(b) (3marks)
Outcomes assessed: H6, H9,H12
Targeted Performance Bands: 2-4

Criteria	Marks
• Begins with two equations for Newton's gravitational equation and the equation for centripetal force. These two can be combined making velocity of satellite the subject in terms of G, mass of earth and distance from Earth of satellite	3
• Begins with two equations for Newton's gravitational equation and the equation for centripetal force. Unable to combine	2
• Gives some indication of awareness of two initial equations OR gives final equation without indication of its derivation	1

Sample answer

For a satellite in a stable circular orbit around the Earth

$\frac{mv^2}{r} = G\frac{mM}{r^2}$, where m is the mass of the satellite and M is the mass of the Earth.

$\therefore v^2 = \frac{GM}{r}$, after cancellation through m and r.

$v = \sqrt{\frac{GM}{r}}$

Question 17 (5 marks)
(a) (1 mark)
Outcomes Assessed: H2, H6
Targeted Performance Bands: 2

Criteria	Mark
• Makes reference to momentum being conserved or maintained	1

CATHOLIC SECONDARY SCHOOLS ASSOCIATION

2004 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	A	H6	2-3
3	C	H6	2-4
4	C	H9	2-4
5	B	H6	2-4
6	D	H9	2
7	C	H7	2-3
8	B	H7	2-4
9	A	H7	2-4
10	B	H9	2-4
11	A (indep 12)	H10	2-4
12	B (indep 11)	H10	2-4
13	D	H10	2-4
14	C	H8	2-3
15	D (indep 15)	H9	2

Part B
60 marks
Questions 16-27

Question 16 (4 marks)
(a) (1 mark)
Outcomes Assessed: H7, H9
Targeted Performance Bands: 2

Criteria	Mark
• Identifies gravitational field, mass and position within field	1

(b) (4 marks)
Outcomes Assessed: H2, H6
Targeted Performance Bands: 3-5

Criteria	Marks
• Uses appropriate equation and accurately records answer	3-4
• Uses appropriate equation but is inaccurate in recording answer or makes error in calculation	1-2

Sample answer

$F_{net} = ma$ (Newton's 2nd Law)

30s after lift off the mass of the rocket is:

$M_{rocket} = 2\times10^6 - 30\times1.5\times10^3 = 1.955\times10^6 kg$

Acceleration of the rocket is:

$8\times10^7 = 1.955\times10^6 \times a \qquad \therefore a = 40.92ms^{-2}$ (2 d.p.)

Net force is:

$F_{net} = 85\times40.92 \qquad \therefore F_{net} = 3478.26N$ (2 d.p.)

Question 18 (5 marks)
Outcomes assessed: H1, H2, H6
Targeted Performance Bands: 3-5

Criteria	Marks
• Gives Einstein's idea and links this with the example given. • Accurately describes the effect using example and the law of simultaneity	5
• Demonstrates a solid understanding of Einstein's idea • Describes the effect using the example	4
• Describes the effect using the example and gives a basic understanding of Einstein's idea.	3
• Uses law of simultaneity and indicates a difference between observers	2
• Indicates a difference	1

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

Criteria	Marks
• Makes reference to vertical and horizontal components of projectile motion • Vertical component dependent upon gravity while horizontal component is unaffected by gravity	2
• Describes just one of the above	1

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

Criteria	Marks
• Uses appropriate equations for getting accurate answer	3-4
• Uses appropriate equation, makes error in calculation or demonstrates lack of understanding of concept	1-2

Sample answer

Let V be the initial speed. Taking positive direction going up, the initial launching point as reference and working on the y -- component:

$$-20 = V\sin30^\circ t + \frac{1}{2}(-9.8)t^2$$

$$\therefore -40 = Vt - 9.8t^2 \ (\text{since } \sin30^\circ = \frac{1}{2})$$

By substituting $t = 10s$ and making V the subject:

$$\therefore V = 94ms^{-1}$$

Question 20 (4 marks)
(a) (1 mark)
Outcomes Assessed: H7
Targeted Performance Bands: 2

Criteria	Mark
• Identifies change from supply to circuit	1

(b) (3 marks)
Outcomes Assessed: H4
Targeted Performance Bands: 2-4

Criteria	Marks
• Provides three areas of discussion not just identifying areas	3
• Identifies but with little discussion	2
• Identifies three areas without discussion	1

Question 21 (5 marks)
Outcomes Assessed: H9, H11, H13, H14
Targeted Performance Bands: 3-5

