CATHOLIC SECONDARY SCHOOLS ASSOCIATION

2005 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	C	H9	2
2	B	H6	3-4

Note: $F=mv^2/r$, A has a higher v and a smaller r so F is larger. (Answer B)

3	C	H7	2-4
4	D	H6	2-4
5	D	H6	3-5

Note: 244 amu = $1.661\times10^{-27} * 244 = 4.053\times10^{-25}$ kg. $E=mc^2 = 3.65\times10^{-8}$ J (Answer D)

6	A	H9	3-4

Note: $\tau = Fd = 7\times10^{-6}$ N.m each side Total = 2 x $\tau = 1.4\times10^{-5}$ N.m (Answer A)

7	B	H9	2-3
8	B	H7, H9	2-4
9	C	H7	3-5

Note: $I = P/V = 100000/240 = 416.67$ A. Loss = $I^2R = 416.67^2 \times 0.3 = 52.1$ kW (Answer C)

10	B	H7, H9	3-5
11	A	H9	2
12	B	H9, H10	3-4
13	A	H8, H10	3-4
14	D	H7, H9	4-5
15	C	H9	3-5

Part B
60 marks
Questions 16-27

Question 16 (4 marks)
(a) (1 mark)
Outcomes Assessed: H9, H11-14
Targeted Performance Bands: 2-3

Criteria	Mark
• Student states/implies reason is to reduce error	1

Sample answer
By taking a second set of results, you can see if the answers are reliable. Outliers can be removed from the data, thereby reducing error.

(b) (3 marks)
Outcomes Assessed: H9, H11-14
Targeted Performance Bands: 3-5

Criteria	Marks
• Clearly identifying any THREE valid reasons such as: • Experimental errors – more in pendulum eg reaction time etc • Accuracy of equipment. eg limit of reading of ruler • Mention of variations due to where on Earth the experiment was carried out	3
• TWO of the above clearly identified	2
• Only ONE of the above clearly identified	1

Sample answer
Data logger equipment is more accurate. It can record results to a greater number of decimal places than the stopwatch that is used with the pendulum, which may improve precision. There are more opportunities for errors in the pendulum practical, for example: reaction time, judging the end of the swing, parallax error. The data logger reduces the number of these errors so it improves accuracy.

The experiments may have been done in different parts of the world. The value for the acceleration due to gravity changes due to altitude, longitude and what type of crustal plate you are standing over. These will change the values the two students could have obtained.

Question 17 (5 marks)
(a) (2 marks)
Outcomes Assessed: H9
Targeted Performance Bands: 2-4

Criteria	Marks
• The velocity is inversely proportional to the square root of the radius of the planet AND • The velocity is proportional to the square root of the Mass of the planet • OR the larger the mass/radius ratio of the planet, the higher the escape velocity (formula not required)	2
• States ONE of the first two criteria above correctly	1

Sample answer

Escape velocity, $v = \sqrt{\frac{2Gm_{planet}}{r_{planet}}}$
Escape velocity is the velocity required to just escape the gravitational pull of the planet. It depends on the ratio of the mass and radius of the planet. The formula shows that the larger the mass/radius ratio of the planet, the greater the escape velocity is. i.e. if 2 planets had the same radius, the planet with the larger mass would have a greater escape velocity.

(b) (3 marks)
Outcomes Assessed: H1, H2, H9
Targeted Performance Bands: 2-4

Criteria	Marks
• Correctly sequences ideas and links the definition of escape velocity to the thought process or good use of an appropriately labelled diagram to convey the ideas	3
• Briefly mentions some of Newton's ideas that led to the concept of escape velocity	2
• Defines escape velocity OR states an idea that led to the concept of escape velocity	1

Sample answer
Newton suggested that a ball could be pushed forward and it would travel a short distance before reaching the ground. If it were pushed harder, it would travel further before touching the ground. Newton then suggested if the ball is pushed hard enough, it would fall towards the earth at a slower rate than the Earth curved away from it, therefore it would never reach the earth's surface and escape the earth's pull, this being Escape velocity, the velocity needed to be achieved in order to escape the Earth's gravitational pull.

