Sydney Girls High School

2002
Trial Higher School Certificate
Examination

Physics

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

| Section I | Pages 2 – 19 |

Total marks (75)

This section has two parts, Part A and Part B

Part A
Total marks (15) Pages 2 - 6
- Attempt questions 1 – 15
- Allow about 30 minutes for this part

Part B
Total marks (60) Pages 8 - 19
- Attempt questions 16 –27
- Allow about 1 hour and 45 minutes for this part.

| Section II |

Total marks (25) Pages 20 - 21

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

1. A current is induced in a coil by moving a magnet into and out of it. Which of the following would NOT increase the size of the current induced?

    (A) Move the magnet more quickly.

    (B) Increase the strength of the magnet.

    (C) Stretch the coil out so it is longer.

    (D) Replace the coil with one made from wire with a lower resistance.

2. A satellite is moving at a constant speed along a circular path as shown in the diagram.
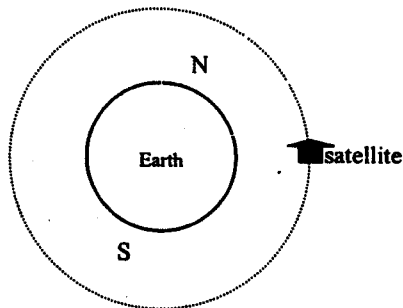
    Which statement best describes the motion of the satellite at th instant shown in the diagram above?

    (A) Velocity is constant and the acceleration is towards the Earth.

    (B) Speed is constant and the acceleration is zero.

    (C) Velocity is towards the Earth and the acceleration is to the North.

    (D) Speed is constant and the acceleration is towards the Earth.

3. A semiconductor is doped with a small amount of boron. This means that

    (A) It is negatively charged, and so will conduct electricity more easily.

    (B) It is positively charged, and so will conduct electricity more easily.

    (C) It is neutral, but has more electrons available for conduction.

    (D) It is neutral, but has more holes available for conduction.

4. A person weighs 650 N on Earth. Calculate the person's weight on Jupiter, given that the acceleration due to gravity on Jupiter is 23.1 ms^{-2}.

(A) 66.3 N

(B) 276 N

(C) 650 N

(D) 1532 N

5. A circular coil of wire has a diameter of 30 cm and contains 20 loops. There is a 1 A current running through the wire, which is placed in a 2 T magnetic field. What is the maximum force that the coil can experience?

(A) 0.0 N

(B) 11.3 N

(C) 18.8 N

(D) 75.4 N

6. An experiment is carried out to investigate the relationship between drift velocity and electron density. Two wires of identical dimensions are provided with the same current. Wire A is made of a material which has an electron density half that of wire B. If the drift velocity of wire A is v ms^{-1} what is the drift velocity of wire B?

(A) 0.5v

(B) v

(C) 2v

(D) 4v

7. Hertz carried out a series of experiments with radio waves. Which of the following conclusions did he reach?

(A) Radio waves have momentum and energy.

(B) Radio waves can be focussed by magnetic fields.

(C) Radio waves would be useful for communications.

(D) Radio waves have a velocity of 3 × 10^8 ms^{-1}.

8. Using the apparatus shown below, scientists were able to:
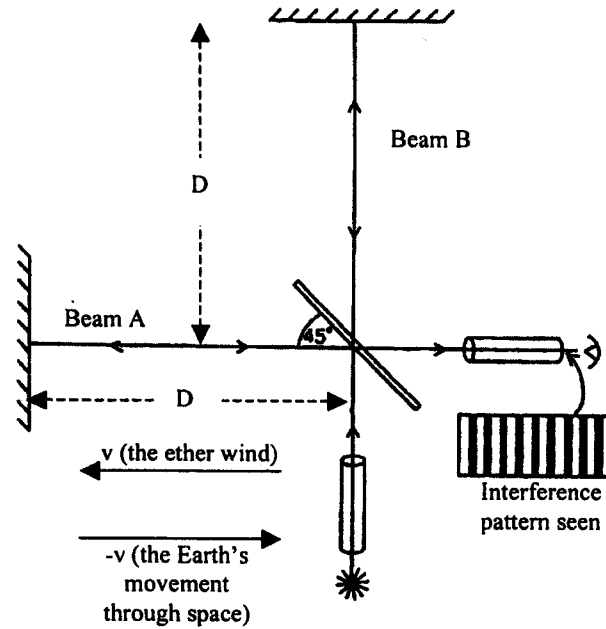
(A) Determine the speed of light on Earth.

