Student No. _____

Barker College

2003
TRIAL HIGHER SCHOOL CERTIFICATE

Physics

ANSWER SHEET

Staff Involved:

AM WEDNESDAY 13 AUGUST

- DJB*
- CAD
- AMT
- MCA

85 copies

Section I

Part A – Multiple Choice

Choose the best response and fill in the response oval completely

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

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AM WEDNESDAY 13 AUGUS

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using blue or black pen
- Board-approved calculators may be used
- Draw diagrams using pencil
- Show ALL relevant working in questions involving calcualtions (i.e. marks will be deducted for not showing working).
- A Periodic Table, a Data Sheet and Formulae Sheets are provided on the back pages of this paper. It may be necessary to you to refer to these to answer some of the questions in this examination paper.

Total marks – 100

Section I Pages 2 - 23

Total marks – 90
This section consists of two parts Part A and Part B

PART A – 15 marks
- Attempt Questions 1 – 15
- Allow about 25 minutes for this part
- Indicate all answers on the Answer Sheet provided

PART B – 75 marks
- Attempt Questions 16 – 32
- Allow about 2 hours and 15 minutes for this part
- Indicate all answers in the spaces provided

Section II Pages 24 - 25

Option – 10 marks
- Attempt Questions 33 – 36
- Allow about 15 minutes for this section

Section I

Total marks – 90

Part A

15 marks

Attempt Questions 1 – 15

Allow about 25 minutes for this part

Use the multiple-choice answer sheet

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

(A) ○ (B) ● (C) ○ (D) ○

If you think you have made a mistake, put a cross through the incorrect answer and fill in th new answer.

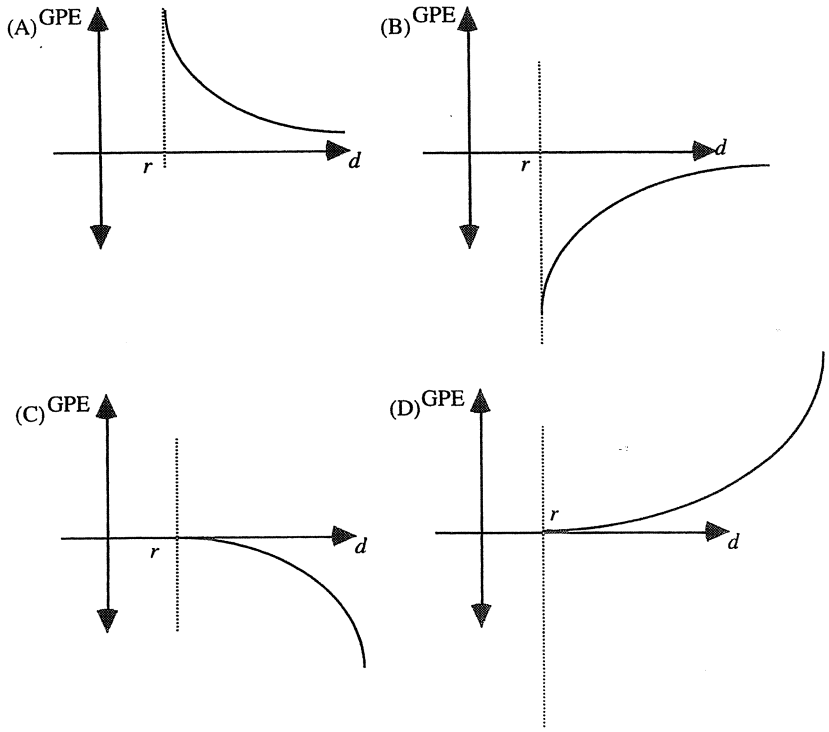
(A) ● (B) ⊗ (C) ○ (D) ○

If you change your mind and have crossed out what you consider to be the correct answer, then indicate this by writing the word *correct* and drawing an arrow as follows.

correct ←

(A) ⊗ (B) ⊗ (C) ○ (D) ○

1. Which of the following graphs best describes the way in which Gravitational Potential Energy (GPE) of an object varies with its distance (d) from a planet of radius 'r'?



2. Which of the following statements most correctly describes the force acting on a satellite in circular orbit around the Earth?

