Centre Number

Student Number

CATHOLIC SECONDARY SCHOOLS
ASSOCIATION OF NEW SOUTH WALES

2006
TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

Physics

Afternoon Session
Thursday 10 August 2006

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

EXAMINERS

M Edwards (convenor)	Caroline Chisholm College, Glenmore Park
P Arena	Kincoppal, Rose Bay
D Buckley	St. Francis Xavier's College, Hamilton
S Kinchington	Parramatta Marist High School
T Murray	St. Andrew's College, Marayong
G Simms	Hennessy Catholic College, YOung
S Woodward	Oakhill College, Castle Hill

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

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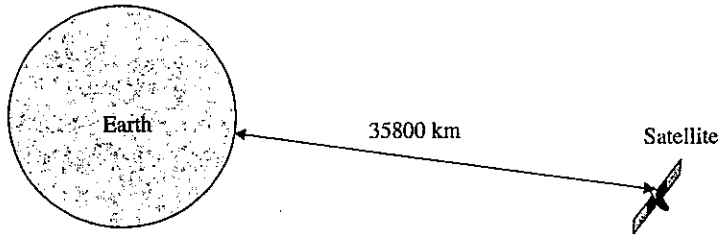
1 The weight force for a 9.8 kg rocket component resting on planet Earth is closest to

(A) 1 N
(B) 9.8 N
(C) 19.6 N
(D) 96 N

2 The diagram below shows a satellite of mass 3000 kg orbiting at an altitude of 35800 km above the Earth. The diagram is not drawn to scale.



Use the radius of the Earth = 6.38×10^6 m to calculate the gravitational potential energy of the satellite within the Earth's gravitational field.

(A) -2.85×10^{10} J
(B) -3.35×10^{13} J
(C) -1.87×10^{11} J
(C) -3.35×10^{10} J

3 In order to take advantage of the Earth's rotational motion, rockets are launched

(A) from near one of the poles and towards the East

(B) from near the equator and towards the East

(C) from near one of the poles and towards the West

(D) from near the equator and towards the West

4 An object, mass m, is travelling with speed v in uniform circular motion at a radius r from the centre of the circle. Which of the following would require the greatest increase in centripetal force?

(A) Doubling the mass of the object while keeping speed and radius unchanged

(B) Maintaining the speed and mass while reducing the radius by 80%

(C) Tripling the speed without changing the radius or mass

(D) Halving the radius and doubling the speed, leaving mass constant

5 Which of the following statements is NOT consistent with Einstein's postulates in his theory of special relativity?

(A) The light from the headlights of a rapidly reversing spacecraft will travel at the speed of light

(B) The laws of physics have the same form inside a spacecraft travelling at half the speed of light as they do inside a stationary spacecraft

(C) The light from the headlights on a spacecraft travelling at half the speed of light is no faster than the light from the headlights on a stationary spacecraft

(D) The laws of physics have the same form inside an accelerating spacecraft as they do inside a stationary spacecraft

6 The turning moment of a force is known as the

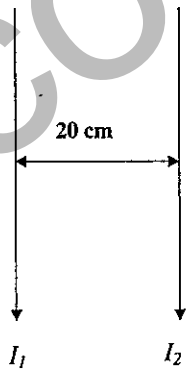
(A) magnetic field

(B) motor effect

(C) torque

(D) back emf

7 The following diagram shows two current-carrying wires separated by a distance of 20 cm. Current $I_1 = 2A$ and current $I_2 = 5A$.



The force per metre between the two wires is closest to:

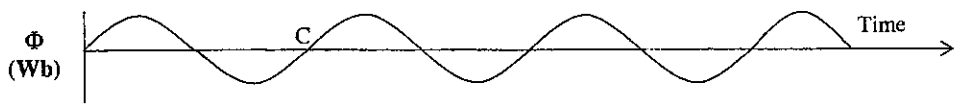
(A) 1×10^{-5} N

(B) 1×10^{-8} N

(C) 5×10^{-5} N

(D) 2 N

8 The variation of magnetic flux through a single generator coil as it turns is shown in the following graph:



At point C in the cycle the induced emf is

(A) zero
(B) maximum and positive
(C) minimum and positive
(D) maximum and negative

9 An electric motor is constructed so that the rotor is not connected to the external power supply and there are no brushes or commutator.

