2 4M RJJF

SYDNEY GRAMMAR SCHOOL

Class

Student Number

2002
FORM VI
HIGHER SCHOOL CERTIFICATE
TRIAL EXAMINATION

Physics
Part A
ANSWER SHEET

1. ● B C D
2. A ● C D
3. A B C ●
4. A B ● D
5. A B C ●
6. A ● C D
7. A B C ●
8. A B ● D
9. A ● C D
10. A ● C D
11. ● B C D
12. A B ● D
13. A ● C D
14. A ● C D
15. ● B C D

General Instructions

- Write your class and student number in the space provided.
- Attempt all questions 1 – 15
- Use a blue or black pen
- Select the alternative A, B, C, or D that best answers the question.
- Fill in the response oval completely.

Examiners use only	
Marks for Part A:	

Section I (continued) **Marking Scheme AWW**

(Masters only)

Part B – 60 marks
Attempt Questions 16 - 28
Allow about 1 hour and 55 minutes for this part

Answer the questions in the spaces provided.
Show all relevant working in questions involving calculations.

Marks

Question 16 (5 marks)

A communication satellite is often placed in a geostationary orbit around the Earth so that it has an orbital period of 24 hours (8.64×10^4 s).

(a) Explain the main advantage of a geostationary orbit.

Maintains a constant geographical position (stays over one point on the Earth's surface
AND
therefore a ground receiver can be aimed at a constant angle (OR allowing constant 24 hr contact between satellite and ground) **1**

(b) Calculate the radius of a geostationary orbit.

Any calculation leading to radius = 4.2×10^7 metres (4240 km) **1**

(c) Discuss the impact of the Earth's rotational motion on the launch of a rocket.

- **Describe that rotation of Earth gives a surface velocity at the equator that adds an initial velocity to the space craft if it is launched in the direction of rotation.** **1**
- **Recognise the energy advantage/disadvantage involve** **1**
- **Recognises that a launch north-south adds no advantage** **1**

OR a launch to west gives a negative initial velocity

OR use good physics to show that the equator is better than other latitudes

Marks

Question 17 (3 marks)

Describe Galileo's analysis of projectile motion. **Total 3**

Describes the proposal of two independent components of the motion	**1**
Describes BOTH components: • **Horizontal – constant velocity** • **Vertical – accelerating at g, OR has a gravitational force acting**	**1**
States that the final parabolic path is the result of both components acting simultaneously	**1**

Question 18 (6 marks)

Discuss the difficulties associated with effective and reliable communications between satellites and Earth. **Total 6**

• **States at least two causes of difficulties from:** **Distance , van Allen Belts, Sun spot activity**	**1**
• **States any third cause of difficulty.** **Examples: ionosphere, atmospheric absorption, line of sight occlusion, other EM communications on Earth or in space (noise)**	**1**
• **Discuss how each cause produces communication difficulties between Earth and satellite. (1 mark each)**	**3 (max)**
• **Shows an exceptional understanding of the physics of the causes OR shows the link between solar activity and van Allen Belts or ionosphere**	**1**

Marks

Question 19 (5 marks)

The Voyager 2 space probe, launched by NASA in 1977 was designed to tour the planets of the solar system. It reached Jupiter in 1979 and left Saturn in 1981. This space probe has a mass of 750 kg and is now 9.8×10^9 km from the Sun after 25 years. The current velocity of Voyager 2 is about 16 kms^{-1}.

(a) Calculate the gravitational force on Voyager 2 in its present position. The mass of the Sun is 2.0×10^{30} kg and the mass of other planets may be ignored. **Total 2**

$$F = \frac{Gm_1m_2}{r^2} = \frac{6.7x10^{-11}\,x2.0x10^{30}\,x750}{(9.8x10^{12})^2}$$ **1**

$= 1.05 \times 10^{-3}$ N includes unit **1**

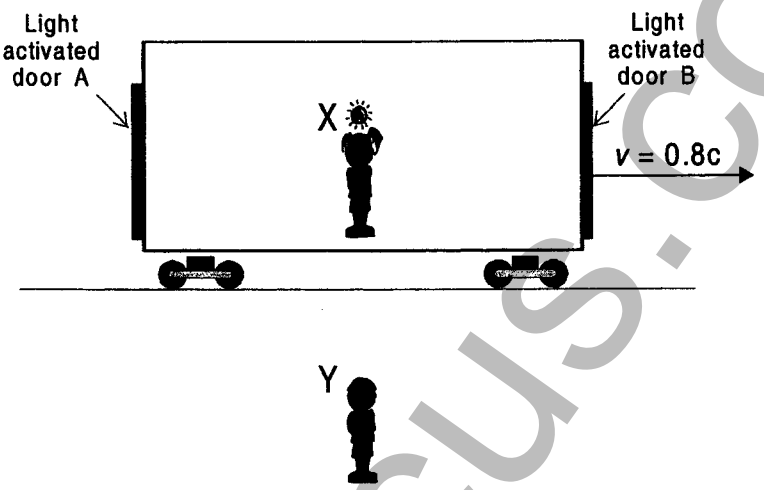
(b) Describe how a slingshot effect around Jupiter was used to accelerate the space probe. **Total 3**