(A) It is an electrostatic force that remains constant.

(B) It is a centre-seeking gravitational force that maintains a constant magnitude.

(C) It is a gravitational force that has a constant direction, but varies in magnitude.

(D) It is a centrifugal force that keeps the satellite in orbit.

3. Launching rockets into space requires vast amounts of energy. In order to reduce these energy requirements space programs have been selective in the location and direction of launch.

Which of the following situations would require the least amount of energy to get a rocket to escape the Earth's attraction if launched from Australia?

(A) Launched from Queensland in the easterly direction.

(B) Launched from Tasmania in the easterly direction.

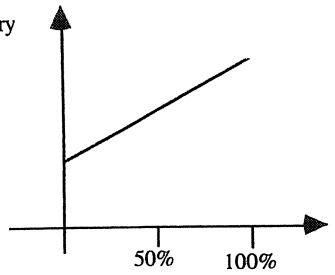
(C) Launched from Queensland in the westerly direction.

(D) Launched from Tasmania in the southerly direction.

6. In an experiment you conducted during the 'Motors and Generators' module you would have measured the voltage drop across the secondary coil of a transformer. A number of measurements would have been taken while a soft iron core was inserted into the secondary coil.

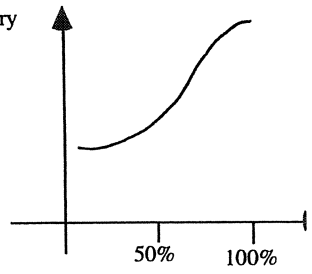
Which graph below best represents the effect of the iron core on the secondary voltage as the percentage of the iron core is inserted?

(A) Secondary Voltage



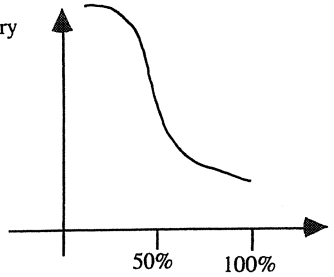
% of iron ore in the coil

(B) Secondary Voltage



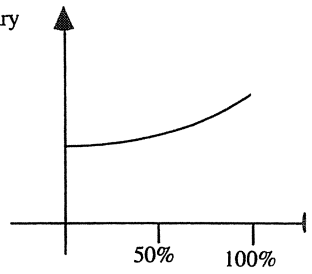
% of iron ore in the coil

(C) Secondary Voltage



% of iron ore in the coil

(D) Secondary Voltage



% of iron ore in the coil

9. A galvometer is designed so that the torque of the current-carrying coil is not dependent upon t angle ' θ' of rotation and is given by the equation $\tau = nBIA$.

In order to provide a counter torque on the coil, a spring is used.

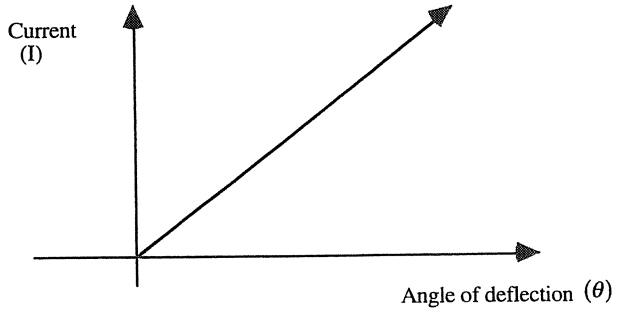
The torque provided by the spring varies with the angle ' θ' of deflection according to the equation

$\tau = k\theta$

k = spring constant

θ = angle of deflection

When the galvometer is operating it is found that the following graph describes the relationshi between the current and the angle of deflection.