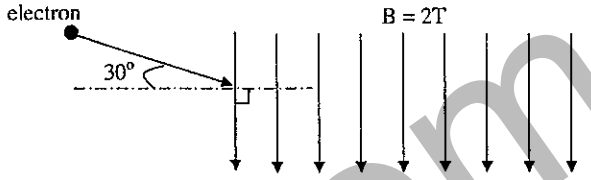
The motor is most likely to be

(A) an AC induction motor
(B) an AC universal motor
(C) a simple DC motor
(D) a DC universal motor

10 Across an ideal transformer,

(A) the voltage may increase while the current remains unchanged
(B) energy is conserved
(C) the power can be increased from the primary to the secondary coil
(D) it is possible to reduce the current and voltage simultaneously

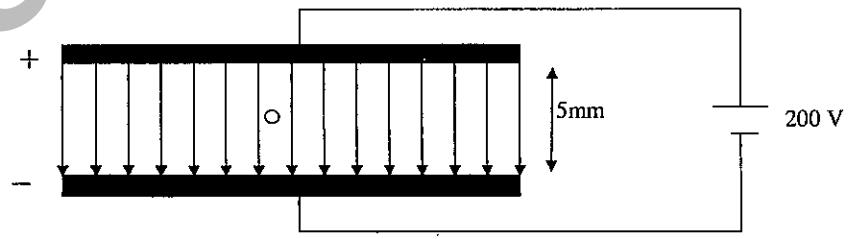
11 An electron travelling at 5.0×10^4 m s^{-1} enters a downward magnetic field (of strength 2.0 T) at the angle shown below:



Determine the magnitude of the force experienced by the electron.

(A) 8.7×10^4 N
(B) 5.0×10^2 N
(C) 8.0×10^{-15} N
(D) 1.4×10^{-14} N

12 Determine the electric force on a proton when placed in the uniform electric field between the plates shown below:



(A) 4.0×10^4 N down
(B) 4.0×10^1 N down
(C) 6.4×10^{-18} N down
(D) 6.4×10^{-15} N down

13 Heinrich Hertz failed to investigate

(A) the speed of radio waves
(B) the photoelectric effect
(C) how radio waves relate to light waves
(D) the effect of a radio wave on a receiver

14 Semiconductors have

(A) almost filled valence bands and a small energy gap to the conduction band
(B) completely filled valence bands and a large energy gap to the conduction band
(C) partially filled valence bands and a very small (or zero) energy gap to the conduction band
(D) partially filled valence bands and a very large energy gap to the conduction band

15 The Braggs developed an X-ray spectrometer to study diffraction of X-rays from crystal surfaces.

Which of the following shows the correct arrangement of components for such a spectrometer?

(A) X-ray tube → Crystal → Photographic screen → Collimator
(B) X-ray tube → Collimator → Crystal → Photographic screen
(C) Crystal → X-ray tube → Collimator → Photographic screen
(D) X-ray tube → Crystal → Collimator → Photographic screen

Centre Number

Student Number

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 (6 marks) **Marks**

(a) Identify an example of a non-inertial frame of reference. **1**

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(b) During the course you undertook an investigation to distinguish between inertial and non-inertial frames of reference. **2**

Outline the method that you used in your investigation.

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(c) Assess the reliability of the results that you obtained in the first-hand investigation outlined in part (b). **3**

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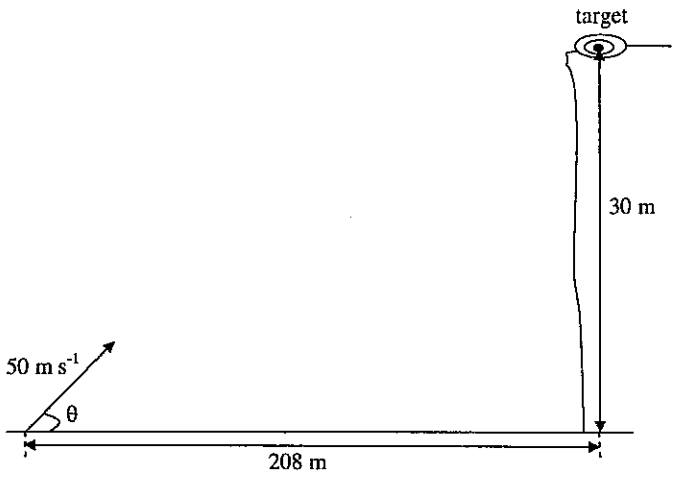
Question 17 (5 marks) **Marks**

A projectile is launched at an angle θ with initial speed = 50 m s^{-1} so that it lands on the target shown in the following diagram (not drawn to scale):



(a) If the projectile takes 5.43 seconds to hit the target, calculate the angle at which it was launched. **2**

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(b) Calculate the final vertical velocity of the projectile. **3**

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Question 18 (6 marks) **Marks**

A physics student made the following statement: **6**

On Earth, the acceleration due to gravity is a constant value of 9.8 m s^{-2}

Discuss the student's statement.

