targeted Performance Bands: 2-3

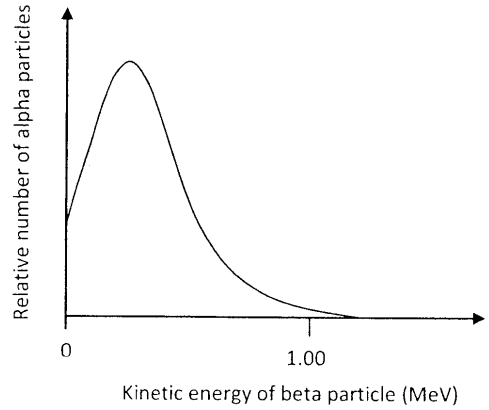
Criteria	Marks
• Explains that the mass defect is the origin of the energy of these particles by relating mass defect to Einstein's mass-energy equivalence.	2
• Identifies mass-energy equivalence or mass defect.	1

Sample answer:
The energy is available because of the mass defect of the nuclear reaction. This mass defect is converted into energy as calculated by Einstein's mass-energy equivalence formula.

(ii) (2 marks)
Outcomes Assessed: H6
Targeted Performance Bands: 2-6

Criteria	Marks
• Presents a representative sketch of a beta decay curve. AND • identifies the production of a neutrino	2
• Presents a representative sketch of a beta decay curve.	1

Sample answer:



The energy distribution for β-particle is different because a β-decay reaction, eg $^{210}Bi \rightarrow {}^{210}Po + \ell + \bar{\nu}$, also produces a neutrino.

(iii) (3 marks)
Outcomes Assessed: H7
Targeted Performance Bands: 2-6

Criteria	Marks
• Names a medical radioisotope studied AND • A well constructed description of a medical use of a radioisotope is given	2-3
• Names a medical radioisotope studied OR • Identifies a medical use of a medical radioisotope	1

Sample answer:
One radioactive isotope studied was iodine-131. It's quick take up by the thyroid makes it particularly useful in the medical scanning of that gland and therefore an important diagnostic tool

Question 32 – The Age of Silicon (25 marks)
(a) (5 marks)
(i) (2 marks)
Outcomes Assessed: H7
Targeted Performance Bands: 3-5

Criteria	Marks
• gives features of an LDR • identifies the relationship between resistance and amount of light falling on an LDR	2
• identifies an LDR OR • identifies a feature of an LDR	1

Sample answer:
A light dependent resistor (LDR) is made of a high resistance semiconductor material. When exposed to electromagnetic radiation of a particular frequency the electrical resistance falls. The brighter the radiation the lower the electrical resistance falls. Resistance falls because photons eject electrons from the semiconductor into the conduction band. The more electrons ejected, the lower the resistance.

(ii) (3 marks)
Outcomes Assessed: H
Targeted Performance Bands: 2-6

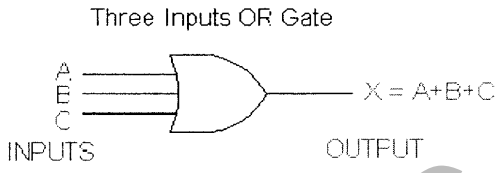
Criteria	Marks
• identifies reasons for all THREE being input transducers	2-3
• identifies reasons for ONE being an input resistor	1

Sample answer:
All three have in common the production of electrical energy as output. This satisfies the definition of an input transducer.
Solar cells convert sunlight into electrical energy in output circuits in which they are connected.
Switches convert mechanical energy into electrical energy. The light meter in a camera is usually an LDR that varies the electric current flow in a circuit according to the amount of light falling on it. That output variable current is linked to the shutter controls in the camera.

(b) (6 marks)
(i) (2 marks)
Outcomes Assessed: H7
Targeted Performance Bands: 3-5

Criteria	Marks
• identifies features of constructing truth tables • applies this to truth tables for logic gate	2
• identifies features of constructing truth tables OR • draws an example truth table	1

Sample answer:
A truth table considers all possible inputs into a logic gate and determines the output for the logic gate. For example, if we took a three input OR gate, we could construct a truth table for it as follows:



the related truth table would be ->

A	B	C	X = A+B+C
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

(ii) (4 marks)
Outcomes Assessed: H3, H7
Targeted Performance Bands: 2-6

Criteria	Marks
• identifies at least TWO uses of logic gates AND • explains the use of the logic gates	3-4
• identifies at least ONE use of logic gates OR • explains ONE use of logic gates	1-2

Sample answer:
Combinations of gates can be used to create half or full adders. Such logic gates are used to make decisions and play a critical role in control electronics and computers.

