



TRINITY GRAMMAR SCHOOL

YEAR 12 SEMESTER ONE EXAMINATION 2001

Thursday 3rd May 2001

8:45-11:45

PHYSICS

2 UNIT

Time allowed – 3 hours
(plus 5 minutes reading time)

Directions to candidates

All answers are to be written on the spaces provided in the ANSWER BOOKLET
Do not remove any pages from the answer booklet

Write your NAME and CLASS on each page of the ANSWER BOOKLETS

Answer ALL questions

Write using blue or black pen.
Draw diagrams using pencil.

PAPER A

15 one mark multiple choice questions. Write ALL answers on the Section A Answer Sheet

PAPER B

15 three mark questions. Write ALL answers in the correct space in the Section B Answer Booklet

PAPER C

8 five mark questions. Write ALL answers in the correct space in the Section C Answer Booklet

In ALL questions neglect air resistance

A data sheet is provided on the back of this examination paper. Any scientific constant needed in this examination will be found listed on the data sheet

A Board of Studies equation sheet and Glossary of Keywords may be referred to during this examination

SECTION A

Questions 1 to 15 (1 mark each)

For each of the questions (1 to 15) choose the best of the four possible answers and indicate by placing a cross (X) in the appropriate space on the ANSWER SHEET

Question 1

Two bodies of mass m_1 and m_2 whose centres are separated by a distance d attract each other with a gravitational force of F . If the mass of each body is doubled and their separation distance reduced to one-half of the original value, the new force of attraction is given by:

- (A) F
- (B) $16F$
- (C) $32F$
- (D) $64F$

Question 2

As the Space Shuttle orbits the Earth in a circular orbit, it has:

- (A) a constant speed but a changing velocity
- (B) no resultant force acting on it
- (C) a constant velocity and a constant acceleration
- (D) a constant velocity but changing speed

Question 3

As a rocket accelerates from the launch pad, the acceleration:

- (A) increases as less fuel is burnt per second
- (B) always remains constant
- (C) decreases due to air resistance
- (D) increases since the mass of the spacecraft and rocket decreases

Question 4

A 'small window' exists for safe re-entry of spacecraft to Earth. This 'window' is determined by:

- (A) the size of the spacecraft
- (B) a compromise between too much heat and keeping safe g-forces
- (C) the landing site
- (D) the hole in the Ozone Layer

Question 5

A cannon was used to fire a cannonball horizontally from the top of a mountain. Which of the following statements best describes the acceleration of the cannonball?

- (A) increasing throughout the motion
- (B) it remains constant
- (C) decreasing throughout the motion
- (D) remains zero

Question 6

AC generators:

- (A) are only available in low power ratings
- (B) have slip rings
- (C) have split rings
- (D) are less efficient than DC generators

Question 7

Two long parallel wires carry currents of 2A and 3A respectively in the same direction. If separated by 10cm in air, what is the force per metre between the wires?

- (A) 1.2×10^{-5} N attraction
- (B) 1.2×10^{-5} N repulsion
- (C) 2.4×10^{-6} N attraction
- (D) 2.4×10^{-6} N repulsion

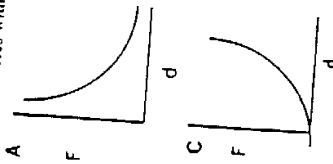
Question 8

The path of an electron injected at right angles to a uniform magnetic field is:

- (A) circular
- (B) parabolic
- (C) straightline
- (D) down

Question 9

The force, F , between two wires, parallel to each other and each carrying a current I is measured at different distances d of separation. Which of the sketches below indicates the way in which F varies with d ?



Question 10

James Clerk Maxwell predicted the existence of electromagnetic waves in 1873. Who was the first scientist to successfully generate and detect them?

- (A) Heinrich Hertz
- (B) Albert Einstein
- (C) Max Planck
- (D) JJ Thomson

Question 11

Which of the following properties of cathode rays is incorrect?

- (A) they have a charge to mass ratio less than that of a hydrogen ion
- (B) they cause glass to fluoresce
- (C) they possess energy and momentum
- (D) they travel from the cathode to the anode in a discharge tube

Questions 12 and 13 refer to the following information...

