Centre Number

Student Number

CATHOLIC SECONDARY SCHOOLS
ASSOCIATION OF NEW SOUTH WALES

2005
TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

Physics

Afternoon Session
Thursday 11 August 2005

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using blue or black pen
- Draw diagrams using pencil
- Board-approved calculators may be used
- Use Multiple Choice Answer Sheet provided
- A Data Sheet, Periodic Table and Formulae Sheets are provided separately
- Write your Centre Number and Student Number at the top of this page and page 9

Total marks – 100

Section I Pages 2–20

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 16–27
- Allow about 1 hour and 45 minutes for this part

Section II Pages 21–32

25 marks
- Attempt ONE question from Questions 28–32
- Allow about 45 minutes for this section

Section I
75 marks

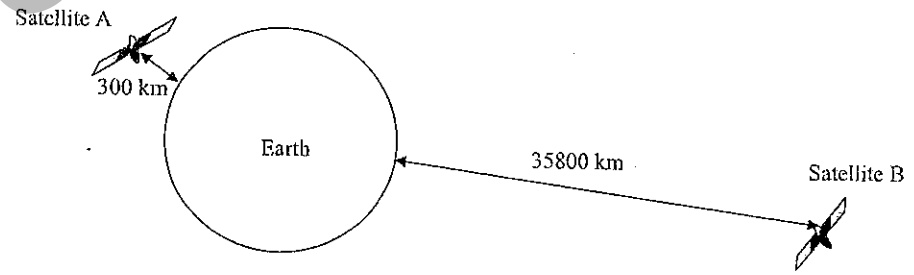
Part A – 15 marks
Attempt Questions 1-15
Allow about 30 minutes for this part

Use the Multiple Choice Answer Sheet provided

1 The force on an object due to a gravitational field is known as its

(A) mass
(B) gravitational potential energy
(C) weight
(D) acceleration

2 The diagram below shows two satellites of the same mass and the altitude at which they are orbiting above the Earth. The diagram is not drawn to scale.



Choose the most correct statement from the following.

(A) Satellite B completes one orbit of the Earth in less time than Satellite A
(B) Satellite A experiences a greater centripetal force than Satellite B
(C) Satellite B moves at a faster speed than Satellite A
(D) Satellite A is likely to remain at a fixed position in the sky

3 Astronauts are more easily able to cope with an application of g-forces which results in the eyeballs undergoing relative motion towards the body rather than away from it. Which of the following combination of astronaut positions are most desirable to achieve this effect?

(A) Astronaut facing in the direction of motion during launch and re-entry

(B) Astronaut facing opposite to the direction of motion during launch and re-entry

(C) Astronaut facing in the direction of motion during launch and facing opposite to the direction of motion during re-entry

(D) Astronaut facing opposite to the direction of motion during launch and facing in the direction of motion during re-entry

4 The unit of length known as the standard metre

(A) is currently defined as a certain number of wavelengths of light emitted from an excited Krypton atom

(B) must be defined independently of time

(C) is currently defined as a fraction of the Earth's quadrant passing through Paris

(D) is currently defined as the length of the path travelled by light in vacuum during a time interval of 1/299 792 458 of a second

5 Calculate the energy equivalent of one atom of Plutonium that has a rest mass of 244 amu.

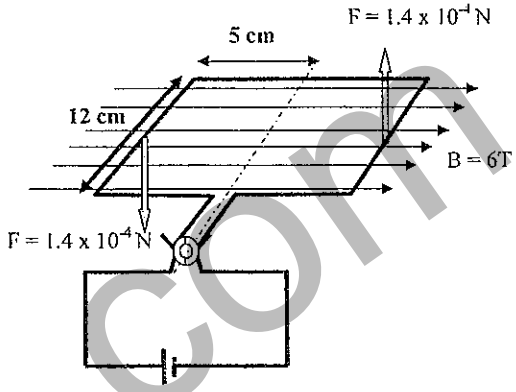
(A) 2.196×10^{19} Joules

(B) 1.22×10^{-16} Joules

(C) 4.053×10^{-25} Joules

(D) 3.65×10^{-8} Joules

6 One turn of wire with dimensions shown is in a uniform magnetic field of strength 6 T. A current travels through the wire, producing a force $F = 1.4 \times 10^{-4}$ N on each side of the turn of wire as shown.



Determine the total torque on the turn of wire.

(A) 1.4×10^{-5} N.m

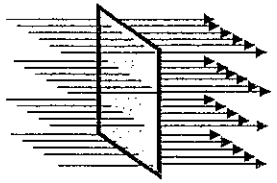
(B) 7.0×10^{-6} N.m

(C) 7.2×10^{-2} N.m

(D) 1.008×10^{-5} N.m

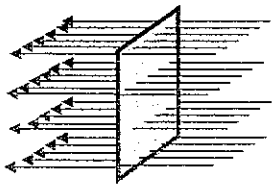
7 The following diagrams are all drawn to the same scale and show separate loops of wire that have a magnetic field cutting through them so that the field lines run perpendicular to the surface of the loop. Choose the diagram with the strongest magnetic field.