Question 18 (5 marks)
(a) (3 marks)
Outcomes Assessed: H1, H3, H6, H9
Targeted Performance Bands: 2-5

Criteria	Marks
• Correctly identifies both equations, equates them and verifies the correct expression for orbital velocity	3
• Begins to equate the two equations but makes mistake during manipulation	2
• Equates the correct equations but does not attempt manipulation	1

Sample answer
centripetal force = gravitational force

$$F_c = F_G$$

$$\frac{mv^2}{r} = \frac{Gm_1m_2}{r^2}$$

$$v^2 = \frac{Gm_2}{r}$$

$$V = \sqrt{\frac{Gm_{planet}}{r_{orbit}}}$$

(b) (2 marks)
Outcomes Assessed: H1, H3, H6, H9
Targeted Performance Bands: 2-4

Criteria	Marks
• Correctly substitutes values into equation derived in part (a) and gets correct value	2
• Substitutes values in but makes mistake	1

Sample answer
v = ?
m = mass of the earth = 6.0×10^{24} kg
r = $6.378 \times 10^6 + 300 \times 10^3$ m
G = 6.67×10^{-11}

$$V = \sqrt{\frac{6.67 \times 10^{-11} (6 \times 10^{24})}{(300 \times 10^3 + 6.378 \times 10^6)}}$$

= 7741.32 m/s
= 7.7 km/s

Question 19 (6 marks)
(a) (2 marks)
Outcomes Assessed: H1, H6
Targeted Performance Bands: 3-4

Criteria	Marks
▪ Clearly states the conversion relationship between mass and energy using the equation (must identify c as the speed of light in a vacuum OR 3×10^8 m/s)	2
▪ Brief statement without detail of equation	1

Sample answer
Einstein's famous equation $E = mc^2$ (where c is the speed of light in a vacuum) shows that mass is energy merely in a different form. The equation can be used to calculate the energy equivalent of mass or vice-versa.

(b) (4 marks)
Outcomes Assessed: H4, H5, H6
Targeted Performance Bands: 3-6

Criteria	Marks
• Mention of large distances needing speed in order to achieve in lifetime. States what happens to mass, time and length at these speeds. Relates these effects to the probability of getting there	4
• States the effect of TWO of mass, time or length and relates the effects of TWO of these to space travel	3
• States the effect of TWO of mass, time or length and relates the effects of ONE of these to space travel	2
• States effects of TWO of mass, time or length or identifies THREE relevant formulae	1

Sample answer
In order to travel such large distances, we would need to do it very quickly or we would not live long enough to get there. This is where the problem arises.

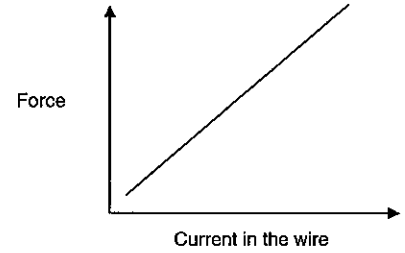
Einstein stated that at very fast speeds time dilates. This means that the faster you travel, the slower time progresses, which is an advantage. Length at these speeds is contracted, which would shorten the distance, also an advantage.

The biggest problem would be that of mass and energy. At the speeds we would need to travel, mass increases by very large amounts. The more massive an object is, the more energy is needed to move it. Additional energy input is further converted to mass, making the problem worse. The energy required makes it very difficult to reach the speeds needed.