If the design of the galvometer is such that the number of loops = n, the magnetic field = B an the area of each loop = A, then the gradient of this graph is best given by:

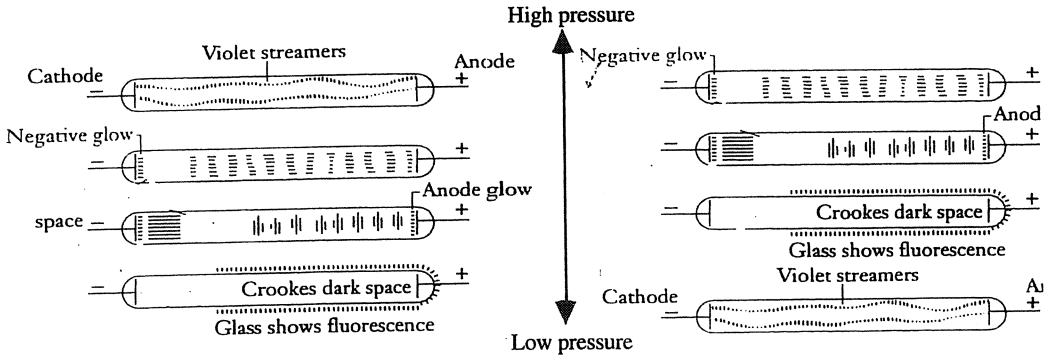
(A) $\frac{k}{nBA}$

(B) $\frac{nBA}{k}$

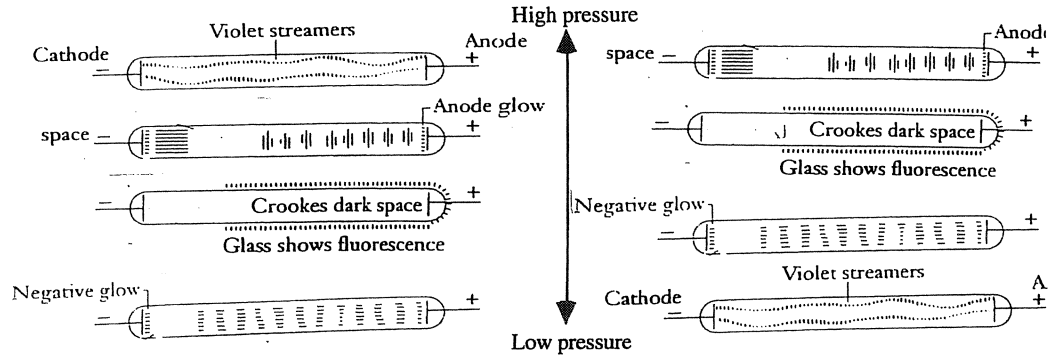
(C) $\frac{kn}{BA}$

(D) $\frac{k\theta}{nBA}$

11. Which of the following sequence of discharge tubes shows the correct patterns for varying pressures?

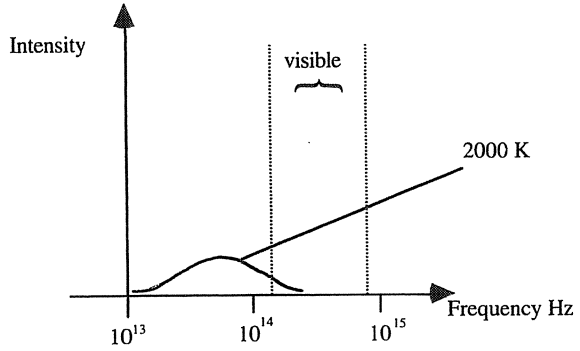


(A) (B)



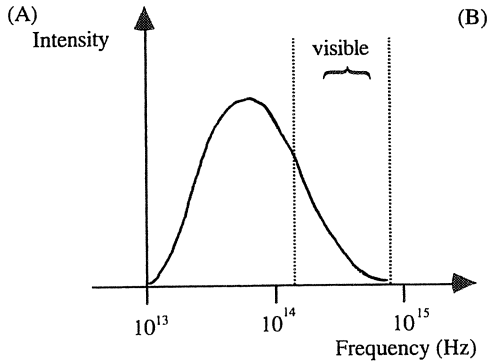
(C) (D)

14. The graph below shows the characteristic curve for the intensity of radiation from a heated black body at 2000 K.

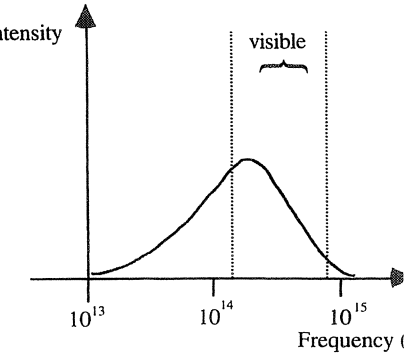


Which of the following graphs best shows the characteristic curve of the same body when heated to 6000 K?