- **Recognises that the orbital velocity of Jupiter adds to the probe velocity** **1**
- **Describes a mechanism in terms of momentum exchange during a non-contact elastic collision with Jupiter OR adds to the description by discussing velocity relative to the sun.** **1**
- **Shows an exeptional understanding of the process (eg by including a diagam or algebraic treatment including a vector addition of velocities)** **1**

Marks

Question 20 (4 marks)

In this thought experiment to demonstrate relativity, an observer (X) on a train travelling at 0.8 c makes a light flash, in the centre of the carriage, to open the light activated doors (A and B) at each end of the carriage. Observer Y is observing this from a stationary platform outside the train. 4



Explain how this thought experiment can show the relativity of simultaneity of events for observer X and observer Y.

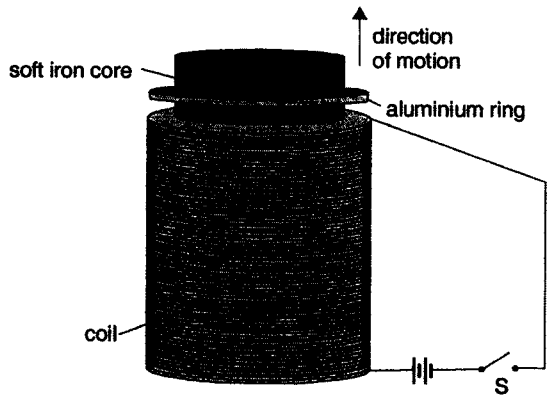
- **Shows a basic understanding of the concept of relativity of simultaneity** 1
- **Gives a basic description of what BOTH observers see including distance and/or time of travel for light 'rays'** 1
- **(X sees A & B open simultaneously: Y sees A open before B because it 'runs into the light)**

- **Shows a good understanding of the reasons why the door openings A & B are not simultaneous for B but are simultaneous for A, in terms of train movement and light movement** 1

- **Relates the reasons to the constancy of the velocity of light v =c, for BOTH observers.** 1

Question 21 (4 marks)

An aluminium ring rests over the end of a coil of wire so that their vertical axes coincide as shown in the diagram below. Just after switch S is closed the aluminium ring moves upwards.



Explain how Faraday's Law and Lenz's Law are applied to explain the movement of the aluminium ring. 4

As current in coil increased, it produces a changing B inside the ring. This induces a current in the ring (Faraday). Current In the ring produces a B of its own. The direction of this B opposes the B of the coil (Lenz), therefore the ring jumps off.

4 for an answer which shows a thorough understanding of this
3 for an answer which misses a major point
2 for a general idea of the process
1 for a poor understanding
0 for an answer which contains no correct physics.

Question 32 (continued)

(e) Discuss and assess the contributions of Heisenberg and Pauli to the development of atomic theory. **6**

3 marks for each scientist, one mark for each of the following points:

Heisenberg:

- Uncertainty principle states that there are limits to our knowledge about the position and momentum of an object
- Mathematically: $\Delta x \, \Delta p \geq \hbar$ where Δx = uncertainty of position,
  Δp = uncertainty of momentum
  $\hbar = h/2\pi$
  or a good explanation as to why momentum and position can't be determined simultaneously
- This principle led to the development of our quantum mechanical model of the atom where we talk in terms of probabilities rather than definite and predictable values. Electrons exist in clouds

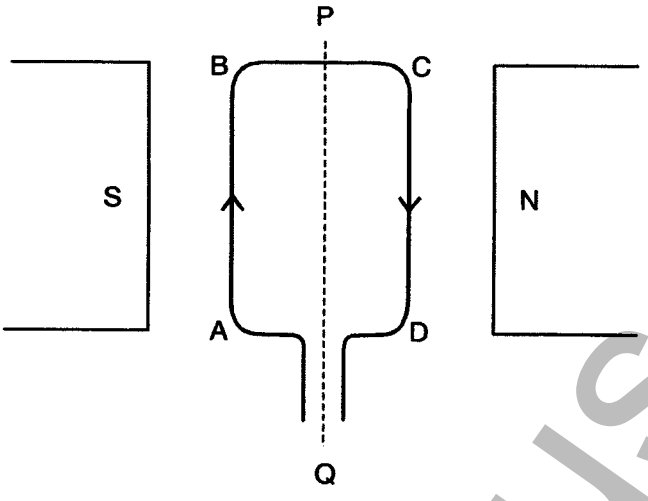
Pauli:

- Exclusion principle which states that no two electrons can have the same quantum state. (quantum numbers)
- This explained the periodic table by showing why the shells had a maximum number of electrons
- Postulated the existence of the neutrino which explained beta decay more fully.