(B) Show that the speed of light never exceeds $3.0 \times 10^8 \, ms^{-1}$.

(C) Determine the wavelength of light in the ether.

(D) Show that the speed of light is independent of the frame of reference.

9. After a few years a satellite in a Low Earth Orbit (LEO) will fall back to Earth, because:

(A) It will run out of fuel.

(B) The Earth's gravity pulls it in.

(C) The atmosphere slows it down.

(D) Its kinetic energy exceeds its gravitational energy.

10. At what speed relative to a stationary observer would a moving clock run at one third the rate that is observed by a person moving with the clock?

(A) $2.00 \times 10^8 \, ms^{-1}$

(B) $2.83 \times 10^8 \, ms^{-1}$

(C) $3.00 \times 10^8 \, ms^{-1}$

(D) $8.49 \times 10^8 \, ms^{-1}$

11. A spot is to be placed in the top left hand corner of the screen of an oscilloscope. Determine the appropriate polarities of the deflection plates from W to Z.
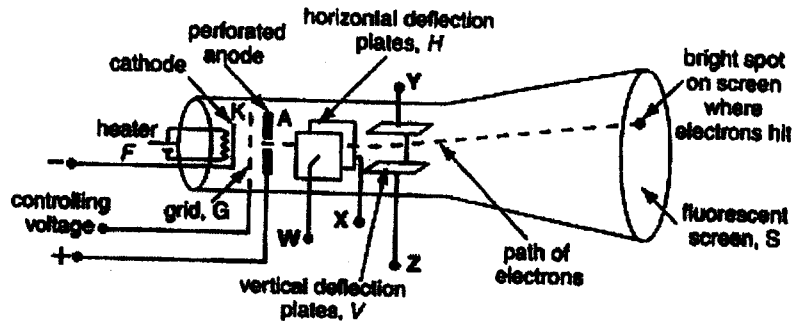
	W	X	Y	Z
(A)	+	–	+	–
(B)	+	–	–	+
(C)	–	+	+	–
(D)	–	+	–	+

12. A CD player requires a 6V power source. If the mains power (240V) is to be used, what is the turns ratio that would be required in the adaptor transformer?

(A) 1:40

(B) 1:4

(C) 4:1

(D) 40:1 .

13. The Braggs showed that diffraction of which type of beam could be used to study crystal structure?

(A) X-rays.

(B) Electrons.

(C) Neutrons.

(D) Light.

14. The north pole of a magnet is brought near a superconductor until it floats just above the superconductor.

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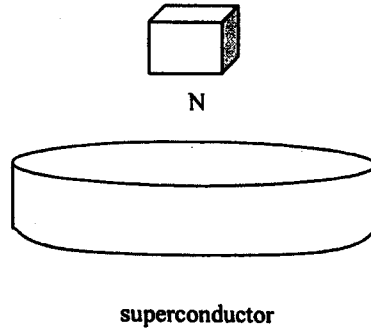
superconductor

What would be the direction of the eddy currents in the superconductor which causes the magnet to float.

(A) Clockwise.

(B) Anticlockwise.

(C) Vertical loops, downwards at the front.

(D) Vertical loops, upwards at the front.

15. An aircraft flies over Alaska, where, since it is near the Geographical North Pole, the Earth's magnetic field has a considerable vertical component. Determine which part of the aircraft would have the most electrons using the diagram below.
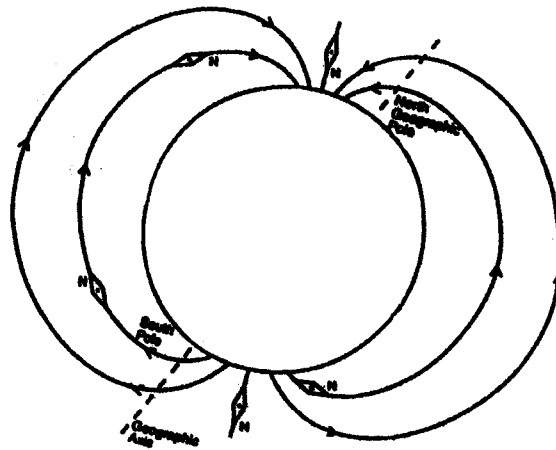
(A) The front.