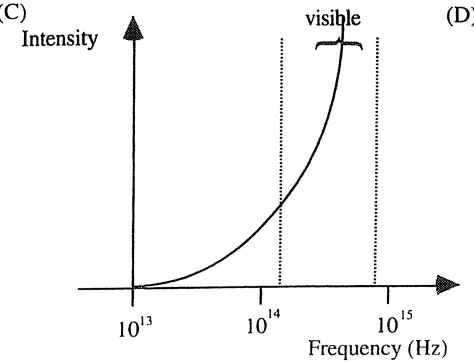
(A)



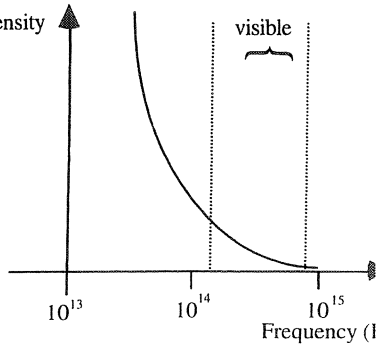
(B)



(C)



(D)



Student No. _____

Section I (Continued)

Part B

75 marks
Attempt Questions 16 – 33
Allow about 2 hours and 15 minutes for this part

Write your answers in the appropriate space on the paper. Marks allocated to each question are shown following the question. Show all relevant working in questions involving calculations (i.e. marks will be deducted for not showing working).

Marks

SPACE – (20 marks)

Question 16 (4 marks)

The recent break-up of the space shuttle Columbia on re-entry into the atmosphere has highlighted the extreme dangers of space exploration.

Discuss the factors that NASA scientists need to consider in the safe re-entry of manned spacecraft. 4

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Student No. _____

Mark

Question 17 (8 marks)

The international space station (ISS) is being assembled at an altitude of 370 km above the surface of the Earth of radius 6.38×10^6 m. The moon has a period of orbit of 27.3 days and has a radius of orbit of 3.83×10^8 m.

(a) What is the radius of orbit for the ISS in metres?

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(b) Calculate the period of orbit for the ISS in hours.

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(c) How many times will the ISS circle the Earth each day?

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(d) What will be the centripetal force that the ISS experiences when it is completed and has a mass of 500 tonnes?

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(e) Is the ISS likely to suffer from orbital decay? Justify your answer.

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Student No. _____

Marks

Question 18 (4 marks)

Time dilation, length contraction and mass increase were predicted by Einstein well before experimental evidence was found for them occurring.

Describe **ONE** of the experiments and explain how the results demonstrate that Einstein's Theory of Special Relativity does, in fact, predict events in the real world. 4

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Question 19 (4 marks)

A spacecraft with a total mass of 8.50×10^2 kg is requiring an increase in forward velocity of 20.0 m s^{-1}. If the velocity of the gas being ejected is 3.00×10^3 m s^{-1}, then determine the total mass of gas that needs to be released in order to achieve this.

State your answer to three significant figures. 4

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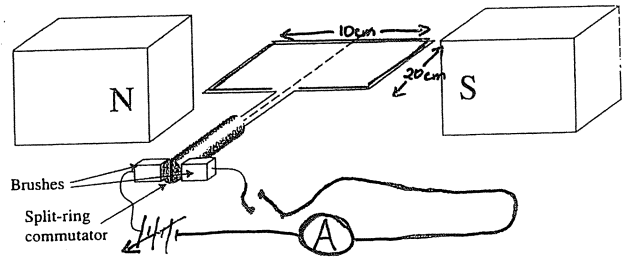
Student No. _____

Marks

Question 20 (7 marks)

A simple DC motor comprises 100 rectangular loops as shown in the diagram below.

A 10.0 V DC supply is connected along with an ammeter and switch.



The total resistance of the motor coil is 2.5 Ω. The magnetic field is uniform between the poles of the magnet and has a value of 4.5 mT.