Marks

Question 22 (5 marks)

The following diagram shows a rectangular loop in a uniform magnetic field of 0.085 T. The loop is free to rotate on the axis PQ.



not drawn to scale

The length of side AB is 25 cm and side BC is 20 cm.

Calculate the torque on the loop. 1

Torque = nBIA = 1 x 0.085 x 4.5 x (0.25 x 0.2)

∴ T = 0.019 Nm (no, or incorrect units lost the mark)

Describe the net result of the forces on the loop. 2

The loop rotates about PQ (side CD goes down) - 1 mark

The loop (eventually) stops at 90^{o} - 1 mark

Discuss the importance of the invention of the commutator to the development of the electric motor. 2

Commutator reverses the direction of the current in the loop every half turn - 1 mark

So that the loop continues to rotate. - 1 mark

Marks

Question 23 (3 marks)

Describe how you carried out an investigation to demonstrate the principle behind the operation of an induction motor. 3

1 mark for a description of an experimental setup which will demonstrate the Motor effect or induction

1 mark for description of a result which was due to the above effect.

1 mark for an explanation of the result in terms of the effect under consideration or a link to the induction motor.

Question 24 (3 marks)

Describe the operation of an A.C. generator. 3

Loop rotates in B which induces a current in the loop - 1 mark

Loop's direction wrt field reverses each half turn, therefore the current Reverses as a consequence - 1 mark

Slip rings allow the current produced to be fed into an external circuit. - 1 mark

Marks

Question 25 (8 marks)

Analyse the impact of the development of transformers on society. 8

Transformers allow voltages to be changed to allow:

- Distribution at high voltages to reduce losses over long distances
- As P=IV, high V means low I
- Power generation away from population centres (less pollution, power for remote areas, urban sprawl)
- Stepped down at domestic end for safety
- Allows a wide range of applications which need various voltages
- Labour saving devices widespread domestically and industrially - unemployment
- More energy consumed - pollution and depletion of fossil fuels, carbon dioxide and global warming
- Some health risks may be associated with high tension power lines
- Less dependance on coal for heating led to an improvement of air quality in cities

1 mark for any reasonable point to a maximum of 8 marks

Note:

- it was difficult to get more than 6 marks unless some negative impacts were mentioned.
- many boys wasted time and effort describing the transformer itself, rather than its impact.
- Many answers were repetitive.

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Quanta to Quarks

Q32a (i) $\lambda = h/p = h/(mv) = 1.5987 \times 10^{-10}$ m.(1mark)

(ii) De Broglie proposed that electrons had wave properties and that the electron formed a non radiating standing wave around the nucleus. He stated that an integral number of electron wavelengths fit around the circumference of the orbit.(2marks)

(iii) Resolving power is inversely dependent on wavelength. High speed electrons have a much smaller wavelength than visible light and hence have much great resolving power.(1mark)

(b) ${}_{83}Bi^{214} \rightarrow {}_{2}He^{4} + {}_{81}Tl^{210}$ (1mark)

c) Chadwick repeated the experiment of Joliot and Curie of firing alpha particles into Be and then letting the neutral rays pass through paraffin and nitrogen gas. By measuring the momentum and kinetic energy of the protons released and nitrogen atoms he was able to demonstrate that the neutral radiation had a mass slightly larger than a proton. In particular he derived an equation using the laws of conservation of momentum and energy which connected the velocity of the proton or nitrogen to the mass of the neutron.

(3 marks for a superior description with diagram), (2 marks for good description but with details left out),(1 mark for some indication that the pupil knew of Chadwick's work)

d) $m_I = 3.91848 \times 10^{-25}$ kg (1 mark)
$m_F = 3.91516 \times 10^{-25}$ kg
mass defect $\Delta m = 3.32 \times 10^{-28}$ kg (1mark)
$E = \Delta mc^2 = 2.988 \times 10^{-11}$ kg (1mark)

(e) over page.

f) 3 marks for Bohr's postulates
i.e. angular momentum is quantized $mvr = nh/2\pi$
there exist stable electron orbits where electrons do not radiate e-m waves
Energy is emitted or absorbed when electrons move from one orbit to another. $\Delta E = hf$.

1 mark for connecting the energy emitted by an electron when it moves from one orbit to another as producing a photon which leads to the hydrogen spectral lines

2 marks for a description of limitation eg Zeeman effect(splitting of spectral lines in a magnetic field), Hyperfine splitting of spectral lines due to the interaction of the magnetic moment of the nucleus with the electron.