(B) The back.

(C) The left wing.

(D) The right wing.

Section I (continued)

Part B – 60 marks
Attempt Questions 16 – 27
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.

Marks

Question 16 (3 marks)

(a) Explain the operation of an induction stove.   2

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(b) An induction stove has accidentally been left on. Is it safe to   1
touch the cooking surface? Justify your answer.

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Question 17 (7 marks)

(a) Describe typical results from an experiment investigating the photoelectric effect.

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(b) Define the term "work function of a metal".

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(c) Sodium has a work function of 2.28 eV. It is exposed to violet light, which has a wavelength of 450 nm and on another occasion to red light of wavelength 680 nm. Determine which of the two wavelengths will cause the photoelectric effect in sodium.

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Question 17 (continued)

(d) Describe Einstein's explanation of the photoelectric effect.

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Question 18 (6 marks)

Transformers are used in many electrical items. Explain the operation of transformers and evaluate their importance in society.

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Question 19 (7 marks)

A projectile is launched horizontally from the edge of a 68m high cliff at a speed of 30 ms^{-1}.

(a) Calculate

(i) The distance from the base of the cliff the projectile strikes the ground.

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(ii) The projectile's velocity just before it hits the ground.

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(b) Newton used a thought experiment to show that it was theoretically possible 3
to put an object into orbit around the earth. Describe this thought experiment
and include appropriate diagrams.

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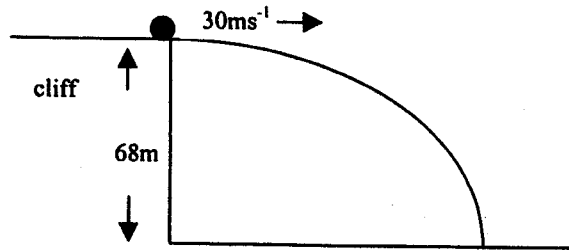
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Question 20 (5 marks)

Since the discovery of superconductivity many people have proposed innovative uses for these substances.

(a) Compare the behaviour of electrons in normal conductors and superconductors.

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(b) Identify ONE of the inherent limitations of the use of superconductors and relate it to a possible application.

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Question 21 (5 marks)

When the same current flows through the two 1 m wires shown in the diagram, an extra 0.8 grams needs to be added to the right hand balance pan to restore a balance.
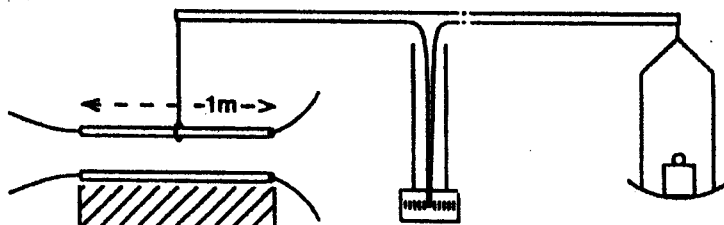
If the two wires are kept 0.4 cm apart determine:

(a) The size of the force between the wires.   2

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(b) The magnitude and direction of the current travelling through   2
each wire.

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(c) On the diagram above, draw the direction of the magnetic field around   1
each wire.

Question 22 (3 marks)

Propose how you would test a reference frame to find out whether or not it is an inertial frame.

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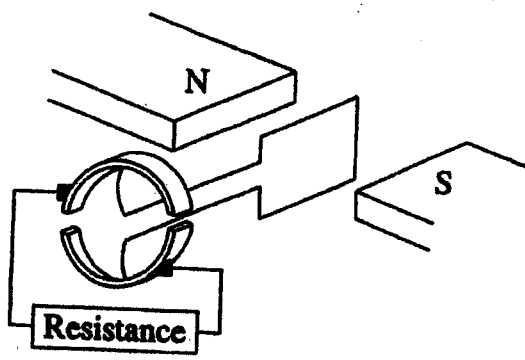
Question 23 (6 marks)

One type of generator is shown below.