(a) Calculate the initial current that will flow in the motor when the switch is closed. 1

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(b) When viewed from the power supply, which direction will the motor spin? 1

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(c) Calculate the initial torque on the motor when the switch is closed. 1

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(d) When in full operation the motor spins at 50 Hz. Calculate the back Emf that is produced when this motor is in full operation.

Use the equation $\text{Emf} = \frac{\Delta\phi}{\Delta t}$. 2

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(e) Outline **TWO** design changes that could be made to the simple motor so that the torque it produces is more constant. 2

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Student No. _____

Marks

Question 21 (3 marks)

Eddy currents are responsible for lowering the efficiency of transformers. However, eddy currents can often be put to good use.

With reference to **ONE** example, explain how eddy currents are produced and how they can be put to good use. **3**

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Question 22 (2 marks)

High voltage power lines are common across our landscape. They carry high voltage AC currents and are potentially dangerous.

Describe how these lines are insulated from their support structures and protected from lightning strikes. **2**

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Question 23 (4 marks)

During the Motors and Generators Module you will have performed an investigation to demonstrate the principle by which an AC induction motor operates.

Describe the demonstration and **explain** the principle. **4**

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Student No. _____

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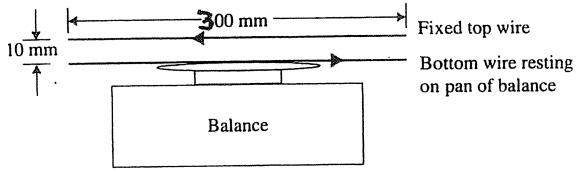
Question 24 (7 marks)

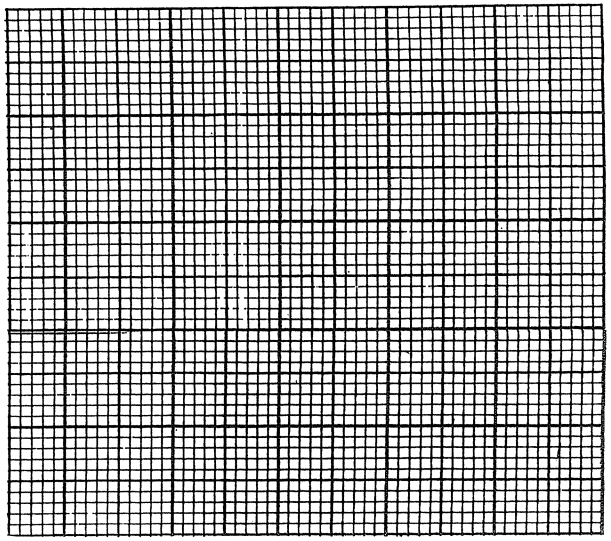
A physics student set up the following experiment to measure the magnetic force between two current-carrying wires. The top wire, 300 mm long, is fixed in place, with the bottom wire resting on the pan of very sensitive electronic balance, insulated from the balance. Currents flow in the wires in the directions shown by the arrows in the diagram below.



The table below shows the resulting readings on the balance as the current is increased in the top wire.

Reading on Balance $(\times 10^{-5}\text{N})$	**Current in bottom wire** (A)	**Current in top wire** (A)
not taken	2.0 A	0A
1.5	2.0 A	1.0 A
2.7	2.0 A	2.0 A
3.9	2.0 A	3.0 A
5.1	2.0 A	4.0 A

(a) On the grid provided, construct a graph of 'Force on Balance' vs 'Current in the top wire'.



Question 24 continues on page 19

Question 24 (continued)

Marks

(b) Use your graph to determine the **mass** of the bottom wire. $1\frac{1}{2}$

(c) From your graph determine a value for 'k', the magnetic force constant. $1\frac{1}{2}$

Question 25 (3 marks)

A colour TV operates with 3 electron guns, deflection coils and a fluorescent screen.

