Centre Number

Student Number

CATHOLIC SECONDARY SCHOOLS
ASSOCIATION OF NEW SOUTH WALES

2008
TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

Physics

Afternoon Session
Tuesday, 12 August 2008

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 13

Total marks – 100

Section I Pages 2–26

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 29–36

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

EXAMINERS

N. Valentine (convenor)	Aquinas College, Menai
K Bucher	St Paul's International School, Moss Vale
A Prasad	Nagle College, Blacktown South
S. Woodward	Oakhill College, Castle Hill
A Hey	All Saints Catholic Senior College, Liverpool
J English	Holy Spirit College, Lakemba
J Tanner	Blue Mountains Grammar School, Wentworth Falls

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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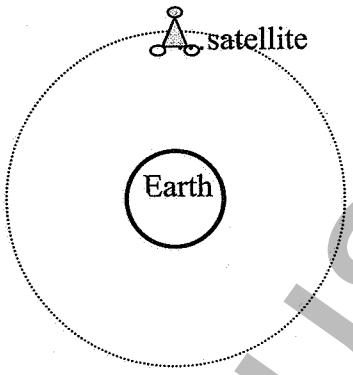
1 An Optus satellite is orbiting Earth in a stable clockwise orbit, as shown in the diagram below.



Which alternative shows the correct direction for the satellite's velocity, acceleration and centripetal force for the position shown in the diagram.

	VELOCITY	ACCELERATION	CENTRIPETAL FORCE
(A)	→	→	→
(B)	→	↓	↓
(C)	↓	↓	↓
(D)	→	→	↓

2 Spacecraft returning to Earth encounter a considerable problem with heating during re-entry. This heat is mostly the result of

(A) high temperatures in the upper atmosphere.

(B) rocket fuel ignition used by retro-rockets required to slow the spacecraft.

(C) being exposed to solar radiation and high velocity charged particles in the ionosphere.

(D) friction caused by air molecules bouncing off the spacecraft.

3 A telecommunications satellite is required to move from a low Earth orbit to a geostationary orbit.

What change will have resulted in the satellite's potential energy and its orbital velocity when it has reached the geostationary orbit?

As a result, what is the overall change in the satellite's potential energy and its orbital velocity, once it has reached its new geostationary orbit.

	Potential Energy	Orbital Velocity
(A)	increase	decrease
(B)	increase	increase
(C)	decrease	decrease
(D)	decrease	increase

4 Nigel, a weightlifter, has been sent to Venus to improve his PBs (Personal Bests). His best lift on Earth is 140kg.

Given the acceleration due to gravity on Venus is 8.93 ms^{-2}, what should Nigel be able to lift on Venus, with the same effort?

(A) 128 kg.

(B) 140 kg.

(C) 154 kg.

(D) 160 kg.

5 A soccer player kicked a soccer ball with an initial velocity of 18 ms $^{-1}$ at an angle of θ. The ball took 2.0s to reach the ground again and landed 30m away.

What were the x-component of the ball's initial velocity and the angle θ from the horizontal at which it was launched? (ignore air resistance)

(A) 9.9 ms $^{-1}$ and 34°

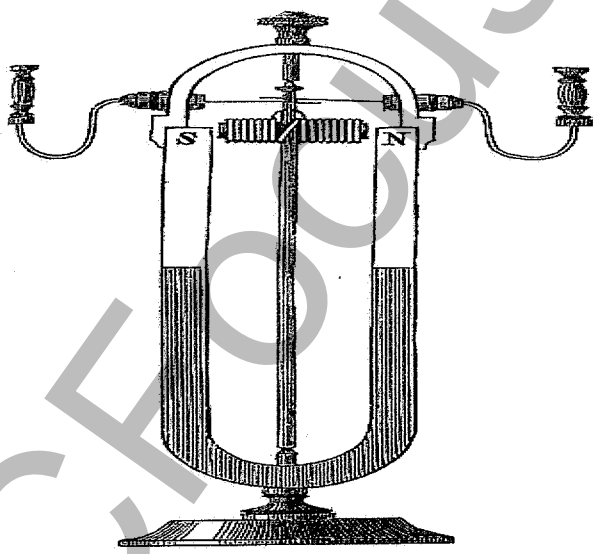
(B) 9.9 ms $^{-1}$ and 56°

(C) 15 ms $^{-1}$ and 34°

(D) 15 ms $^{-1}$ and 56°

6 The following apparatus, a coil of wire inside a magnetic field, was set up to demonstrate the motor effect, but it didn't work.