(c) (7 marks)
Outcomes Assessed: H3, H5, H6, H7
Targeted Performance Bands: 2-6

Criteria	Marks
• Analyses use of amplifiers AND • identifies TWO technologies that use amplifiers AND • identifies TWO technologies of amplifiers AND • compares the uses of these TWO amplifiers AND • concise and succinct	6-7
• identifies TWO technologies that use amplifiers AND • identifies TWO uses of amplifiers AND • compares the uses of ONE of these ONE amplifiers	4-5
• identifies TWO technologies that use amplifiers AND • identifies TWO uses of amplifiers	2-3
• identifies ONE technology that use amplifiers OR • identifies ONE use of amplifiers	1

Sample answer:
In an ideal amplifier the output voltage is an exact copy of the input voltage, only amplified. There are many uses of amplifiers: audio and video pre-amplifiers, precision peak detectors, voltage and current regulators, analogue-to-digital converts, oscillators and waveform generators. Hence a lot of new technology uses amplifiers.
In some devices amplifiers are used as current regulators, to control the current in the device within certain limits required by it. Amplifiers are also used in analogue to digital converters, where they take an analogue signal as input and convert it into the binary code required by digital devices.
Amplifiers are very small and some can even be integrated into the integrated circuit in a range of technologies. Different amplifier types can be used in different ways, within the one device.

(d) (7 marks)
(i) (2 marks)
Outcomes Assessed: H4
Targeted Performance Bands: 2-3

Criteria	Marks
• identifies TWO impacts of the silicon chip on electronics • gives reasons for ONE impact	2
• identifies ONE impact of the silicon chip on electronics	1

Sample answer:
The impact of the silicon ship on the development of electronics can be demonstrated by referring to the differences between separate transistors and ICs. The use of ICs has enabled computers to become portable (laptops and notebooks); telephones once connected to a fixed network can become mobile; and once separate devices are now available in a single package (convergence). By taking once separate ICs performing different functions and combining them into one package, we now have home entertainment systems (multimedia players, Sony Playstation and X box) that provide video, TV and games capability along with related stereo or surround sound. Mobile phones can be purchased that are personal digital organisers (PDAs), computers and digital cameras that can be capture and store single and video images for later sending to another phone or computer as needed.

Targeted Performance Bands: 2-6

Criteria	Marks
• gives reasons for the invention of the silicon chip • justifies the use of silicon chips in integrated circuits	2
• gives reasons for the invention of the silicon chip OR • justifies the use of silicon chips in integrated circuits	1

Sample answer:
The invention of the silicon chip was necessary for the electronics industry to progress or develop. Many devices depended on the production of the silicon chip (eg computers, mobile phones, etc) as a central device, to enable them to become smaller and more manageable. Integrated circuits use silicon chips as their memory storage device, then add amplifiers, etc, to enable the IC to perform a certain function.

(iii) (3 marks)
Outcomes Assessed: H1, H4, H7
Targeted Performance Bands: 2-6

Criteria	Marks
• describes development of electronics • relate to impact on society	2-3
• identifies an milestone in the development of electronics OR • identifies an impact of electronics on society	1

Sample answer:
The key phases in the development of electronics are related to the Thermionic valve, the transistor (and IC) and the replacement of analogue with digital coding of information. The development of the Thermionic value enabled the start of the electronic age by making it possible to switch a signal many times, depending on the path chosen. But it was large, and susceptible to over heat, as well as being fragile. Hence its use was limited. The development of the transistor, to perform the same function as the thermionic valve, was a huge step forward. It was small, cheap, only used small voltages and was not as susceptible to overheat. Its successor, the IC, is able to be printed cheaply and easily – made it more portable and user friendly. Battery technology soon caught up and devices became even smaller. ICs are becoming even more compact and hold a lot of resistors and capacitors.
The smaller the device, the more portable it is, and as the technology become cheaper as well, more people are purchasing and using the devices. In the communications industry it has meant that people are more accessible for friends and work related communication, ipods are becoming more sophisticated and complex, enabling people to have their entertainment with them at all times, perhaps making them less social in certain situations, which can have positive and negative impacts on society.