Outline the role of the electron gun and the fluorescent screen in producing the colour picture. 3

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Question 26 (4 marks)

With particular reference to microchips and microprocessors, assess the impact of the transistor on society. 4

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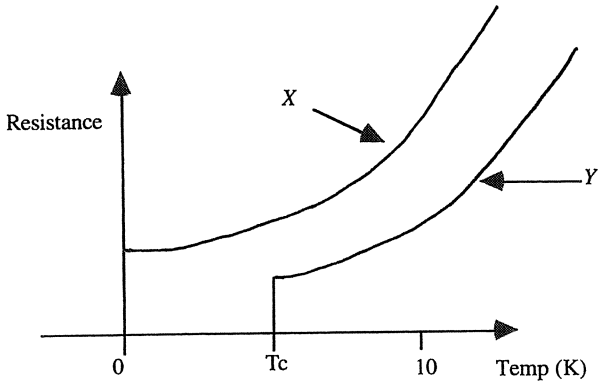
Student No. _____

Marks

Question 27 (3 marks)

The graph below shows the resistance of two conducting materials, X and Y, with temperature.



Describe the nature of these two conductors.

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Question 28 (4 marks)

Describe how doping can be used to produce n-type and p-type semiconductors and the resulting electrical properties of these materials.

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Student No. _____

Marks

Question 29 (3 marks)

Heinrich Hertz performed a number of significant experiments using radio waves.

Outline **ONE** of his experiments and the resulting advancement in scientific understanding. 3

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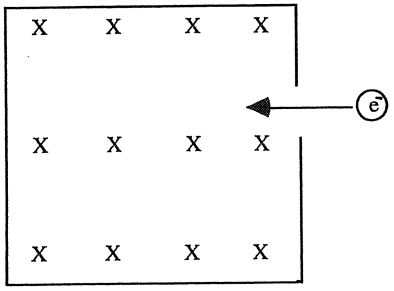
Question 30 (3 marks)

An electron moving at 5.0×10^6 m.s^{-1} enters a magnetic field of 2.0 mT as shown in the diagram below.



(a) In which direction will the electron initially experience a force upon entering the magnetic field? 1

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(b) Calculate the radius of curvature for the path of the electron in the magnetic field. 2

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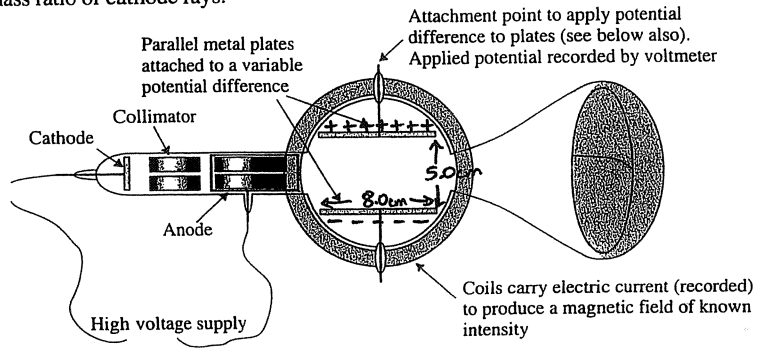
Student No. _____

Mark

Question 31 (7 marks)

The diagram below shows the cathode ray tube that can be used to determine the charge to mass ratio of cathode rays.



The voltage applied across the parallel plates is 4 500 Volts.

(a) Calculate the strength of the electric field that exists between these plates.

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(b) With only the electric field on, describe the shape of the cathode rays' path as they move between the plates.

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(c) If the cathode rays are travelling at 3.0×10^7 m.s^{-1}, then determine the direction and strength of the magnetic field that would balance the deflection caused by the electric field.

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(d) Neglecting relativistic effects, how long will the cathode rays take to travel the length of the plates?

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(e) If the magnetic field is turned off, then calculate the distance of the vertical deflection of the cathode rays as they pass across the plates.

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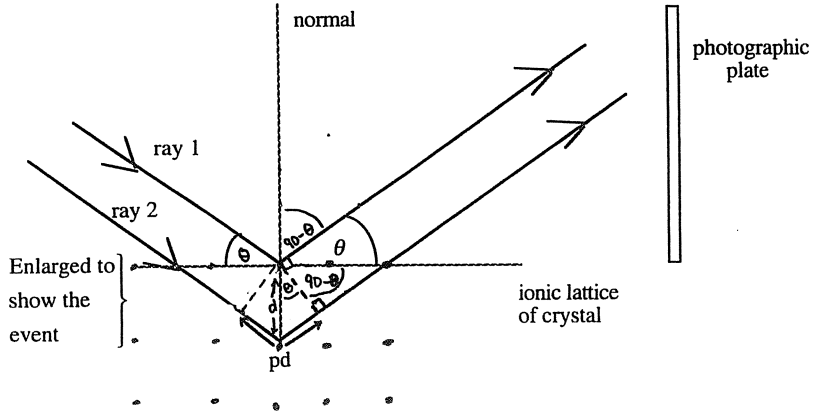
Student No. _____