What needs to be added to the apparatus so that the motor effect can be effectively demonstrated?



(A) a changing flux

(B) a magnetic field

(C) a power source

(D) a rotor

7 A DC motor connected to a 12V power supply accelerates from start up speed to its maximum speed.

Which statement regarding the motor is correct?

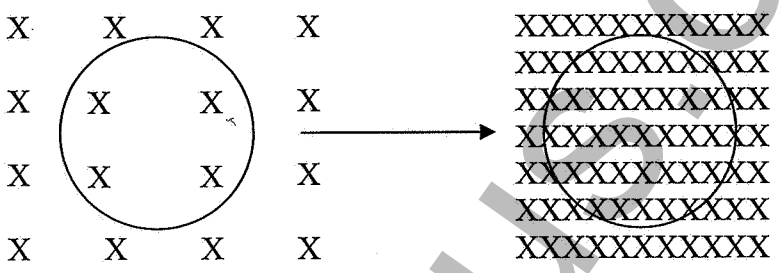
(A) Its net energy increases during this time.

(B) The supply voltage is decreased as it reaches maximum speed.

(C) The sum of the electrical, heat loss and kinetic energy remains constant.

(D) A larger current is generated in the motor due to the greater rate of change of flux.

8 A wire ring is placed in a magnetic field and the magnetic field within the ring changes as shown.



Situation Y
Original
magnetic field

Situation Z
Changed
magnetic field

What happens in the ring when the magnetic field is changed?

(A) A clockwise current is generated by a change in flux.

(B) An anticlockwise current is generated by a change in flux.

(C) There is no current produced by the change in magnetic field strength.

(D) An alternating current is produced by a change in magnetic field strength.

9 Which of the following is a disadvantage of the electromagnetic braking system on trains.

(A) No contact is required between the brake and the wheel.

(B) The faster the wheel turns the stronger the braking force.

(C) It does not wear out as quickly as conventional brakes.

(D) The heat built up by the eddy currents in the wheel dissipates quickly.

10 Magnetically levitated (Maglev) trains use superconductors which are associated with an effect known as

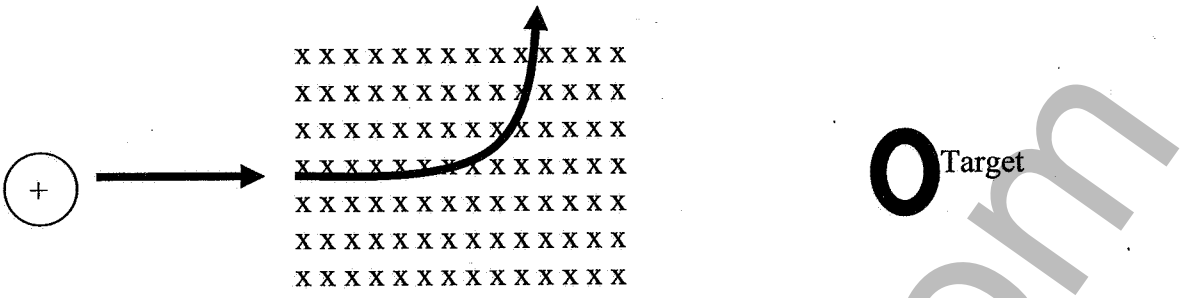
(A) the Doppler Effect
(B) the Meissner Effect
(C) the photoelectric Effect
(D) the photon Effect

11 In semiconductors, electrons and holes both help to carry current.

Holes are understood to

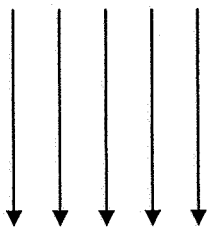
(A) be positively charged particles
(B) be neutral particles
(C) move in the direction of the applied electric field lines
(D) move in the same direction as the electrons

12 The diagram below shows how a proton curves as it passes through a magnetic field and does not hit the target.

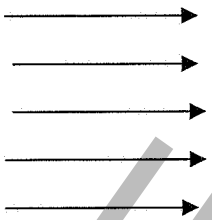


If an electric field were now applied, (in the same region as the magnetic field), and the proton hit the target, what must have been its direction?