Question 20 (4 marks)
(a) (1 mark)
Outcomes Assessed: H9, H14
Targeted Performance Bands: 2-3

Criteria	Mark
• Graph is an increasing straight line	1

Sample answer



(b) (3marks)
Outcomes Assessed: H7, H9
Targeted Performance Bands: 3-5

Criteria	Marks
• Identifies the main components of a loudspeaker • Describes the relationship between varying current and motion of the cone thoroughly • Concludes that the vibrating cone produces sound waves	3
• Describes the relationship between varying current and motion of the cone AND • One other of the above criteria	2
EITHER • Describes the relationship between varying current and motion of the cone OR • Identifies the main components of a loudspeaker OR • States that a vibrating cone produces sound waves	1

Sample answer
A coil connected to an external power source is located in a radial magnetic field produced by circular permanent magnets in the loudspeaker. The cone of the loudspeaker is connected to the coil. The external power source is varied according to the recording being played and subsequently the direction and strength of the current through the coil is varied. The motor effect (due to a current-carrying coil in a magnetic field) causes the coil to experience forces that cause it to move back and forth at various rates and distances. This causes the cone to move (or vibrate) generating longitudinal sound waves of various frequencies and volume.

Question 21 (5 marks)
Outcomes Assessed: H7, H9
Targeted Performance Bands: 2-5

Criteria	Marks
• Clearly states correctly Lenz's Law and defines eddy currents • Clearly relates the falling magnet to a change in flux and induction of current • Clearly relates the resistance of the material of the pipes to the amount of current produced • Clearly distinguishes that a slit in metal reduces the size of current produced • Clearly links the size of current produced to the time taken for the magnet to fall, making reference to the results of the student	5
• States correctly Lenz's Law and either defines eddy currents or describes induction currents in the pipes • Relates the falling magnet to a change in flux and induction of current • Relates the resistance of the material of the pipes to the amount of current produced • Distinguishes that a slit in metal reduces the size of current produced • Attempts to link the size of current produced to the time taken for the magnet to fall	4
• States Lenz's Law and either defines eddy currents or describes induction currents in the pipes • Relates the falling magnet to the induction of current • Attempts to relate the material of the pipe to the variation in time taken	3
• States Lenz's Law and attempts to relate the falling magnet to the production of eddy currents OR • Any TWO relevant statements demonstrating an understanding of the concepts	2
• States Lenz's Law OR • Any relevant statement demonstrating an understanding of the concepts	1

Sample answer
Lenz's Law states that an induced current will form that creates a magnetic field to oppose the original change in flux. In this situation the falling magnet is creating a change of flux in the pipes. This induces eddy currents, which create a magnetic field to oppose the falling magnet and therefore increasing the time taken for the magnet to fall through the pipes.

The variation in the time taken is due to the amount of current being produced in the pipe. PVC is an insulator and therefore the changing flux of the magnet fails to produce any significant current. It therefore falls at the same rate as freefall as there is no opposing force. The difference between Pipe A and Pipe D is that the slit in Pipe D prevents large eddy currents being produced, compared to Pipe A. However, some eddy currents do exist in Pipe D and this slows the magnet down compared to Pipe C (PVC). Pipe B is made from aluminium, which has a higher resistance than copper. Therefore the eddy currents in Pipe B are smaller than Pipe A and the force on the magnet is less and the time taken to fall is less. This gives the result of Pipe C as the shortest time, then Pipe D, then Pipe B, and finally Pipe A.

Question 22 (5 marks)
(a) (1 mark)
Outcomes Assessed: H7, H9
Targeted Performance Bands: 2

Criteria	Mark
• Correctly identifies that the split-ring commutator maintains current direction	1

Sample answer
The split-ring commutator is used to ensure that the current continues to travel in the same direction through the external circuit rather than changing direction with each turn of the coil.

(b) (4 marks)
Outcomes Assessed: H7, H9
Targeted Performance Bands: 3-5

Criteria	Marks
• Identifies AND explains ONE valid similarity and ONE difference between a DC motor and DC generator	4
• Identifies AND explains ONE valid similarity or ONE difference between a DC motor and DC generator. AND • Identifies ONE valid similarity or ONE difference between a DC motor OR • Identifies at least TWO similarities and TWO differences	3
EITHER • Identifies AND explains ONE valid similarity or ONE difference between a DC motor and DC generator OR • Identifies ONE similarity AND ONE difference	2
• Identifies ONE similarity OR ONE difference	1

Sample answer
1. In a motor the relationship is that a current in a magnetic field creates a force and subsequent motion on the conductor, whereas in a generator the motion of a conductor in a magnetic field creates a current (Faraday's Principle).