2 marks for either a description of the mathematics or the mathematics for how Bohr derived the Rydberg equation eg
Bohr set the centripetal force = to the electrostatic force and then
Bohr used the quantization of angular momentum and the fact that the total energy of the electron was made up of electrical potential energy + the kinteic energy of the electron to shown that the Energy of the electrons depended on $1/n^2$.

Question 28 (a) (1 mark)

Marking Guidelines

Criteria	Marks
• anode.	1

Question 28 (b) (1 mark)

Marking Guidelines

Criteria	Marks
• outlines the correct role of the electrodes in the electron gun relating to: – – accelerating the electron beam to high speed; OR – focus the beam; OR – producing the electrons.	1

Question 28 (c) (2 marks).

Marking Guidelines

Criteria	Marks
• Demonstrates a thorough understanding of the impact of the development of the oscilloscope on experimental physics by discussing in detail a range of reasons relating to: – viewing – analysing – measuring plus example.	2
• Demonstrates some understanding of the impact of the development of the oscilloscope on experimental physics by discussing briefly a range of reasons relating to: – viewing – analysing – measuring plus example.	1

Criteria	Marks
OR • Clearly and correctly explains why the apparent inconsistent behaviour of cathode rays caused a debate, using a range of reasons relating to any two from the above list for either waves or particles and any one from the above list for the other. e.g. 2 behaviours for waves, 1 behaviour for particles OR. 2 behaviours for particles, 1 behaviour for waves.	2
OR. • A well argued statement re inconsistent behaviour regarding cathode rays not deflected in electric fields but being deflected in magnetic fields. clear, well explained physics required to obtain two marks.	2
• States at least two reasons but does not explain which relates to waves and which one is to particles.	1
OR • States at least one or two reasons for either waves or particles only OR • States one reason for waves and reason for particles.	1

Question 27 (c) (3 marks)

MARKING GUIDELINES

Criteria	Marks
• Clearly and correctly explains why the apparent inconsistent behaviour of cathode rays caused a debate, using a range of reasons relating to at least <u>three</u> from: <u>Particle nature of cathode rays.</u> - push objects along (paddle wheel). - deflected by magnetic fields - deflected by electric field - cathode rays deposited negative charges on impact with an object. AND at least three from: <u>Electromagnetic radiation nature</u> (= light like characteristics) - passed through the thin metal films because no particles had ever been observed to do this. - not deflected by electric fields. - travels in straight lines - causes fluorescence. - causes chemical reactions.	3
• Clearly and correctly explains why the apparent inconsistent behaviour of cathode rays caused a debate, using a range of reasons relating to any two from the above list for wave phenomena AND any two from the above list for particle phenomena.	2

Question 27 (a) (1 mark)

MARKING GUIDELINES

Criteria	Marks
• Correctly describes the observation made when the metal target was upright in the path of the cathode rays.	1

Sample answer:

A shadow of the metal target appeared in the midst of the green glow at the end of the tube.

Question 27 (b) (1 mark)

MARKING GUIDELINES.

Criteria	Marks
• Identifies a correct property of cathode rays revealed by the observation described in part (a).	1

Sample answer:

Cathode rays travel in straight lines or cathode rays cannot pass through metal.

Question 26(c) continued.

Acceptable applications include:

- Cathode ray oscilloscopes – useful to control X- or/and Y- deflection
- Electron microscopes
- velocity selector
- determination of q/m ratio for electrons.

Did not accept

Television

Lightning rods.

Maximum of 1 mark for use of electric fields in photocopier operation.

Sample Answer:

Electrically charged plates are used in cathode ray oscilloscopes, to direct the electron beam up, down, left or right before hitting the fluorescent screen. This enables the complex wave patterns to be analysed.

Question 26 (a) (1 mark)

MARKING GUIDELINES

Criteria	Marks
• Correct answer $F_B = Bqv\sin\theta$ $= 7.5\times10^{-2}\times1.602\times10^{-19}\times5.7\times10^{3}\times1$ $= 6.85\times10^{-17}\,N$	1

Question 26 (b) (2 marks)

MARKING GUIDELINES

Criteria	Marks
• Uses the correct formulae for F_E, substitutes correct values into $F_E = qE$ and correctly adds vectorially F_E and correct or incorrect F_B from part (a) (i.e. Answer (a) + $1.602\times10^{-19}\times250$) Sample Answer: net force = $6.85\times10^{-17}\,N\downarrow + 1.602\times10^{-19}\times250$ $= 1.086\times10^{-16}\,N$ (down)	2
• Correct addition vectorially of incorrect F_E with F_B	1

Question 26 (c) (2 marks)

MARKING GUIDELINES

Criteria	Marks
• States an example in which the application of electrically charged parallel plates is useful. AND • A purpose for this use.	2
EITHER • States an example in which the application of electrically charged parallel plates is useful. OR • A purpose for this use.	1