Marks

Question 32 (5 marks)

Two coherent X-rays (ray 1 and ray 2) are incident onto the ionic lattice of a crystal. They reflect off the top two layers of the crystal and combine on the photographic plate as shown below.



(a) Which father and son team won the Nobel Prize in 1915 for their work on X-ray crystallography? 1

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(b) For the two rays to constructively interface on the photographic plate, then, what must be true about the path difference (pd) shown in the diagram? 1

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(c) If X-rays of wave length 2.9×10^{-12} m are shone onto the ionic lattice, it is found that constructive interference occurs at the smallest glancing angle (θ) of 12^o.

Determine the interspatial distance 'd' between the atoms of the ionic lattice. 2

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(d) If you were to consider the particle nature of these X-rays, then determine the energy of these photons. 1

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Student No. _____

Marks

Section II – Option
10 marks
Attempt Questions 33 – 36
Allow about 15 minutes for this section

Answer this section in the spaces provided.

Question 33 (2 marks)

Calculate the wavelength of photon emitted when an electron moves from the 6th to the 3rd energy level of hydrogen. 2

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Question 34 (2 marks)

Describe the results of Rutherford's α scattering experiment and how it led to his model of the atom. 2

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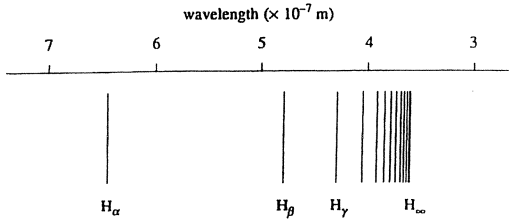
Question 35 (1 mark)

The diagram below shows the visible line spectra for hydrogen.



Between which two energy levels are electrons moving in order to produce the green line $-H_\beta$? 1

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Student No. _____

Marks

Question 36 (5 marks)

The Bohr-Rutherford model of the atom was mostly successful in explaining atomic behaviour and line spectra. However, some questions remained unanswered.

Discuss some of the limitations of the Bohr-Rutherford model in explaining line spectra. **5**

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End of Paper

DATA SHEET

Charge on the electron, q_e	-1.602×10^{-19} C
Mass of electron, m_e	9.109×10^{-31} kg
Mass of neutron, m_n	1.675×10^{-27} kg
Mass of proton, m_p	1.673×10^{-27} kg
Speed of sound in air	340 m s^{-1}
Earth's gravitational acceleration, g	9.8 m s^{-2}
Speed of light, c	3.00×10^8 m s^{-1}
Magnetic force constant, $\left(k \equiv \frac{\mu_0}{2\pi}\right)$	2.0×10^{-7} N A^{-2}
Universal gravitational constant, G	6.67×10^{-11} N m^2 kg^{-2}
Mass of Earth	6.0×10^{24} kg
Planck's constant, h	6.626×10^{-34} J s
Rydberg's constant, R_H	1.097×10^7 m^{-1}
Atomic mass unit, u	1.661×10^{-27} kg 931.5 MeV/c^2
1 eV	1.602×10^{-19} J
Density of water, ρ	1.00×10^3 kg m^{-3}
Specific heat capacity of water	4.18×10^3 J kg^{-1} K^{-1}