(a)   Identify the type of generator shown.

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Question 23 (continued)

(b) If the coil rotates clockwise, deduce the direction of the current
in the wire closest to the south pole.

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(c) Identify the angle (relative to the magnetic field lines) of the
plane of the coil, when it produces a:

(i) Maximum emf.

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(ii) Minimum emf.

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(d) Identify one method to make the coil continuously generate electricity
without using fossil fuels. Discuss the importance of reducing the use
of fossil fuels.

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Question 24 (5 marks)

(a) Account for the differences in conductivity (at room temperature) of   3
insulators, semiconductors and conductors with reference to the
available energy levels for electrons.

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(b) Identify ONE use for semiconductors and discuss why they are preferred   2
to thermionic devices.

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Question 25 (7marks)

A manned two-stage rocket is launched vertically into space. Eighty percent of the initial mass of the rocket is propellant. During the launch, propellant is consumed at a constant rate and ejected at a constant nozzle velocity for both the 1st and 2nd stages of the rocket.

After 80 seconds during the launch the 1st stage has used up all its fuel and disengages from the 2nd stage. Ten seconds later the 2nd stage ignites and burns for 60 seconds.

(a) Sketch a graph that shows how the velocity varies during the time of launch.

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(b) Clarify why multistage rockets are generally used for launch.

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Question 25 (continued)

(c) If the rocket had a mass of 2.8 x 10⁶ kg and the 1ˢᵗ stage engines had a thrust of 36 x 10⁶ N, calculate:

(i) The initial acceleration.

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(ii) The 'g' force on each astronaut at lift off.

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Question 26 (3 marks)

In your course you have investigated the properties of cathode rays using various apparatus. Describe ONE experiment that you carried out and explain the results in terms of a named property of cathode rays.

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Question 27 (3 marks)

Explain the effect that sunspots have on satellite communication. 3

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Section II

25 marks
Allow about 45 minutes for this section

Answer the question in the writing booklet. Extra writing booklets are available.

Show all relevant working in questions involving calculations.

From Quanta to Quarks (25 marks)

Marks

(a)   Outline the experiment Rutherford carried out which led him to develop   **2**
a new model for the atom.

(b)   (i)   Using Bohr's model of the Hydrogen atom account for the   **3**
Balmer series of spectral lines.

       (ii)   Calculate the energy of the photon emitted when an electron jumps   **2**
from the $n=4$ to the $n=2$ orbital.

       (iii)   Discuss 2 limitations of the Bohr model.   **2**

(c)   (i)   State how de Broglie's proposal was used to explain the stability   **3**
of certain electron orbits in the Bohr atom.

       (ii)   Discuss how Davisson and Germer provided evidence to support   **3**
de Broglie's proposal.

(d)   Electron microscopes have a greater resolving power than light microscopes.

       (i)   Describe how a Transmission Electron Microscope   **2**
works.

       (ii)   Account for the greater resolution of a Scanning Electron Microscope
compared to a light microscope.   **2**

(continued over page)

(e)   In a typical fission reaction, a neutron collides with a Uranium-235 nucleus as shown in the equation below.

$$_{0}^{1}n + _{92}^{235}U \rightarrow _{56}^{141}Ba + Z + 3_{0}^{1}n$$
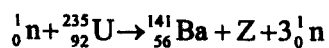
(i)   Deduce the missing daughter nuclide (Z).   1

(ii) If the kinetic energy of the colliding neutron is ignored, calculate   3
      the kinetic energy (in Joules) carried away by the fission products.

Mass of U-235 nucleus   = 235.0439 u
Mass of Ba-141 nucleus   = 140.9139 u
Mass of Z nucleus   = 91.8973   u
Mass of neutron   = 1.0087   u

(f)   In recent years, the number of radioisotopes produced has increased   2
      dramatically. Name ONE radioisotope used in medicine and describe its
      application.

END OF PAPER