Some metals will emit electrons when bombarded with high frequency light

Question 12

If the frequency of the light is increased without increasing the intensity

- (A) the same number of electrons will be emitted with increased speed
- (B) more electrons will be emitted with unchanged speed
- (C) less electrons will be emitted with unchanged speed
- (D) more electrons will be emitted with increased speed

Question 13

If the intensity is increased without increasing the frequency:

- (A) the same number of electrons will be emitted with unchanged speed
- (B) more electrons will be emitted with unchanged speed
- (C) more electrons will be emitted with increased speed
- (D) less electrons will be emitted with increased speed

Question 14

In a transformer, the iron core:

- (A) traps eddy currents
- (B) aids flux linkage
- (C) allows the magnetic fields of the coils to be separated
- (D) decreases efficiency

Question 15

High voltage is used for the transmission of electricity because:

- (A) less insulation is needed
- (B) the wires can be thinner and hence cheaper
- (C) there is less chance of wire breakage
- (D) transmission is faster

END OF SECTION A

SECTION B

For each question (16 to 30) write your answer in the appropriate space in the ANSWER BOOK. You are advised to show FULL WORKING for all answers as marks may be awarded for relevant working.

Question 16 MARKS
A charge of $1.2 \times 10^{-11} \text{ C}$ travelling at 100 ms^{-1} enters a magnetic field of $1.0 \times 10^{-1} \text{ T}$ at right angles.

- What is the magnitude of the force acting on it?
- If its mass is $1 \times 10^{-26} \text{ kg}$, find the radius of its path.

Question 17 MARKS
Cathode Ray Tubes (CRTs) have three main components:

- Identify these three components.
- Describe the purpose of each of these components.

Question 18 MARKS
Outline two features of eddy currents

- Identify the problem eddy currents might cause in the operation of a transformer.
- Discuss how this problem is minimised in the construction of a transformer.

Question 19 MARKS
Outline two features of a geostationary orbit.

- Describe the types of satellites that might commonly use such an orbit.
- Where would such a satellite be launched and why?

Question 20 MARKS
Identify two factors which influence reliable communications between artificial satellites and the Earth.

- Outline the main features of Kepler's First Law.
- Outline the Physics principles involved in the gravitational slingshot effect.

Question 21 MARKS
Household electricity is provided at 240V. It is generated at 20,000V and sent via transmission lines at 100kV.

- What is the ratio of turns needed in the primary to turns needed in the secondary of the step-up transformer that converts 20,000V to 330kV?
- What is the ratio of primary to secondary coils of the step-down transformer that converts 330kV to 60kV for local distribution?
- Explain why, in practice, the power output of a transformer is significantly less than its power input.

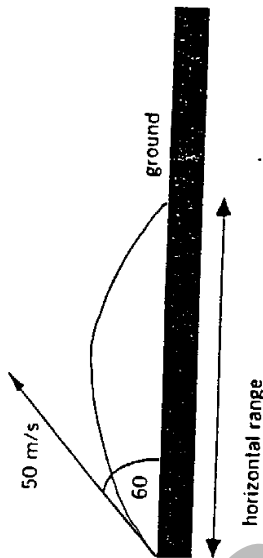
Question 22 MARKS
Draw a labelled diagram of Crookes' Paddle Wheel apparatus as used in a cathode ray tube.

- State two properties of cathode rays that Crookes believed the experiment demonstrated.

Question 23 MARKS
When a high voltage is applied across an air filled tube, at decreasing pressures, the tube first assumes a glow, then breaks up into bands. As the pressure is further reduced, the glow disappears but the glass glows around the anode.

- Account for the final glow observed in the tube.
- Explain why a series of bright and dark bands (striations) appear in the tube at low pressures.

Question 24 MARKS
An object is projected at a speed of 50 ms^{-1} so that it makes an angle of 60° degrees with the horizontal as depicted in the figure below.



- What is the vertical component of the velocity at the instant that the ball is released?
- How long does it take for the object to reach its greatest height above the ground?
- What is the horizontal range of the object?

Question 25 MARKS
A DC electric motor has a rectangular coil of 100 loops, $120 \text{ mm} \times 100 \text{ mm}$. The coil sits in a magnetic field of strength 200 mT . A current of 5 A flows through the split ring commutator to the coils.

- Describe the role of the split-ring commutator.
- What is the maximum torque that acts on the coils of the motor?

Question 26 MARKS
Describe the Michelson-Morley experiment using a diagram to aid your description.

- Discuss how the results of this experiment contributed to our further understanding of the nature of light and its propagation.