2. Both a DC generator and DC motor use a split-ring commutator that in a motor allows the coil to turn in the one direction, and in a generator allows the produced current to pass through the external circuit in the same direction.

3. Both a motor and generator have a moving coil inside a magnetic field. However, in a motor the coil moves due to magnetic interaction and in a generator it moves due to an external force.

Other identified similarities might include: brushes, coils of wire, magnetic field, rotor etc.

Question 23 (6 marks)
(a) (2 marks)
Outcomes Assessed: H7, H9
Targeted Performance Bands: 2-4

Criteria	Mark
• Clearly relates the varying current to the energy loss in power lines • Identifies that voltage and currents are inversely proportional to each other in transformers	2
• The above criteria lacking correct detail and/or thoroughness OR • Identifies that voltage and currents are inversely proportional to each other in transformers only	1

Sample answer
Transformers are used to vary the current and voltage of the transmitted electricity. By increasing the voltage the current is decreased as P=VI, thereby reducing the amount of power lost to the heating of the conductors (Power loss = I^2R). Another transformer can be used closer to the end of the line to increase the current and decrease voltage.

(b) (4 marks)
Outcomes Assessed: H7, H9, H11-14
Targeted Performance Bands: 3-5

Criteria	Marks
• Uses correct numerical data to discuss the error between expected and actual results • Makes a correct judgement of the validity and supports with argument • Identifies and explains ONE valid improvement to the demonstration	4
• Discusses the error between expected and actual results • Makes a correct judgement of the validity and supports with argument • Identifies and explains ONE improvement to the demonstration	3
• Attempts to discuss the error between expected and actual results • Makes a judgement of the validity AND/OR • Identifies and explains ONE improvement to the demonstration	2
• Attempts to discuss the error between expected and actual results OR • Makes a judgement of the validity OR • Identifies and explains ONE improvement to the demonstration	1

Sample answer
The desired results according to theory would be 12V in the secondary coil. This means that the actual result was less than the expected by 4V or 33%. The results though are not valid as the set up does not reliably demonstrate a step-down transformer, and the student cannot guarantee that the voltage of the circuit is the same as the power source. To improve reliability the student could include a soft iron core in each of the transformers, making sure that it was laminated to reduce loss to eddy currents. The student should also use a voltmeter in the primary circuit to more accurately measure the primary voltage.

Question 24 (5 marks)
(a) (2 marks)
Outcomes Assessed: H10, H11-14
Targeted Performance Bands: 2-4

Criteria	Marks
• Identifies ONE correct safety risk • Explains correct procedure for addressing the hazard	2
• Only ONE of the above criteria completed	1

Sample answer
In the experiment there existed a risk of exposure to high levels of x-ray radiation from the induction coil. This was addressed by maintaining a reasonable distance and using lead foil to prevent direct exposure.

(b) (3 marks)
Outcomes Assessed: H1, H2, H8, H10
Targeted Performance Bands: 3-5

Criteria	Marks
• Correctly explains the experimental observations from the discharge tubes, of cathode rays, that gives evidence for wave nature • Correctly explains the experimental observations from the discharge tubes, of cathode rays, that gives evidence for particle nature • Draws out and relates the observations to the debate on the nature of cathode rays	3
• Correctly explains the experimental observations from the discharge tubes, of cathode rays, that gives evidence for wave nature AND/OR • Correctly explains the experimental observations from the discharge tubes, of cathode rays, that gives evidence for particle nature AND/OR • Draws out and relates the observations to the debate on the nature of cathode rays	2
• Attempts to explain observations of the particle and wave nature of cathode rays	1

Sample answer
The discharge tube with the Maltese cross can be used as evidence for the cathode ray having the properties of an electromagnetic wave. This is because an EM wave will create a shadow around an opaque object therefore travelling in a straight line. This result is evident in the CRT where a shadow of the Maltese cross is cast from the cathode rays onto the glass casing. However, when cathode rays are observed in a discharge tube with moveable paddle-wheel it can be concluded that the cathode rays have momentum and are therefore particles, as the cathode ray is able to make the paddle-wheel move. The debate was as to whether cathode rays were particles or EM waves because they can be observed to have properties from both.