Criteria	Marks
• Details equipment, provides accurate method and or diagram that clearly demonstrates techniques, records results, identifies variables that have been controlled	5
• Provides four requirements only or all but some are poorly done	4
• Provides three requirements only or inadequate	3
• Identifies two requirements only	2
• Identifies one of the requirements only	1

estion 22 (5 marks)
(1 mark)
Outcomes Assessed: H9
Targeted Performance Bands: 2

Criteria	Mark
• Uses correct formula and units AND provides correct answer	1

Sample answer

$$F_m = 0.1 \times 0.001 \times 0.15 \sin 45^\circ$$

$$\therefore F_m = 1.06 \times 10^{-5} N$$

(4 marks)
tcomes Assessed: H9
rgeted Performance Bands: 3-5

Criteria	Marks
• States definition of torque and magnetic flux • Links the two with movement through a magnetic field and explains the different situations leading to minimum and maximum torque	4
tates definitions but explains the situations poorly or explains just one of the tuations	3
Identifies the situations without providing any explanation or states the definitions only	2
Performs only one of the above requirements	1

estion 23 (6 marks)
(1 mark)
utcomes Assessed: H7
Targeted Performance Bands: 2-4

Criteria	Mark
• States one difference between AC and DC generators	1

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

Criteria	Marks
• Provides a detailed identification of the technologies and the relationships among them for both individuals	5
• Provides suitable identification of the technologies and the relationships among them for both individuals	4
• Provides satisfactory identification of some technologies but lacking any real analysis of the relationships among them for both individuals	3
• Provides two identifications of technologies from either individual	2
• States one identification from either individual	1

Question 24 (5 marks)
(a) (2 marks)
Outcomes Assessed: H7, H10
Targeted Performance Bands: 2

Criteria	Marks
• Detailed diagram or description of the experiment	2
• Describes the experiment but lacks a specific part or lacks detail	1

(b) (3 marks)
Outcomes Assessed: H7, H10
Targeted Performance Bands: 3-5

Criteria	Marks
• Effectively uses equation to get the value of the voltage	3
• Correctly equates $F_m = F_e$ and makes subject V but has an error in calculation	2
• Starts working on $F_m = F_e$	1

Sample answer

For the electron to pass undeflected through the electric and magnetic fields:

$$F_m = F_e \therefore qvB = qE \therefore E = vB \therefore \frac{V}{d} = vB \text{, since } E = \frac{V}{d},$$

$$\therefore V = vBd$$

$$\therefore V = 1 \times 10^4 \times 1 \times 10^{-1} \times 1 \times 10^{-1} V$$

$$\therefore V = 100V$$

Question 25 (6 marks)

(a) 0.57 seconds^2 1

(b) Using the formula $T = 2\pi\sqrt{L/g}$ and squaring both sides, the slope of the graph is seen to equal T^2/L which is also equal to $4\pi^2/g$. Knowing the slope and the value of π, the value of acceleration due to gravity can be determined. 2

(c) $T^2 = 4\pi^2 \frac{L}{g}$; $g = \frac{4\pi^2}{4.2} = 9.4\ ms^{-2}$ 1 ea.(2mks)

(d) The lower value of "g" as determined by the experiment indicates that the experiment was performed at a high altitude. 1

26 24 (4 marks)

(a) Sample answers: 2
- **travel in straight lines**: a 'Maltese Cross' type discharge tube (appropriate diagram would be good)
- **the rays are able to transfer energy and do work**: a 'paddle wheel' type discharge tube (with diagram)

(b) Maltese cross: When the cross is not erect, but lying flat down, the end of the glass tube opposite the cathode fluoresces. When the cross is erect, the cross casts a sharp shadow at the end of the tube. The sharp shadow indicates straight line travel. Paddle wheel: On the start of discharge, with the wheel positioned at the cathode end of the tube, it rotates and rolls towards the opposite end of the tube. Since the moving wheel has gained kinetic energy, work has been done by the cathode rays

27 28. (a) Explains how eddy currents are generated 1
Gives reasons for eddy current production 1
Identifies that eddy currents obey Lenz's Law – causing slowing of fall rate 1
(b) Gives clear account of how eddy currents are produced in some other application associated with the slowing of a moving body, eg: amusement park rides. 2

Q31 From Quanta to Quarks

(a) (i) A high voltage from an induction coil is passed across a glass tube containing hydrogen gas at low pressure and viewed through a spectroscope in a darkened lab. A line emission spectrum is seen, consisting of a red line, green line and blue line. 2