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Question 19 (3 marks) **Marks**

(a) The mass of an object is measured by an observer when the object is at rest relative to the observer. It is then measured again (by the same observer) when the mass is travelling at close to the speed of light relative to the observer. **2**

Qualitatively compare these mass measurements and also state the relevant equation.

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(b) An object that is travelling at a speed of 0.9c relative to an observer has a mass of 100 kg measured by the observer. Calculate the mass of the object measured by the same observer when it is at rest relative to the observer. **1**

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Question 20 (5 marks) **Marks**

(a) A galvanometer contains a coil (with sides of fixed length) that lies in a magnetic field of constant strength. **3**
Explain what causes the galvanometer needle to move from its rest position when connected to a closed circuit containing a power source.

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(b) Calculate the magnitude of the force on a 2 cm length of conductor which carries a current of 1.5 mA through a perpendicular magnetic field of strength 40 T. **2**

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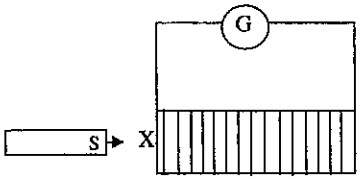
Question 21 (5 marks) **Marks**

When the south pole of a bar magnet is pushed towards the end of a conducting coil which is connected to a circuit, a current flows in the coil to produce a south pole at X. **5**



Account for the production of the south pole by the coil at X, using Lenz's law and the principle of conservation of energy.

Question 22 (6 marks) **Marks**

Laptop computers require a transformer to operate when connected to the 240 V mains in a house or office.

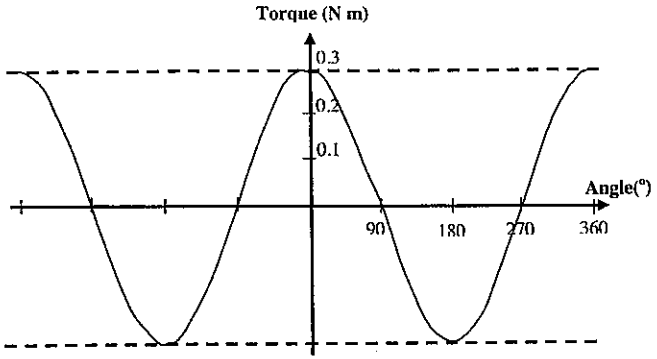
(a) Describe the purpose of a transformer. **2**

(b) Identify ONE OTHER home appliance that requires a transformer to operate from the mains. **1**

(c) Explain, with reference to the laptop computer and the appliance you have identified in part (b), why the transformer is needed when connecting to the 240 V mains. **3**

Question 23 (4 marks) **Marks**

The following graph (for a simple DC motor) shows the variation of torque as the angle between the plane of the coil and the uniform magnetic field changes:



(a) A current of 600mA is travelling through the windings when the coil is parallel to the magnetic field. The coil consists of 200 turns of wire and has an area of 1.5×10^{-3} m^2. Use this information and the graph above to calculate the magnetic field strength. **2**

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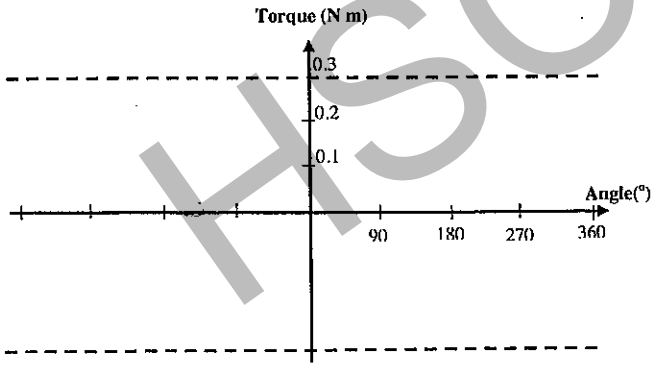
(b) Sketch the variation of torque with angle if all other variables are kept the same as in part (a) and the magnetic field strength is halved: **2**



Question 24 (6 marks) **Marks**

During the course you performed a first-hand investigation to observe the occurrence of different striation patterns for different pressures in discharge tubes.