NB: There are many other possibilities for answers that should gain full marks.

Question 25 (6 marks)
(a) (2 marks)
Outcomes Assessed: H2, H10
Targeted Performance Bands: 3-4

Criteria	Marks
• States evidence of light as particle that cannot be explained as a wave. Stating that when considered to be particles, light is packets of energy (or photons)	2
• States evidence of light being a particle	1

Sample answer
Light can be thought of as packets of energy that behave like particles. This was used to explain why the predicted blackbody curve was not representative of experimental results.

(b) (i) (2 marks)
Outcomes Assessed: H8, H10
Targeted Performance Bands: 3-4

Criteria	Marks
• Calculates correct value for frequency including units	2
• States the correct equation and substitutes or rearranges correctly	1

Sample answer

$c = f\lambda$
$f = c/\lambda = 3 \times 10^{8} / 4 \times 10^{-7} = 7.5 \times 10^{14}$ Hz

(b) (ii) (2 marks)
Outcomes Assessed: H7, H8, H10
Targeted Performance Bands: 3-4

Criteria	Marks
• Calculates correct value for energy including units	2
• States the correct equation and substitutes correctly (h and the value of f from (i))	1

Sample answer

$E = hf = 6.626 \times 10^{-34} (7.5 \times 10^{14}) = 4.97 \times 10^{-19}$ J

Question 26 (4 marks)
Outcomes Assessed: H9
Targeted Performance Bands: 3-5

Criteria	Marks
• Table drawn with columns, headings, and filled in • Columns should include material, type, number of electrons and comparison, correctly filled in	4
• ONE of the above missing	3
• TWO-THREE of the above missing	2
• FOUR OR MORE of the above missing yet some realistic attempt has been made	1

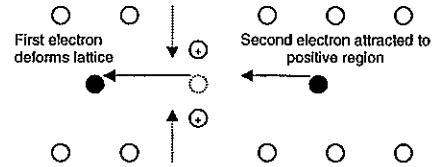
Sample answer

Material	Type	Relative Number of free electrons	Comparison
Copper	Conductor	Lots	Conductors have lots of loosely bound electrons in each atom. Therefore with only a small amount of energy, these electrons will move to the conduction band and a free to move between atoms
Silicon	Semiconductor	Few	In semiconductors. The electrons on the outer shell in each atom are less tightly bound than in an insulator and more tightly bound than in a conductor. Therefore, they require a bit more energy than conductors to move into the conduction band and move between atoms, therefore there are fewer electrons available to move than in a conductor
Glass	Insulator	None	In an insulator the electrons are held tightly to the atoms. Therefore they need very large amounts of energy to move between atoms. Because of this, there are very few, if any electrons available to move between atoms

Question 27 (5 marks)
Outcomes Assessed: H7, H8, H9, H10
Targeted Performance Bands: 3-6

Criteria	Marks
• Constructs clear diagram with labels • Discusses the effect of the critical temperature on lattice structure • Defines the term 'cooper pairs' and the bcs theory • Correctly relates diagram to discussion • Thoroughly discusses conduction and lattice structure both above and below critical temperature	4-5
Any FOUR of: • Constructs a diagram • Discusses the effect of the critical temperature on lattice structure • Defines the term 'cooper pairs' • Relates diagram to discussion • Discusses conduction and lattice structure above and below critical temperature	3
Any THREE of: • Constructs a diagram • Attempts to discuss the effect of the critical temperature on lattice structure • Defines the term 'cooper pairs' • Discusses conduction and lattice structure above or below critical temperature	2
• Constructs a diagram OR • Defines the term 'cooper pairs' OR • Basic discussion of conduction and lattice structure either above or below critical temperature	1