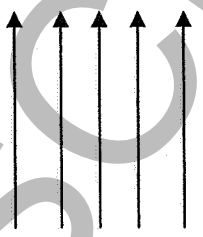
(A)



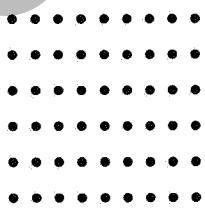
(B)



(C)



(D)



13 Hertz studied and measured the speed of radio waves.

Which of the following properties of radio wave was NOT studied by Hertz?

(A) Diffraction

(B) Quantization

(C) Refraction

(D) Superposition

14 The table below presents results of an experiment on the photoelectric effect. The cut-off voltage was measured, the wavelength was identified from the filters used and the frequency of the wave and the energy of the photoelectrons were calculated.

Wavelength (nm)	**Frequency of Wave (X 10^{14} Hz)**	**Cut-Off-Voltage (V)**	**Energy of Photoelectrons (J X 10^{-19})**
430	7.0	0.774	1.24
370	8.1	1.074	1.72
333	9.0	1.498	2.40
294	10.2	2.010	3.22

Assume that there are two parallel plates 5mm apart in the photocell that is used in this experiment and the cut-off-voltage is equivalent to the voltage across the two plates. This voltage stops the photoelectrons from moving.

For the 294 nm wave the magnitude of the opposing electric force required to stop the photoelectrons was

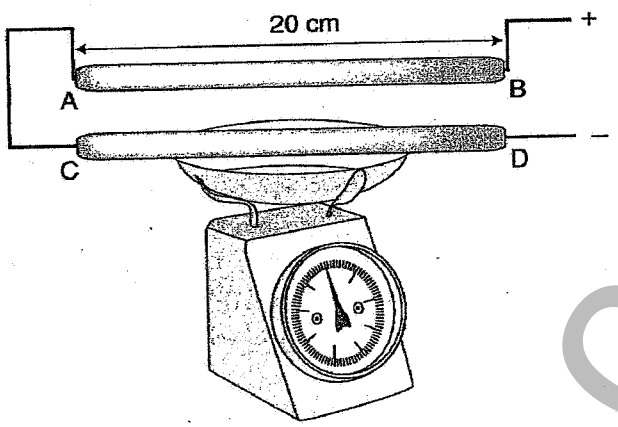
(A) 3.22×10^{-19} N

(B) 4.71×10^{-17} N

(C) 6.44×10^{-17} N

(D) 402 N

15 In the experiment pictured below the force between two parallel conductors is determined by passing a known current through the conductors.



Which of the following actions will most help to ensure that the experiment is valid?

(A) repeating it several times so that you can declare a result average over several observations

(B) making allowance for the back emf produced

(C) ensuring that the measuring instruments are properly calibrated before you start

(D) ensuring that all readings and measurements are accurately made and recorded

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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

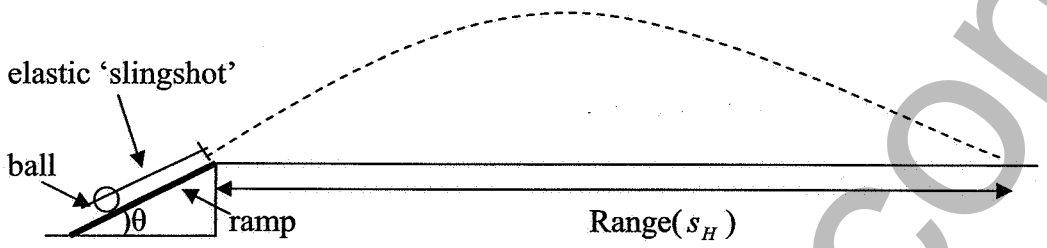
Show all relevant working in questions involving calculations.

Please turn over

Marks

Question 16 (5 marks)

A ramp and an "elastic slingshot" is set-up as in the diagram below, to launch a small metal ball over a level surface. The elastic is stretched back the same distance on the ramp, so the initial launch velocity is the same for each trial. The angle of the ramp is then changed and the range (horizontal displacement) of the ball is measured. Air resistance is negligible.



A student's results are shown below:
Mass of ball = 0.05kg.

