Sydney Girls High School

2003

TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

Physics

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black or blue pen
- Draw diagrams using pencil
- Board-approved calculators may be used
- A data Sheet, formulae sheets and Periodic Table are provided at the back of this paper.

Total marks – 100

Section I Pages 2 – 17

75 marks

This section has two parts, Part A and Part B

Part A – 15 marks

- Attempt questions 1 – 15
- Allow about 30 minutes for this part

Part B – 60 marks

- Attempt questions 16 –24
- Allow about 1 hour and 45 minutes for this part.

Section II Pages 18 – 20

25 marks

- Attempt all parts of this question
- Allow about 45 minutes for this section.

1. The Space Telescope is a satellite in geo-stationary orbit around the Earth. What is the net force acting on this satellite?

   (A) Zero.
   (B) The net force is equal to mg, where m is the mass of the earth and g is 9.8 ms^{-2}
   (C) The net force is equal to mg, where m is the mass of the satellite and g is 9.8 ms^{-2}
   (D) The force required to accelerate the satellite toward the centre of the Earth.

2. The Space Shuttle takes approximately 1.5 hours to orbit the Earth. If the radius of the Earth is 6 400 km calculate the altitude of the shuttle.

   (A) 2.8×10^4 m
   (B) 2.6×10^5 m
   (C) 3.8×10^5 m
   (D) 6.7×10^6 m

3. Identify one characteristic of an inertial frame of reference.

   (A) The speed of light is less than 3×10^8 ms^{-1}.
   (B) An observer cannot identify from experiment whether they are stationary or moving at a constant velocity.
   (C) The concept of an *ether* is used as a reference point for all motion.
   (D) Time will be dilated as viewed by a second observer travelling with a constant acceleration relative to the first observer.

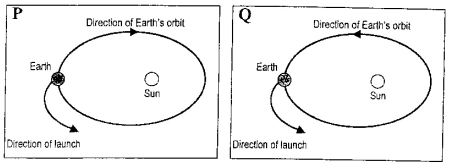
4. The table below shows a variety of data concerning the planets Venus and Earth.

Planet	*Relative mass*	*Diameter (km)*
Venus	0.82	12 104
Earth	1	12 756

The *Venera 14* spacecraft weighs 10 000 N on the Earth's surface. Calculate its weight on the surface on Venus.

(A) 837 N
(B) 1020 N
(C) 7526 N
(D) 9107 N

5. These diagrams show the direction of the Earth's orbit around the Sun.



In what direction should a rocket be launched from the equator to minimize the amount of fuel required to travel to the outer planets?

(A) Toward the west as in diagram P.
(B) Toward the east as in diagram P.
(C) Toward the west as in diagram Q.
(D) Toward the east as in diagram Q.

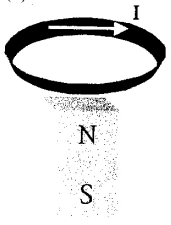
6. What is the construction and function of a step up transformer?

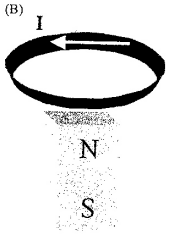
   (A) It has more turns in the secondary coil causing an increase in voltage.
   (B) It has more turns in the secondary coil causing an increase in current.
   (C) It has less turns in the secondary coil causing an increase in voltage.
   (D) It has less turns in the secondary coil causing an increase in current.

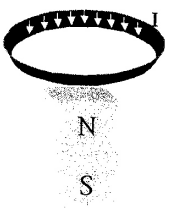
7. Who discovered that a moving magnet would generate an electric current within a conductor?

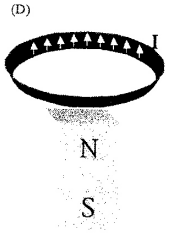
   (A) Michael Faraday
   (B) Emil Lenz
   (C) Heinrich Hertz
   (D) Hans Oersted

8. Which of the following diagrams best illustrates the direction of the induced current in a metal ring which is dropped over a bar magnet?

(A)


(B)


(C)


(D)


9. Identify one feature of a single coil DC generator.

   (A) It uses slip ring commutators to connect the rotating coil with the external circuit.
   (B) There are no brushes as eddy currents are formed in the external circuit.
   (C) No current is generated when maximum flux passes through the cross sectional area of the coil.
   (D) It produces a constant current.

10. Describe one advantage of using DC electricity for transmission through power lines.

(A) It can be produced at higher voltages than AC.
(B) There is no energy loss due to electromagnetic induction in nearby conductors.
(C) There is no energy loss due to the heating effect of the current in the wire.
(D) It is more easily converted in step-up and step-down transformers.