(ii) $\frac{1}{\lambda} = R\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$ $1/\lambda = 1.097\text{x}10^7\,(1/4 - 1/16) \Rightarrow \lambda = 4.9 \text{ x } 10^{-7}\text{m}$ 2

(iii) (3 marks)
Outcomes Assessed: H6-10
Targeted Performance Bands: 2-3

Criteria	Marks
• States Bohr's postulates and gives a detailed description of how they help account for the spectra lines given	3
• States Bohr's postulates and gives a satisfactory description of how they help account for the spectra lines given	2
• Gives just one of the above requirements	1

(b) (i) Diffraction is the spreading of waves around corners or through small openings. 1

(ii) Following the application of Planck's hypothesis to the photoelectric effect by Einstein, de Broglie reversed the idea and applied the wave model to particles, considering them as wave packets. He had been grappling with the question of why Bohr's postulates applied to the electron orbits in his doctoral thesis and came up with his extraordinarily peculiar explanation that particles had a wave nature. There was no experimental evidence for his hypothesis.
He suggested that $\lambda = h / mv$ where mv is the momentum of the electron, λ its wavelength and h is Planck's constant. Other physicists laughed when they heard it and he almost failed to get his degree until it was sent to Einstein who was so impressed that he wrote an introduction. Soon afterwards his hypothesis was experimentally verified and within a few years, the wave hypothesis of de Broglie was developed by Heisenberg, Schrödinger and others into a complete theory of quantum mechanics that replaced classical physics. 3

(c) (i) A moderator slows the fast neutrons to avoid capture by U-238. U-238 either absorbs faster neutrons or undergoes fission but does not produce sufficient neutrons to reliably sustain a chain reaction. A moderator is made from material of low mass number so that the kinetic energy of the neutrons is transferred from the neutrons in collisions with the atoms of the moderator. 2

(ii) Accelerators are devices in which charged particles can be accelerated to high kinetic energies. These particles, moving at close to the speed of light, are made to collide with the nucleus of atoms to cause fission or with neutrons and protons to liberate smaller particles.
Collisions with other nuclei produces radioactive isotopes that are used in medicine, agriculture and engineering. In medicine, radioisotopes kill cancer cells and are used in diagnostic tests. These isotopes could not be imported as their half-lives must be short and therefore the accelerator has to be built near the hospital where they are used.
Physicists use the high energy particles to probe nuclear particles and this has resulted in the current "standard model of matter". This states that protons and neutrons are not fundamental particles but made up of quarks. A large number of subatomic particles have been identified.
While the value of isotopes in medicine is obvious and the usefulness of other applications also accepted, it could be argued that the benefits of understanding the structure of matter is doubtful and that the cost of building bigger and faster accelerators is unjustified. However, it is usually many years after new knowledge is discovered that its potential benefits are realised. 4

(d) Bohr produced a theoretical model of the atom that accounted for the stability of electrons in their orbits and the production of a line spectrum rather a continuous spectrum. In his mathematical analysis, he used Planck's hypothesis, successfully applied by Einstein, and derived a formula for the wavelengths of the lines of the hydrogen spectrum. His formula matched the format of the empirical formula derived first by Balmer, modified by Rydberg and applied to find other groups of spectral lines. In one sense, he knew the answer to the problem and may not have produced his model without the preceding work.
Chadwick's discovery of the neutron followed the experiments of a number of scientists involving the bombardment of small atoms with alpha particles, producing unknown radiation. These physicists had unsuccessfully applied to their results the accepted physics laws of conservation of mass, momentum and energy developed much earlier. Chadwick also had the benefit of the earlier suggestion by Rutherford that the nucleus contained a neutral particle. He repeated the experiments producing the unknown radiation and based on all the preceding work, showed that a neutral particle accounted for the results.
Fermi achieved the first nuclear fission reaction although he was unaware that he had done so. He and his team were working bombarding heavy elements with neutrons in an attempt to produce transuranic elements. This work would not have been possible without the understanding that there were neutral particles in the nucleus that could be emitted on bombardment with alpha particles. He later provided the analysis that explained the energy decay curves for beta decay using the neutrino that had first been suggested by another scientist, Pauli. During World War II, Fermi with many others set the first chain reaction using the fission of uranium – this reaction had been explained by 2 other physicists as fission, the splitting of the uranium nucleus. 8
It can be seen that each of the famous scientists above built on the work of other scientists who had previously made important breakthroughs.