MARKS

Question 27

The wheels of a car have a diameter of 600mm. The wheels rotate at a constant 10 revolutions per second. The vehicle is being driven in a 60kmhr⁻¹ zone.

- (a) What is the linear speed of the car in ms⁻¹? (Show working to justify your answer)
- (b) Is the driver speeding?

2
1

Question 28

A space vehicle is moving at $2.7 \times 10^8 \text{ ms}^{-1}$. A radio transmission is sent from this vehicle to Earth.

- (a) What is the speed of the transmission relative to the Earth?
- (b) What is the speed of the transmission relative to the spaceship?
- (c) If the space vehicle is $9 \times 10^7 \text{ km}$ from Earth, how long will it take the transmission to reach the Earth relative to an observer on Earth?

1
1
1

Question 29

The moon has an orbital period of 27.32 days, an average orbital radius of 384,400km and a mass of $7.36 \times 10^{22} \text{ kg}$.

- (a) What is the direction of the centripetal force acting on the Moon?
- (b) What is the speed of the Moon in ms⁻¹?
- (c) What is the magnitude of the force between the Earth and the Moon?

1
1
1

Question 30

A moon of Jupiter has a mass of $9.1 \times 10^{26} \text{ kg}$ and a diameter of 4800km.

- (a) What is the acceleration due to gravity on that moon?
- (b) How much would an 80kg explorer weigh on that moon?

2
1

SECTION C

Questions 31 to 38 (5 marks each)

For each question (31 to 38) write your answer in the appropriate space in the ANSWER BOOK. You are advised to show FULL WORKING for all answers as marks may be awarded for relevant working.

Question 31

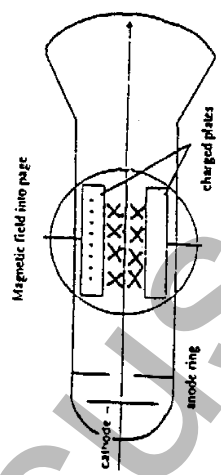
An astronaut leaves Earth for Alpha Centauri at $2.4 \times 10^8 \text{ ms}^{-1}$ and 10 years pass relative to a clock on the spaceship, until his return to Earth.

- (a) What time elapses during this trip as measured by a clock on the Earth?
- (b) Describe the "Twin Paradox" and its relevance to the above question.
- (c) Explain how inertial and non-inertial frames of reference are associated with the above question.

MARKS

Question 32

The apparatus shows a beam of cathode rays passing undeflected through perpendicular electric and magnetic fields.



- (a) Name the scientist who used the above apparatus to determine the charge to mass ratio of cathode rays.
- (b) Write an expression which gives the charge to mass ratio of an electron as determined by the above apparatus given E, B and the accelerating voltage V. (Show all working)
- (c) As a result of these experiments, outline what was suggested about the nature of cathode rays.

1
3
1

Question 33

An object is projected horizontally from the top of a cliff 1000m high with a velocity of 200ms⁻¹. Find:

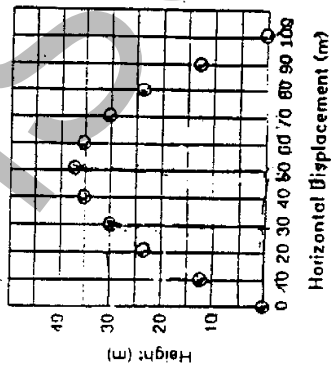
- (a) The time it takes the object to strike the ground.
- (b) How far, measured from the base of the cliff, where the object strikes the ground.
- (c) The speed of the object when it strikes the ground.
- (d) The velocity (magnitude and direction) of the object 5s after it is projected from the top of the cliff.

1
1
1
1
2

END OF SECTION B

Question 34

The following diagram represents a stroboscopic photograph of an object projected from a level surface. The stroboscope was flashing at a frequency of 1.82 Hz. The maximum height the object attained was 37 m.



- (a) What was the horizontal component of the object's velocity during flight?
- (b) What was the vertical component of its initial velocity?
- (c) At what angle to the horizontal was the object projected?

1
2
2

Question 35

An electron beam is fired between two metal plates which have a potential difference of 100V. A uniform magnetic field of 0.05T is directed parallel to the plates and at right angles to the electron beam as shown in the diagram below...