(A)

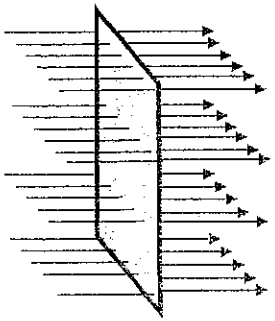


(B)

(C)



(D)



8 An induction cooker produces a rapidly changing magnetic field that

(A) produces eddy currents in the ceramic cooktop to warm food
(B) produces eddy currents in a saucepan to warm food
(C) produces eddy currents in the food to warm without any loss of energy
(D) ignites gas to heat the ceramic cooktop and saucepan above it

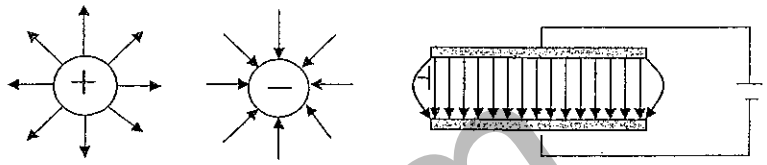
9 A student is designing a power station that is to be located 20 km from a town and will generate power at 100 kW. If the power is transmitted at 240 V and the transmission lines have a total resistance of 0.3 Ohms, calculate the power loss in the transmission lines.

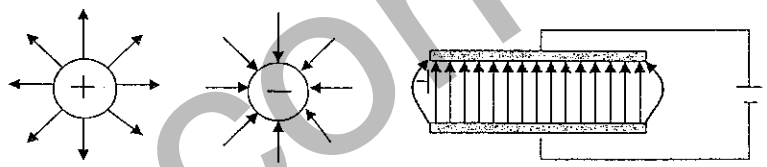
(A) 192 kW
(B) 416.7 W
(C) 52.1 kW
(D) 100 kW

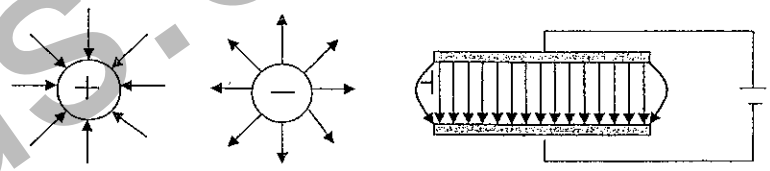
10 Which of the following is NOT a method used to overcome heating difficulties in transformers?

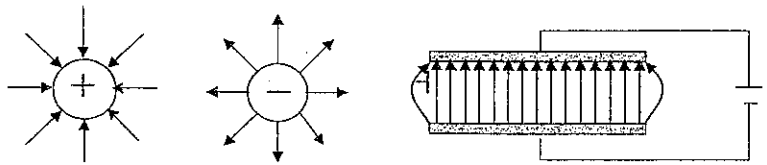
(A) The use of ferrites in the core, because they are not good conductors of electricity
(B) Increasing the primary voltage in the transformer
(C) Oil cooling of large transformers
(D) The use of a laminated iron core

11 Which of the following shows three correct diagrams representing electric field lines?

(A) 

(B) 

(C) 

(D) 

12 In the cathode ray tube of a conventional TV display or oscilloscope, which components focus the beam, control brightness and accelerate electrons along the tube?

(A) Heating filament
(B) Electrodes in the electron gun
(C) Deflection plates or coils
(D) Flourescent screen

13 Heinrich Hertz was able to measure the speed of radio waves of known frequency by

(A) measuring the wavelength using interference effects
(B) passing the radio waves through a half-silvered mirror
(C) timing the transmission of radio waves across his family estate
(D) studying cathode rays in a vacuum tube

14 When subjected to an electric field, the electrons in the valence band of a conductor

(A) require an additional energy input to move to the conduction band
(B) require no additional energy and move freely in the direction of the electric field
(C) are free to maintain a random, cloud-like motion in all directions
(D) are derandomised and move freely in the direction opposite to the electric field

15 Electrical resistance in a metal conductor may be affected by the following factors:

(i) An increase in cross-sectional area
(ii) A decrease in cross-sectional area
(iii) Vibrations in the lattice
(iv) An increase in length
(v) A decrease in length
(vi) An increase in temperature
(vii) A decrease in temperature
(viii) The presence of impurities

Which of the following combinations of the above factors all **decrease** resistance?

