SYDNEY BOYS HIGH SCHOOL

HSC TRIAL EXAMINATION 2003

PHYSICS

General Instructions

Reading time 5 minutes
Working time 3 hours
Write using blue or black pen.

Draw diagrams using pencil.

Board-approved calculators may used.

A data sheet, formulae sheets and Periodic Table are provided at the back of this paper.
Show all working.

Total Marks

Section 1 pages 2 - 18
Total marks 75
This section has two sections, 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 -28.
* Allow about 1 hour and 45 minutes for this part.

Section II pages 19-25
Total marks 25

* Attempt ONE question from Questions 23-39

* Allow about 45 minutes for this section.

1. The table gives information about the planets Earth and Uranus.

Planet	*Mass* (10^{24}kg)	*Radius* (km)
Earth	6.0	6.4×10^{3}
Uranus	86	2.4×10^{4}

An astronaut has a weight of 700N at the earth's surface.
Using the information in the table, what is the astronaut's weight on the surfaced of Uranus?

(A) 710 N
(B) 813 N
(C) 786 N
(D) 980 N

2. A body's gravitational potential energy changes with its distance from a planet.
Which graph best describes the gravitational potential energy (*E*) of a body as a measure of its distance (*d*) from the planet's surface?

3. In order to escape from the Sun's gravitational field, interstellar spacecraft need an escape speed over 600kms^{--1}. Pioneer 10 launched in 1972, has a launch speed of only 15kms^{-1}. What was the main reason Pioneer 10 was able to escape the Sun's gravitational field.
(A) The space craft used a solid fuel during lift off and thus by reducing its total mass was accelerated to the required value.

(B) The rocket engines were fired once in a stable parking orbit and thus extra thrust was sufficient to accelerate the space craft to the required value.

(C) The spacecraft used a solid fuel rocket engine designed to burn at a constant rate during launch and thus was accelerated to the required value.

(D) The spacecraft utilised the principles of conservation of momentum and energy to accelerate them through the gravitational fields of planets it encountered along the way.

4. A cricket ball is hit upwards at 125 ms^{--1} and 50E to the horizontal. What is its speed 3 seconds later?
(A) 66 ms^{--1}

(B) 104 ms^{--1}

(C) 80 ms^{--1}

(D) 125 ms^{--1}

5. For a satellite in a low Earth orbit, the altitude above the Earth is small in comparison with Earth's radius.
Compared to a geostationary satellite a low Earth satellite will have a period of orbit which is:

(A) the same

(B) shorter

(C) longer

(D) twice as slow.

6. Which statement is true for a step-down transformer?

(A) It has more turns in the primary than in the secondary.

(B) It reduces current and voltage.

(C) It has less turns in the primary than tin the secondary.

(D) It has a non-laminated iron core.

7. Energy is lost in transmission lines. How can this loss be reduced?

(A) Use thinner wires in the transmission line.

(B) Increase the current in the transmission line.

(C) Insulate the wires with a plastic coating.

(D) Use thicker wires in transmission lines.

8. An ideal transformer has the following characteristics.

Coils in primary	100
Coils in secondary	20
Voltage produced in secondary	2 V

What is the voltage applied to the primary?

(A) 10 v

(B) 0.4 v

(C) 2.5 v

(D) 0.1 v

9. A coil in an electrical meter turns clockwise when a circuit is switched on. How can you make it turn anticlockwise when the circuit is switched on?

(A) Turn the coil through 180E.

(B) Increase the current.

(C) Decrease the current.

(D) Reverse current direction.

10. A wire of length 10 cm is at 90E to a magnetic field B of strength 10^{--2} T. A current of 4A flows in the wire.
What is the force on the wire caused by the field?

(A) $4 \times 10^{--1}$ N, parallel to B

(B) $4 \times 10^{--1}$ N, perpendicular to B

(C) $5 \times 10^{--3}$ N, perpendicular to B

(D) $4 \times 10^{--3}$ N, parallel to B

11. Two flat parallel metal plates are connected to a voltage source. The plates are charged so that a potential difference exists between them as shown in the diagram.

What is the magnitude and direction of the electric field?

(A) 3×10^4 V m^{-1} down the page

(B) 3×10^4 V m^{-1} up the page

(C) 2×10^4 V m^{-1} up the page

(D) 2×10^4 V m^{-1} down the page

12. A beam of cathode rays passes through an evacuated glass discharge tube and makes a glow at a disposition (B) as shown in the diagram.