Sample answer



When a material is below its critical temperature the particles in the lattice structure reduce their vibrations and therefore create pathways through which electrons can move without inhibition. This is the point at which superconductivity occurs as the electrons move with minimal resistance. Above the critical temperature the vibrations in the lattice interfere with the movement of the electrons and electron pairing is not possible. The BCS theory states that when below the critical temperature electrons are able to move through the lattice in Cooper Pairs. This is where a leading electron, that is initially made to move by the introduction of a change in flux or electric field, slightly deforms the lattice structure creating a momentary concentration of positive charge, as it moves faster than the lattice can respond. This positive region attracts the second electron in the pair. This can be seen in the diagram drawn above. Cooper Pairs cannot exist above the critical temperature as the moving lattice disrupts the path of the electrons. Above critical temperature conduction is achieved by the movement of free electrons in the conduction band.

Question 31 – Quanta to Quarks (25 marks)

(a) (4 marks)
(i) (2 marks)
Outcomes Assessed: H7
Targeted Performance Bands: 2-3

Criteria	Marks
• Satisfactorily completed table for BOTH particles	2
• Any FOUR table entries correct	1

Sample answer

	Charge	Mass	Contribution to Mass Number	Contribution to Atomic Number
Proton	+1	1 amu	+1	+1
Neutron	No charge	1 amu	+1	0

(ii)(2 marks)
Outcomes Assessed: H7, H10, H13
Targeted Performance Bands: 3-4

Criteria	Marks
• Explain process with balanced equation	2
• Either explanation or balanced equation	1

Sample answer
In β-decay, a nuclear neutron decays producing a proton and a high energy electron which is known as a β-particle.

$$^{90}_{38}Sr \longrightarrow {}^{90}_{39}Y + \beta$$

(b) (3 marks)
Outcomes Assessed: H2, H7-8, H10, H13-14
Targeted Performance Bands: 2-4

Criteria	Marks
• Accurate and complete description of experiment	3
• Essentially correct description	2
• Elementary description of experiment	1

Sample answer
We attached a glass tube containing hydrogen gas and two electrodes to an induction coil in a darkened room. The induction coil was attached to a power supply and the tube began to glow. We took a hand spectroscope and examined the light from the glow and saw that it consisted of four or five lines in the visible spectrum. It was hard to see this, so we placed a cardboard box over the equipment and put the spectroscope through the hole. This worked much better.

(c) (3 marks)
Outcomes Assessed: H1, H2 H7, H9-10
Targeted Performance Bands: 2-4

Criteria	Marks
• Clear and complete explanation of Bohr model and relationships to deBroglie	3
• Competent description of Bohr model some attempt to relate to deBroglie	2
• Description of Bohr model only	1

Sample answer
The Bohr model places electrons in fixed orbits about the nucleus of the atom (hydrogen). The number of electrons in a level was controlled and inner levels were to be filled before the higher energy outer levels. Electrons were not allowed between levels but the Bohr model could not explain why. DeBroglie predicted that electrons had specific wavelengths and could only exist in levels around the nucleus when the length of the orbit was a whole number multiple of the wavelength of the electron.

(d) (7 marks)
Outcomes Assessed: H1-5, H6-10, H16
Targeted Performance Bands: 3-6

Criteria	Marks
• Complete assessment of impact of splitting the atom on society with at least THREE different examples both positive and negative	6-7
• Coherent assessment of impact on society with several examples and explanation	4-5
• Assessment of impact with one example only	2-3
• Simple statement of opinion without substantiation	1

Sample answer
There could be a wide variety of answers to this question depending on the student's point of view. This could be one answer.
The Manhattan project was an exercise carried out by the United States whose aim was to produce the atomic bomb. This was a contentious issue and caused much discussion in the scientific community at the time but it was kept top secret because of the war. The impact of the production of the atomic bomb has been immense and far reaching and still impacts on our society today. Not only did the bomb bring a swift end to the war but it also set up a political cold war that was to be maintained for some forty years. Political power was held by those countries that had nuclear weapons and smaller countries chose to ally themselves to one or the other super power. The threat of nuclear war changed the nature of international political debate as was seen in the Cuban Crisis. On the other hand the humanitarian developments of the Project are manyfold and there are people walking around today who have benefited from the medical applications in the treatment of such conditions as cancer and other malignant tumours. Our understanding of the world of Chemistry has been enhanced by being able to tag atoms and watch their progress through reactions and through industrial applications. The development of the atomic bomb did have its down side in that it caused the death and suffering of thousands but many more have benefited from its discoveries and continue to do so now and into the future.