(A) (i), (iii), (iv) and (vii)
(B) (ii), (v) and (vii)
(C) (i), (v) and (vii)
(D) (ii), (v), (vi) and (viii)

Centre Number

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Physics
Section I (continued)

Part B – 60 marks
Attempt Questions 16-27
Allow about 1 hour and 45 minutes for this part

Show all relevant working in questions involving calculations.

Question 16 (4 marks) **Marks**

During the course of your studies this year in Physics, you undertook an experiment to determine the acceleration due to gravity on Earth.

(a) When gathering data, it is good practice to take a second set of results. Why is repetition a useful skill when conducting first hand investigations? 1

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(b) Jonathon undertook an experiment where a pendulum was used to determine acceleration due to gravity. He achieved a result of 9.7 m/s^2. Beth had the same aim, but decided to measure gravity using a data logger with light gates. Her value was 9.75 m/s^2. 3

Identify possible reasons for variations in the results obtained.

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Question 17 (5 marks) **Marks**

(a) Explain how the mass and radius of a planet affects the escape velocity of a rocket that is to be launched from its surface. **2**

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(b) Isaac Newton hypothesised about the motion of a projectile launched horizontally from a mountain top. Outline Newton's ideas that led to the concept of escape velocity. **3**

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Question 18 (5 marks) **Marks**

(a) For a satellite undergoing circular motion around a planet, the centripetal force is provided by the gravitational force. Equate centripetal force and Newton's law of universal gravitation to verify that orbital velocity, **3**

$$V = \sqrt{\frac{Gm_{planet}}{r_{orbit}}}$$

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(b) Use the expression from part (a) of this question to calculate the orbital velocity for a satellite moving around the Earth in a circular orbit at an altitude of 300 km. **2**
(Use radius of Earth = 6378 km)

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Question 19 (6 marks) **Marks**

(a) Explain what is meant by the 'equivalence between mass and energy'. **2**

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(b) Most celestial objects outside our Solar System are too distant to reach at current maximum speeds. Discuss the prospect of near light-speed space travel to such destinations with reference to relativistic changes in mass, time and length. **4**

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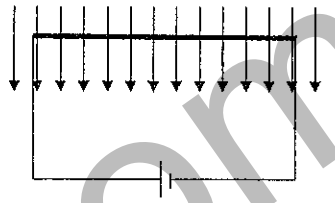
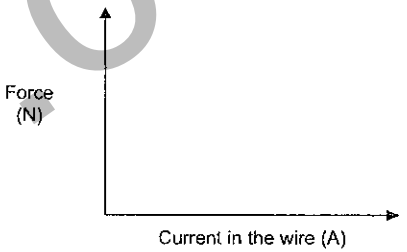
Question 20 (4 marks) **Marks**

A current-carrying conductor is placed in, and perpendicular to, a uniform magnetic field which is represented by the arrows in the following diagram:



(a) On the axes below sketch a graph that shows how the magnitude of force on the wire would vary if the current in the wire was increased. **1**



(b) Describe how a varying current is used to produce sound in a loudspeaker. **3**

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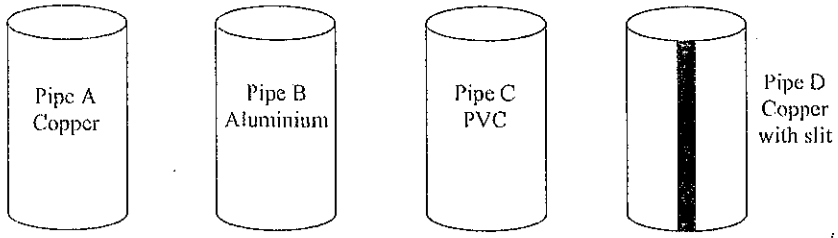
Question 21 (5 marks) **Marks**

Students carried out an experiment where they took four pipes and dropped a magnet through them, timing how long it took the magnet to fall. Pipe A was solid copper, Pipe B was solid aluminium, Pipe C was solid PVC and Pipe D was copper with a vertical slit the length of the pipe.



The students' results showed that the time taken for the magnet to fall through the PVC was equivalent to the time taken to freefall the same distance. Pipe D was the next shortest time followed by Pipe B and finally Pipe A. The time taken to pass through Pipe A was almost three times the time of freefall.

Explain the students' results in this experiment with reference to Lenz's Law. 5

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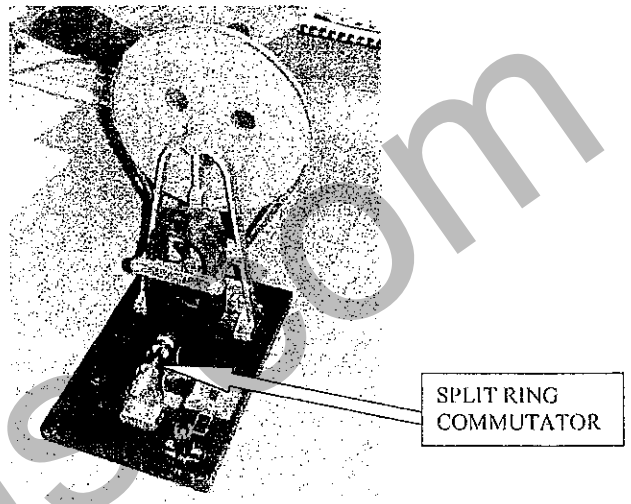
Question 22 (5 marks) **Marks**

Below is a photograph of a hand-operated AC/DC generator.