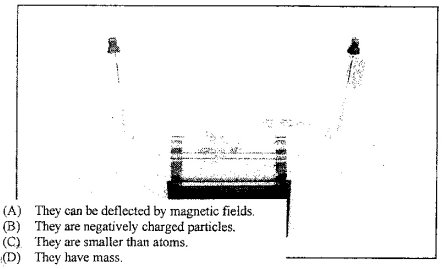
11. Why was germanium used in preference to silicon in early transistors?

(A) Silicon is more metallic than germanium.
(B) Germanium was able to be produced with less impurities.
(C) Silicon's semiconductor properties breakdown at high temperatures.
(D) Germanium is protected by a tough germanium oxide protective layer.

12. Calculate the energy of a photon of wavelength, 600 nm, travelling through a vacuum.

(A) 3.31×10^{-31} J
(B) 3.96×10^{-31} J
(C) 3.31×10^{-19} J
(D) 3.96×10^{-19} J

13. What property of cathode rays can be determined using the discharge tube shown below?



(A) They can be deflected by magnetic fields.
(B) They are negatively charged particles.
(C) They are smaller than atoms.
(D) They have mass.

14. Distinguish between the cathode ray tubes used in oscilloscopes and those used in televisions.

(A) Only in televisions are the electrons deflected by magnetic fields.
(B) Only in televisions are the electrons accelerated by electric fields.
(C) Only in oscilloscopes are the electrons produced by thermionic emission.
(D) Only in oscilloscopes are the electrons projected onto a fluorescent screen.

15. Describe one characteristic that distinguishes an n-type semiconductor.

(A) They have an excess number of holes within the lattice.
(B) They have a excess number of positive charges within the lattice.
(C) They are doped with an element that has five valence electrons.
(D) They are doped with an element that has three valence electrons.

2003 TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

Physics

Part B – 60 marks
Attempt Questions 16 - 24
Allow about 1 hour and 45 minutes for this part

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

Question 16 (6 marks) Marks

The star Pollux is 35.9 light years from the Earth.

(a) Calculate how many years an astronaut would age if they travelled to this star in a spacecraft moving at 0.95 times the speed of light. 2

(b) Determine the distance travelled by the spacecraft according to the astronaut.

(c) Identify two other consequences that are a direct result of such a journey.

Question 22 (7 marks)

Marks

Superconductors are conducting materials that under certain conditions allow electrons to pass through with no energy loss.

(a) Identify two physical limitations to the widespread use of superconductors. 2

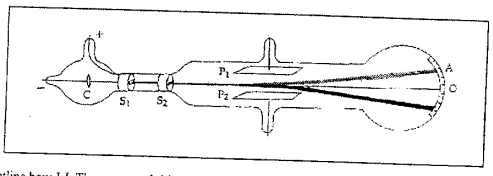
(b) Discuss the advantage of the application of superconductors in computer technology. 2

(c) Describe how the electrons are able to pass through superconductors unimpeded. 3

Question 23 (8 marks)

Marks

This diagram shows one of the evacuated glass tubes used by J.J. Thomson in his experiments.

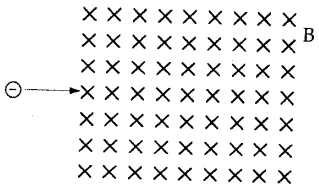


Outline how J.J. Thomson used this apparatus to determine the charge/mass ratio of the electron. 8

Question 24 (5 marks)

Marks

An electron travelling at 1.5×10^6 ms^{-1} is fired into a uniform magnetic field of strength 25T at an angle of 90° as shown below.



(a) Draw the path of the electron within the magnetic field on the diagram above.. 1

(b) Calculate the size of the magnetic force experienced by the electron. 2

(c) With reference to the diagram describe the orientation of the electric field that would be required to alter the path of the electron so that it moved in a straight line. 2

Question 25 – Quanta to Quarks (25 marks)

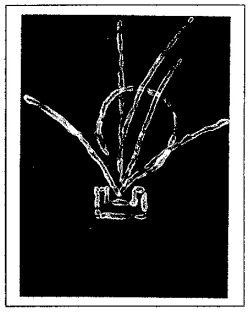
Marks

(a) (i) Identify two observations concerning the emission spectra of hydrogen that cannot be explained using the Rutherford-Bohr model of the atom. 2

(ii) How did de Broglie explain the stability of the electron orbits in Bohr's model? 2

(iii) Calculate the wavelength of an electron moving at 2.2×10^6 ms^{-1}. 1

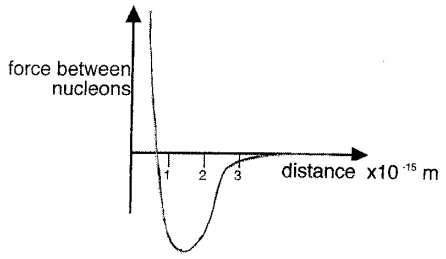
(b) This image shows a negatively charged particle entering a cloud chamber from the bottom of the photograph and colliding with another stationary particle. A strong uniform magnetic field is directed into the page.