(e) (4 marks)
(i) (2 marks)
Outcomes Assessed: H6-7, H9-10
Targeted Performance Bands: 3-4

Criteria	Marks
• Correct calculation	2
• Indication of knowledge of correct process without correct answer	1

Sample answer
The Oxygen-16 atom contains 8 protons each of mass 1.673×10^{-27} kg for a total mass of 1.3384×10^{-26}kg
and 8 neutrons each of mass 1.675×10^{-27}kg for a total mass of 1.34×10^{-26} kg
This gives the atom a calculated mass of 2.6784×10^{-26}kg
The given mass is 15.994915amu which equals 2.6567×10^{-26}kg
This produces a mass defect of 2.165×10^{-28}kg

(ii) (2 marks)
Outcomes Assessed: H6-7, H9-10, H13
Targeted Performance Bands: 3-5

Criteria	Marks
• Relate the position of ^{56}Fe to the fact that this is the limit of atoms that can be sustainably produced by nuclear fission	2
• Observe that this isotope has the highest amount of binding energy per nucleon	1

Sample answer
The position of iron indicated that it has the highest binding energy per nucleon of all atoms. This means that it is the most stable nucleus, with nucleons bound by the strongest average force. Elements lower than iron cannot be produced by sustainable nuclear fission reactions because average binding energy per nucleon decreases, hence energy is not released.

(f) (4 marks)
Outcomes Assessed: H6-7, H9-10, H14
Targeted Performance Bands: 3-6

Criteria	Marks
• Outline Rutherford-Bohr model and describe at least TWO observations that can be explained and TWO that cannot be explained. Analysis	4
• Outline R-B model, list several observations with some explanation. Include at least ONE observation that cannot be explained. Analysis	3
• Outline the model with EITHER some attempt to explain observations OR state TWO observations that cannot be explained	2
• Any TWO statements which show an understanding of the R-B model/energy levels	1

Sample answer
The Rutherford-Bohr atom explained well the production of spectral lines as electrons moved from one energy level to a lower level but it could not explain why the energy levels were in the place where they were nor why there were no energy levels between them. It further has no explanation for the existence of superfine lines in the spectra.

Question 32 – Age of Silicon (25 marks)

(a) (4 marks)
(i) (2 marks)
Outcomes Assessed: H7-10
Targeted Performance Bands: 2-3

Criteria	Marks
• Defines both digital and analogue systems with correct processing	2
• Distinguishes digital and analogue systems **or** recognises continuos or discreet data	1

Sample answer
Digital systems sample continuos analogue signal producing discreet data that can be expressed as binary code.

(ii) (2 marks)
Outcomes Assessed: H7-10
Targeted Performance Bands: 3-4

Criteria	Marks
• Outlines silica's optical non-linearity property and applies to data storage on CDs	2
• Outlines silica's optical non-linearity property OR data storage on CDs	1

Sample answer
Silica has the ability to change the refractive index depending on intensity of incident light (EMR).
CDs store data using pits and lands – the transition between these heights represent 1's. The laser light passing through silica can be made narrower and more intense so requiring a lower energy laser to create the pits.

(b) (3 marks)
Outcomes Assessed: H7, H9-H14
Targeted Performance Bands: 2-5

Criteria	Marks
• Names ONE type of transducer and outline linkage to its environment	3
• Outlines how transducers link circuits to environment	2
• Names ONE type of transducer	1

Sample answer
Input transducer – transforms other types of energy into electrical energy
Eg – microphone, thermocouple, keyboard, photocell
Output transducer – transforms electrical energy into other types of energy
Eg – loudspeaker, relays, light-emitting diodes
The transducer is connected to data logger that samples the input energy. The analogue signal is transformed into a digital signal