(a) Identify the function of the split-ring commutator in this generator. 1

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(b) Compare a DC generator to a DC motor. 4

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Question 23 (6 marks) **Marks**

(a) Explain why using transformers to increase voltage before transmission leads to less power loss in the transmission of electricity. **2**

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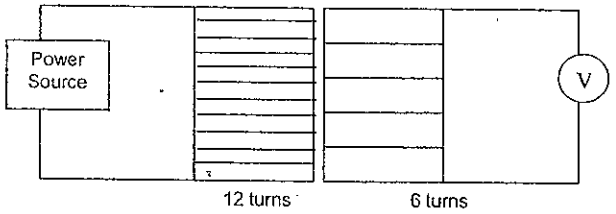
(b) A student carried out an experiment that involved the use of two hollow coils to demonstrate a step down transformer. The set-up is shown below. **4**



The power source was set to 24V and a reading of 8V was observed in the voltmeter.

Assess the validity of this result and propose ONE change to the apparatus that could be made to improve the reliability of this experiment.

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Question 24 (5 marks) **Marks**

In your course you have performed an experiment to demonstrate the properties of cathode rays using discharge tubes.

(a) Identify ONE safety risk involved in the carrying out of these experiments and explain how this was addressed. **2**

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(b) Analyse the information gathered from any TWO of these discharge tubes to suggest why there was a debate as to whether cathode rays were charged particles or electromagnetic waves. **3**

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Question 25 (6 marks) **Marks**

(a) Explain how light can be understood as a 'stream of particles'. **2**

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(b) A beam of light (wavelength = 4×10^{-7} m) is incident upon a metal surface. Calculate

(ii) the frequency of the incident light **2**

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(ii) the energy of one 'particle' of this light **2**

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Question 26 (4 marks) **Marks**

Draw a table to classify and qualitatively compare copper, silicon and glass in terms of the relative number of free electrons that can drift between atoms. **4**

Question 27 (5 marks) **Marks**

The BCS Theory states that in superconducting materials electrons move through the lattice in "Cooper Pairs". **5**

Using a diagram as part of your response, discuss the BCS Theory by considering a material above and below its critical temperature.

Diagram:

Question 31 – From Quanta to Quarks (25 marks) **Marks**

(a) (i) Reproduce the table below in your answer booklet, complete with the integer (whole number) values in the appropriate places, for the components of the nucleus of an atom. **2**

	Charge	Mass	Contribution to Mass Number	Contribution to Atomic Number
Proton				
Neutron				

(ii) Strontium-90 (^{90}Sr) is radioactive and is known to produce β–particles. Outline the process of the production of a β–particle from a ^{90}Sr atom and write a balanced equation for the process. **2**

(b) Describe a first hand investigation you conducted to observe the emission spectrum of a gas such as hydrogen. **3**

(c) Explain the stability of the electron orbit in the Bohr model of the atom with particular reference to the deBroglie hypothesis. **3**

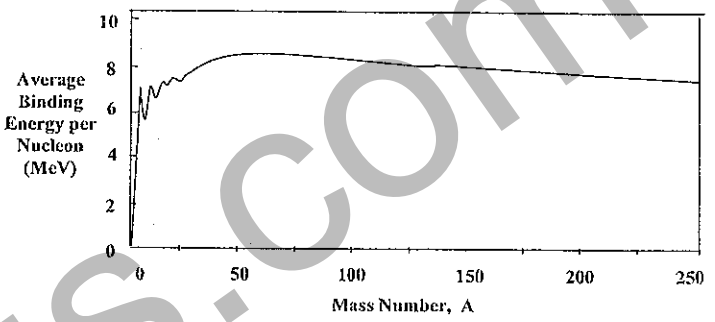
(d) Assess the impact of the Manhattan Project of the 1940s upon today's society. **7**

Question 31 continues on page 29

Question 31 (continued) **Marks**

(e) (i) The mass of the oxygen-16 atom is 15.994915 amu. Calculate the mass defect for this atom. **2**

(ii) Use the following graph of binding energy per nucleon vs. mass number of atoms to explain the significance of the position of Iron-56 (^{56}Fe). **2**



(f) Analyse the ability of the Rutherford-Bohr model of the atom to completely explain observed spectral characteristics. **4**

End of Question 31