A magnetic field is added so it acts into the page and is indicated by crosses (X).
Where will the glowing spot on the fluorescent coating be observed now?

(A) Below the straight-through position.

(B) At the straight-through position.

(C) Slightly above the straight-through position.

(D) Well above the straight-through position.

13. A beam of monochromic light is shone onto a piece of semiconductor material in order to study the photoelectric effect. The flow of current is measured using an ammeter (A) as shown in the diagram below:

If a current is already flowing, which change will result in an increase in the flow of current in the ammeter?

(A) Increasing the frequency of the light source.

(B) Decreasing the intensity of the monochromatic light.

(C) Increasing the intensity of the monochromatic light.

(D) Decreasing the frequency of the light source.

14. Diagrams (1) and (2) below show two possible arrangements of atoms in a substance with a silicon lattice structure. Diagrams (3) and (4) show two possible band structures for the energy relationships between the atoms of the same substance.

Which pair of diagrams correctly represents P-type semiconductors?

(A) 2 and 3

(B) 1 and 4

(C) 1 and 3

(D) 2 and 4

15. Problems with thermionic valves have led to them being replaced by semiconductor devices such as transistors in the communications and information technology industries.
What developments have led to this change?

(A) The development of television tubes based on cathode ray discharge tubes.

(B) The discovery of the elements silicon and germanium.

(C) Increased knowledge of the properties of materials.

(D) Transistors do not use as much electrical energy as valves.

Number: …… **Teacher: ……..**

Part B

Total marks: 60
Attempt Questions 16-28
Allow about 1 hour and 45 minutes for this part.

Answer Part B questions in the spaces provided.
Show all relevant working in questions that require calculations.

Question 16 (4 marks) **Marks**

(A) An astronaut repairing a satellite in orbit lets go of his spanner. Describe the spanner's subsequent motion after leaving the astronaut's hand. **1**

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(B) The spanner has a rest length 30 cm and a rest mass of 5 kg. If the speed of the spanner was later determined to be 0.4*c*, determine the length and mass observed by a stationary observer on nearby Earth. **3**

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Number: …… **Teacher: ……..**

Question 17 (5 marks) **Marks**

(A) Scientists utilise the motion of the Earth and the location of the launch site to assist in attaining the required velocity for a stable orbit. Explain the best direction and most suitable location to launch a rocket. **2**

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(B) Special precautions must be taken with spacecraft returning to the Earth's atmosphere. Discuss what precautions must be taken to ensure that a manned spacecraft safely returns to Earth. **3**

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Question 18 (2 marks)

A 2000 kg satellite orbits a planet in a circle of radius 5.94×10^6 m. The gravitational force of attraction between this satellite and the planet is 1.57×10^6 N. Determine the mass of the planet. **2**

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Number: ……. **Teacher: ……..**

Question 19 (8 marks) **Marks**

During your course of study you performed a first-hand investigation to enable you to determine a value for acceleration due to gravity. **8**

Justify the appropriateness of your experimental procedure for this investigation, clearly stating what data you needed to collect and how you collected the data. Discuss the accuracy of your results and how the accuracy and reliability may be improved.

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Number: ……. **Teacher: ……..**

Question 20 (7 marks) **Marks**

This diagram shows a wire carrying an electric current. The wire is in a magnetic field and is perpendicular to the field.

A force, caused by the field, acts on the wire.

(A) We need to change the magnitude of the force acting on the wire. One way to do this is to change the length of wire in the field. Identify two other ways of changing the magnitude of the force on the wire. **2**

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(B) Justify your answers (A). **2**

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(C) A student attempted to measure the magnitude of the magnetic field produced by the magnets above. He supported the wire on a piece of cardboard sitting on a sensitive balance and measured the length of wire in the field. What other measurements will he need to make in order to find the field strength? **2**

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(D) When measuring the length in part (C), the student will need to make an assumption about the magnetic field. State the assumption. **1**

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Number: ……. **Teacher: ……..**

Question 21 (5 marks) **Marks**

(A) Michael Faraday carried out several experiments during his discovery of the generation of electric current by moving magnets. These experiments all involved a coil of wire. **2**

Using the concept of magnetic flux, explain why Faraday was able to generate electricity.