PERIODIC TABLE OF THE ELEMENTS

KEY

Atomic Number	Symbol of element	Name of element
79	Au	Gold
Atomic Weight	197.0	

1 H 1.008 Hydrogen																	2 He 4.003 Helium
3 Li 6.941 Lithium	4 Be 9.012 Beryllium											5 B 10.81 Boron	6 C 12.01 Carbon	7 N 14.01 Nitrogen	8 O 16.00 Oxygen	9 F 19.00 Fluorine	10 Ne 20.18 Neon
11 Na 22.99 Sodium	12 Mg 24.31 Magnesium											13 Al 26.98 Aluminium	14 Si 28.09 Silicon	15 P 30.97 Phosphorus	16 S 32.07 Sulfur	17 Cl 35.45 Chlorine	18 Ar 39.95 Argon
19 K 39.10 Potassium	20 Ca 40.08 Calcium	21 Sc 44.96 Scandium	22 Ti 47.87 Titanium	23 V 50.94 Vanadium	24 Cr 52.00 Chromium	25 Mn 54.94 Manganese	26 Fe 55.85 Iron	27 Co 58.93 Cobalt	28 Ni 58.69 Nickel	29 Cu 63.55 Copper	30 Zn 65.39 Zinc	31 Ga 69.72 Gallium	32 Ge 72.61 Germanium	33 As 74.92 Arsenic	34 Se 78.96 Selenium	35 Br 79.90 Bromine	36 Kr 83.80 Krypton
37 Rb 85.47 Rubidium	38 Sr 87.62 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.94 Molybdenum	43 Tc [98.91] Technetium	44 Ru 101.1 Ruthenium	45 Rh 102.9 Rhodium	46 Pd 106.4 Palladium	47 Ag 107.9 Silver	48 Cd 112.4 Cadmium	49 In 114.8 Indium	50 Sn 118.7 Tin	51 Sb 121.8 Antimony	52 Te 127.6 Tellurium	53 I 126.9 Iodine	54 Xe 131.3 Xenon
55 Cs 132.9 Caesium	56 Ba 137.3 Barium	57–71 Lanthanides	72 Hf 178.5 Hafnium	73 Ta 180.9 Tantalum	74 W 183.8 Tungsten	75 Re 186.2 Rhenium	76 Os 190.2 Osmium	77 Ir 192.2 Iridium	78 Pt 195.1 Platinum	79 Au 197.0 Gold	80 Hg 200.6 Mercury	81 Tl 204.4 Thallium	82 Pb 207.2 Lead	83 Bi 209.0 Bismuth	84 Po [210.0] Polonium	85 At [210.0] Astatine	86 Rn [222.0] Radon
87 Fr [223.0] Francium	88 Ra [226.0] Radium	89–103 Actinides	104 Rf [261.1] Rutherfordium	105 Db [262.1] Dubnium	106 Sg [263.1] Seaborgium	107 Bh [264.1] Bohrium	108 Hs [265.1] Hassium	109 Mt [268] Meitnerium	110 Uun — Ununnilium	111 Uuu — Unununium	112 Uub — Ununbium	113	114 Uuq — Ununquadium	115	116 Uuh — Ununhexium	117	118 Uuo — Ununoctium

Lanthanides

57 La 138.9 Lanthanum	58 Ce 140.1 Cerium	59 Pr 140.9 Praseodymium	60 Nd 144.2 Neodymium	61 Pm [146.9] Promethium	62 Sm 150.4 Samarium	63 Eu 152.0 Europium	64 Gd 157.3 Gadolinium	65 Tb 158.9 Terbium	66 Dy 162.5 Dysprosium	67 Ho 164.9 Holmium	68 Er 167.3 Erbium	69 Tm 168.9 Thulium	70 Yb 173.0 Ytterbium	71 Lu 175.0 Lutetium

Actinides

89 Ac [227.0] Actinium	90 Th 232.0 Thorium	91 Pa 231.0 Protactinium	92 U 238.0 Uranium	93 Np [237.0] Neptunium	94 Pu [239.1] Plutonium	95 Am [241.1] Americium	96 Cm [244.1] Curium	97 Bk [249.1] Berkelium	98 Cf [252.1] Californium	99 Es [252.1] Einsteinium	100 Fm [257.1] Fermium	101 Md [258.1] Mendelevium	102 No [259.1] Nobelium	103 Lr [262.1] Lawrencium

Where the atomic weight is not known, the relative atomic mass of the most common radioactive isotope is shown in brackets.
The atomic weights of Np and Tc are given for the isotopes ^{237}Np and ^{99}Tc.