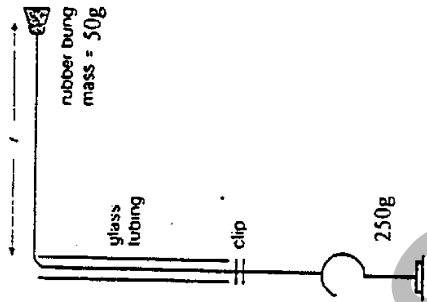


- (a) Calculate the magnitude of the electric field between the plates.
- (b) Determine the magnitude of the electric force acting on the electron beam.
- (c) What is the direction of the electric force on the electron beam?
- (d) What is the direction of the force due to the magnetic field on each electron?

1
1
1
1

Question 36

A rubber bung of mass 50g is swung in a horizontal circle. The mass below the clip remains constant at 250g (including the mass of the mass carrier). The radius is varied and hence the period



- (a) What is the relationship between linear velocity squared (v^2) of the bung and the radius (r)? (Use an equation and show all relevant working)
- (b) Draw a graph of v^2 vs r , demonstrating this relationship. (Use the axes on the answersheet)
- (c) What is the period of rotation of the bung if $r = 50.0\text{cm}$?

Question 37

A coil with resistance 50Ω with 1000 turns and cross-sectional area $5 \times 10^{-3} \text{m}^2$ is connected to a sensitive galvanometer. It is rotated through 90° in 0.50s and an average current of $20\mu\text{A}$ is produced.

- (a) What average EMF is induced in the coil?
- (b) What is the change in magnetic flux through the coil?
- (c) Calculate the value of the Earth's magnetic field if finally the coils are perpendicular to the Earth's magnetic field (assumed uniform).

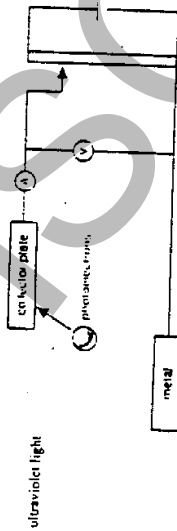
$$V = IR$$

$$V = \frac{\Delta \Phi}{\Delta t} = N \frac{\Delta B}{\Delta t} A \cos \theta$$

PHYSICS DATA SHEET

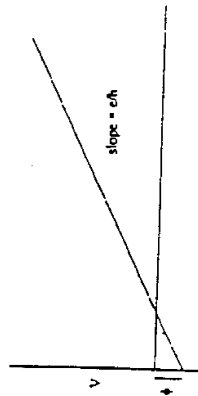
MARKS

Question 38
The diagram and graph below represent the apparatus used and the results obtained in investigating the "Photoelectric Effect".



$$KE_{\text{max}} = hf - \phi$$

$$eV_s = hf - \phi$$



- Name the Physicist responsible for our understanding of "The Photoelectric Effect".
- Outline the meaning of the "work function" and what symbol above is used to represent it?
- Describe what is meant by "threshold frequency"?
- Name two devices in common use which involve application of the photoelectric effect.

1
1
1
2

Numerical values of several constants

Charge on the electron, q_e	$-1.602 \times 10^{-19} \text{ C}$
Mass of electron, m_e	$9.109 \times 10^{-31} \text{ kg}$
Mass of neutron, m_n	$1.675 \times 10^{-27} \text{ kg}$
Mass of proton, m_p	$1.673 \times 10^{-27} \text{ kg}$

Earth's gravitational acceleration, g

$$9.8 \text{ m s}^{-2}$$

Speed of light, c

$$3.00 \times 10^8 \text{ m s}^{-1}$$

Magnetic force constant, $\left(k = \frac{\mu_0}{2\pi}\right)$

$$2 \times 10^{-7} \text{ N A}^{-2}$$

Universal gravitational constant, G

$$6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$$

Mass of Earth

$$6.0 \times 10^{24} \text{ kg}$$

Planck's constant, h

$$6.626 \times 10^{-34} \text{ J s}$$

Rydberg's constant, R_H

$$1.097 \times 10^7 \text{ m}^{-1}$$

Atomic mass unit, u

$$1.661 \times 10^{-27} \text{ kg}$$

$$931.5 \text{ MeV}/c^2$$

1 eV

$$1.602 \times 10^{-19} \text{ J}$$

Density of water, ρ

$$1.00 \times 10^3 \text{ kg m}^{-3}$$

Specific heat capacity of water

$$4.18 \times 10^3 \text{ J kg}^{-1} \text{ K}^{-1}$$

END OF SECTION C