(a) Present the observations you made during this experiment in class. **3**

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(b) Identify the risks and precautions that must be undertaken to do this experiment safely. **3**

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Question 25 (4 marks) **Marks**

(a) Identify the relationship between the frequency of light and the energy of a photon. **1**

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(b) Given that the wavelength of red light is 650nm, determine the energy of each photon of red light. **3**

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Question 26 (5 marks) **Marks**

This photograph shows an office from the 1920's:

The first patent for a transistor was registered in 1928, this was followed by a myriad of inventions and improvements to already invented gadgets, over the following decades.

Assess the impact of the transistor on society during this period of time. **5**

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Question 27 (5 marks) **Marks**

Describe how superconductors and magnetic fields are used in a maglev train. **5**

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End of Section I

Physics
Section II

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

Answer the question in a SEPARATE writing booklet.

Show all relevant working in questions involving calculations.

Pages

2701-1

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

(a) (i) The Modern Atomic Theory is credited to John Dalton in 1805. One of Dalton's postulates was that "the atoms of one element are unique and cannot be changed into the atoms of any other element". **2**

Define "atomic transmutation".

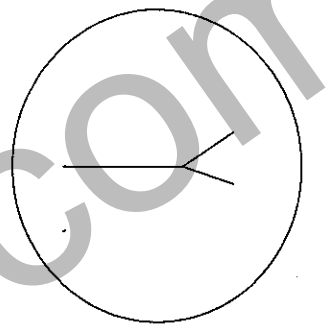
(ii) The element Cobalt–60 ($^{60}_{27}Co$) is known to be radioactive and produces a β–particle (which is a high energy electron from the nucleus). **2**

Write an equation to show the nuclear disintegration of an atom of Cobalt-60 and describe how this contradicts Dalton's postulate. Your equation must show both the mass number and the atomic number of all species shown in the equation.

(b) Identify the difficulties in using the Rutherford-Bohr model of the structure of the atom to explain the hyperfine lines in the emission spectrum of hydrogen. **2**

Question 31 continues on page 29

(c) In the diagram below the straight lines represent the traces left in a Wilson cloud chamber by the products of a radioactive decay. The radioactive source is at the left. **4**



Outline the steps you would take in a normal school laboratory to set up and use a Wilson cloud chamber (or similar detection device) and also describe what has taken place at the intersection of the straight lines.

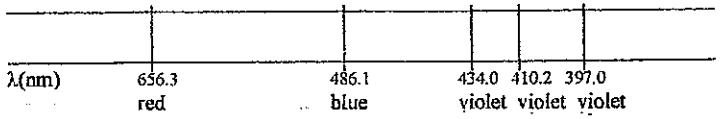
(d) The physicists Werner Heisenberg and Wolfgang Pauli both had a significant impact on our understanding of the structure of the atom. **7**

Outline the contributions of each man and compare their respective influences on the current theory of the internal structure of the atom.

Question 31 continues on page 30

(e) (i) The diagram below represents the emission spectrum for hydrogen gas in the visible region. **2**

The numbers below the lines indicate the wavelength of the respective coloured bands measured in nanometres (10^{-9}m).



Use the Balmer equation

$$1/\lambda = R(1/2^2 - 1/n^2)$$

to solve for the value of n for the production of the blue line with wavelength 486.1nm.

(This equation is a slightly modified form of that which appears in your data sheet)

(ii) Explain what is happening within the atom to generate this emission and explain the significance of the value "2" which is squared in the modified equation above. **3**

(f) Those sub atomic particles known as Baryons are thought to be composed of smaller objects known as "**quarks**". **3**
The table below shows the mass and charge of the six known quarks.

Quark Name	Mass MeV/c^2	Charge Electronic charge
Up	312.37	2/3
Down	313.49	-1/3
Charm	1500	2/3
Strange	560	-1/3
Top	1.76	2/3
Bottom	?	-1/3

Discuss how a collection of quarks can combine to form

i) a proton

ii) a neutron

by balancing both charge and mass.

End of Question 31