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(B) A physics class was trying a variation on Faraday's experiment by moving a wire in the Earth's magnetic field. They went outside the school building, connected both ends of a wire to a sensitive galvanometer and moved the wire up and down. No reading was seen on their meter. They thought the current must have been too small to measure. **1**

Suggest one way the students could increase the potential difference in the wire.

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(C) Justify why the method you have suggested should increase the potential difference. **2**

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Number: …… **Teacher: ……..**

Question 22 (4 marks) **Marks**

The arrangement below can be used to construct a DC motor or a DC generator.

(A) Describe how the equipment above could be used to make a DC generator. **2**

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(B) Contrast the operation of a DC generator with a DC motor. **1**

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(C) How could you convert a DC generator to an AC generator? **1**

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Number: …… **Teacher: ……..**

Question 23 (5 marks) **Marks**

Eddy currents are produced in many electrical devices. They are useful in some situations and cause problems in others. **5**

Outline the production of eddy currents and their uses and problems.

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Number: ……. **Teacher: ……..**

Question 24 (3 marks) **Marks**

Examine the diagrams below:

(A) Name the two devices in the diagrams above. **1**

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(B) Explain the reasons why solid-state devices have replaced thermionic devices in most of our modern electronic equipment. **2**

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Number: ……. **Teacher: ……..**

Question 25 (5 marks)
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Examine the diagram below of J. J. Thompson's famous 1897 experiment that led to a new understanding of cathode rays.

(A) Name the two force fields used by J.J. Thompson in the experiment and outline how he used these to determine the charge to mass ratio (q / m) of cathode rays. **2**

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(B) What was the nature of the debate that existed in the late 1800's over the behaviour of cathode rays and how did J.J. Thompson's experiment contribute to this debate? **3**

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Number: ……. **Teacher: ……..**

Question 26 (4 marks) **Marks**

Draw a labelled diagram of the apparatus Hertz used to demonstrate radio transmission. **4**

On your diagram:

1. Label a change that Hertz observed when ultraviolet light was shone onto the receiver.

2. Draw and explain a change that led Hertz to conclude that he was dealing with wave-based radiation and not particle-based radiation.

Number: …… **Teacher: ……..**

Question 27 (4 marks) **Marks**

A spectral lamp in a chemical analysis machine emits a red light of wavelength 600 nm that falls onto a copper metal conductor.

(A) Calculate the frequency and the energy of each quantum of red light. **3**

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(B) If the work function of copper is 3.0×10^{-19}J, state whether photoelectrons will be emitted from the copper metal conductor and give a reason for your answer. **2**

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Question 28 (4 marks)

(A) Identify one possible use of superconductors in the power generation industry. **1**

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(B) Discuss the limitations of currently available superconductors and why these limitations prevent their widespread use in the power generation industry. **3**

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Section 11

Total 25 Marks

Attempt ONE question from Questions 29-33.
Allow about 45 minutes for this section.
Answer the question in a writing booklet. Extra writing booklets are available.

Number: ……. **Teacher: ……..**

Question 32 -- From Quanta to Quarks (25 marks) **Marks**

(A) Explain how Neils Bohr was able to adapt the concept of the quantization of energy to improve upon the Rutherford model of the atom. **2**

(B) Consider the following nuclear reaction.

$$\frac{1}{1}H + \frac{7}{3}Li \rightarrow \frac{4}{2}He + \frac{4}{2}He$$

The masses are as follows:

$$\frac{1}{1}H = 1.0078\mu$$
$$\frac{7}{3}Li = 7.0160\mu$$
$$\frac{4}{2}He = 4.0026\mu$$

(i) State whether energy is absorbed or released during this reaction. **1**

(ii) Determine the mass defect and the energy in joules associated with reaction.(show all working). **3**

(C) (i) Explain how Niels Bohr's postulates were utilised to explain the line emission spectra of hydrogen. **2**

(ii) Calculate the wavelength of the red line in the Balmer series. (show all working) **2**

(D) Compare the electron reflection experiment of Davisson and Germer's with the X diffraction experiment conducted by Henry and Lawrence Bragg. **2**

(E) Calculate the de Broglie wavelength of proton moving at 2×10^4 ms^{--1}.

(G) Evaluate the contributions of Heisenberg and Pauli to the development of atomic theory. **8**

(F) Justify the existence of the strong nuclear force and describe its properties. **3**