(i) What evidence suggests that both positive and negative particles formed as a result of this collision? 2

(ii) What evidence suggests that an unstable neutral particle also formed? 2

(c) This graph shows the relationship between the strength of the strong nuclear force and the separation distance between nucleons.



(i) Calculate the magnitude of the gravitational force between two neutrons at a distance of 1.4×10^{-15} m. 2

(ii) Describe the effect of the strong nuclear force at a distance of 1.4×10^{-15} m. 2

(iii) Account for the need for the strong nuclear force between nucleons within the nucleus. 2

(d) One possible fission reaction between a single neutron and a Uranium-235 nuclide produces a Lanthanum-148 and a Bromine-85 nuclide.

(i) How many neutrons are released in this reaction? 1

(ii) Use the masses given to calculate the mass defect of the reaction. 2

U-235	235.044 u
La-148	147.915 u
Br-85	84.911 u

(iii) How much energy is released in this reaction? 2

(iv) How do fission reactors control these types of reactions? 2

(e) Describe the engineering applications of one named isotope. 3

THE PERIODIC TABLE

KEY: 79 Au 197.0 — Atomic Number, Symbol of element, Atomic Weight, Name of element

H 1.008 Hydrogen																	He 4.003 Helium
Li 6.941 Lithium	Be 9.012 Beryllium											B 10.81 Boron	C 12.01 Carbon	N 14.01 Nitrogen	O 16.00 Oxygen	F 19.00 Fluorine	Ne 20.18 Neon
Na 22.99 Sodium	Mg 24.31 Magnesium											Al 26.98 Aluminium	Si 28.09 Silicon	P 30.97 Phosphorus	S 32.07 Sulfur	Cl 35.45 Chlorine	Ar 39.95 Argon
K 39.10 Potassium	Ca 40.08 Calcium	Sc 44.96 Scandium	Ti 47.87 Titanium	V 50.94 Vanadium	Cr 52.00 Chromium	Mn 54.94 Manganese	Fe 55.85 Iron	Co 58.93 Cobalt	Ni 58.69 Nickel	Cu 63.55 Copper	Zn 65.39 Zinc	Ga 69.72 Gallium	Ge 72.61 Germanium	As 74.92 Arsenic	Se 78.96 Selenium	Br 79.90 Bromine	Kr 83.80 Krypton
Rb 85.47 Rubidium	Sr 87.62 Strontium	Y 88.91 Yttrium	Zr 91.22 Zirconium	Nb 92.91 Niobium	Mo 95.94 Molybdenum	Tc [98.91] Technetium	Ru 101.1 Ruthenium	Rh 102.9 Rhodium	Pd 106.4 Palladium	Ag 107.9 Silver	Cd 112.4 Cadmium	In 114.8 Indium	Sn 118.7 Tin	Sb 121.8 Antimony	Te 127.6 Tellurium	I 126.9 Iodine	Xe 131.3 Xenon
Cs 132.9 Caesium	Ba 137.3 Barium	57–71 Lanthanides	Hf 178.5 Hafnium	Ta 180.9 Tantalum	W 183.8 Tungsten	Re 186.2 Rhenium	Os 190.2 Osmium	Ir 192.2 Iridium	Pt 195.1 Platinum	Au 197.0 Gold	Hg 200.6 Mercury	Tl 204.4 Thallium	Pb 207.2 Lead	Bi 209.0 Bismuth	Po [210.0] Polonium	At [210.0] Astatine	Rn [222.0] Radon
Fr [223.0] Francium	Ra [226.0] Radium	89–103 Actinides	Rf [261.1] Rutherfordium	Db [262.1] Dubnium	Sg [263.1] Seaborgium	Bh [264.1] Bohrium	Hs [265.1] Hassium	Mt [268] Meitnerium	110 Unun Ununnilium	111 Unun Unununium	112 Uub Ununbium	113	114 Uuq Ununquadium	115 Uup Ununpentium	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
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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 [243.1] 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
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