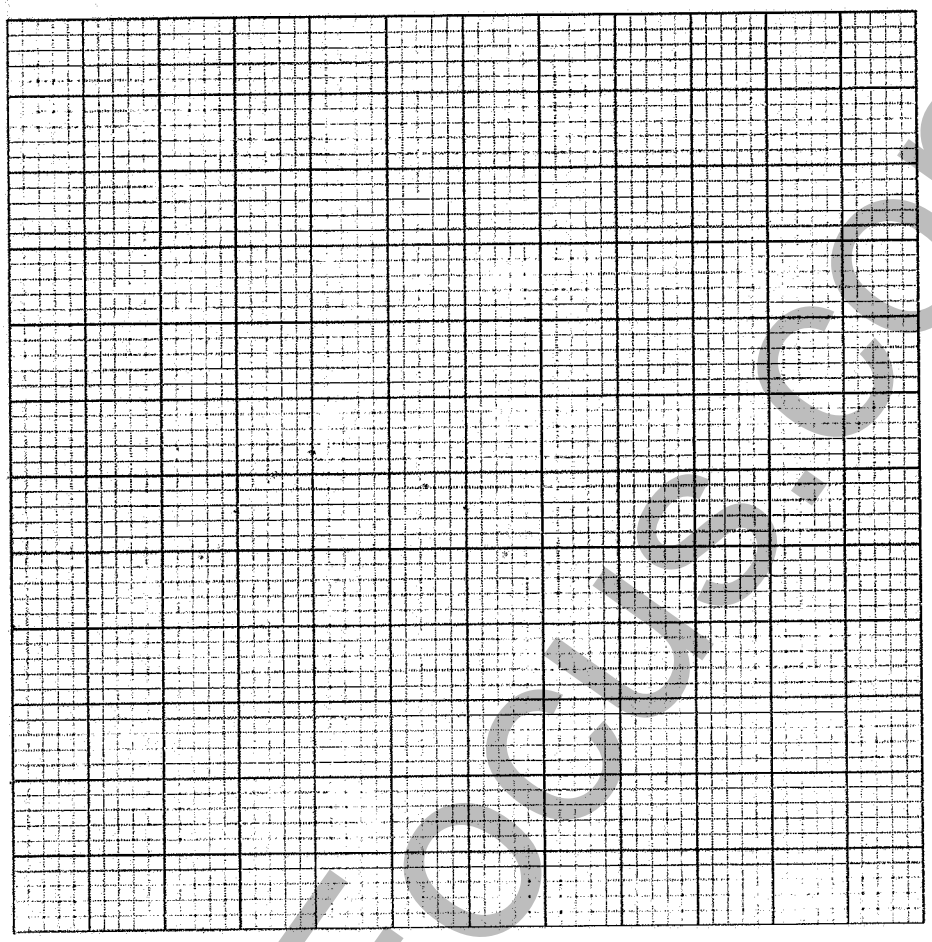
Angle of Ramp (θ)	Range (metres)
20°	10.25
25°	12.25
30°	13.80
35°	15.00
40°	15.70
45°	15.95
50°	15.75
55°	14.55
60°	13.85
65°	12.30
70°	10.30

Question 16 continues on page 15

Marks

Question 16 (continued)

(a) Draw and label a graph of these results, using a curve-of-best-fit **2**



(b) (i) Using the graph, identify and correct any outliers from these results. **1**

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(ii) Given the time of flight is 1.64 seconds, calculate the initial velocity of the ball, when the ramp is set at 40°. **2**

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End of Question 16

Marks

Question 17 (4 marks)

(a) Discuss the effect of the Earth's orbital and rotational motion on the launch of a rocket. **2**

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(b) Given the radius of the Earth is 6400km, the rocket places a satellite into a stable orbit altitude of 6500km. Calculate the period of the satellite. **2**

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Marks

Question 18 (7 marks)

(a) The Michelson-Morley experiment demonstrated to Einstein that the aether model had failed. State Einstein's postulate regarding the speed of light. **1**

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(b) Explain the impact of Einstein's application of the Principle of Relativity on the aether model and this postulate. **3**

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(c) Nigel travels from Earth to Angolis on the latest Dalek model spacecraft that has the capacity to travel at 2.4×10^8 m/s (or 0.8c). Angolis is 40 light years away. Calculate the minimum time this journey takes

(i) according to a clock on Earth **1**

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(ii) according to a clock on the spacecraft **2**

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Marks

Question 19 (6 marks)

One of Einstein's first "thought experiments" was as follows : **6**

> "Suppose I am sitting on a train that is travelling at the speed of light. If I hold up a mirror in front of me and look at it, will I see my own reflection?"

Analyse this thought experiment and discuss the relationship between thought and reality.

Marks

Question 20 (4 marks)

"If someday they say of me that in my work I have contributed something to the welfare and happiness of my fellow man, I shall be satisfied." George Westinghouse. **4**

Assess the impact on the environment of the AC generator to determine if George Westinghouse would be satisfied.

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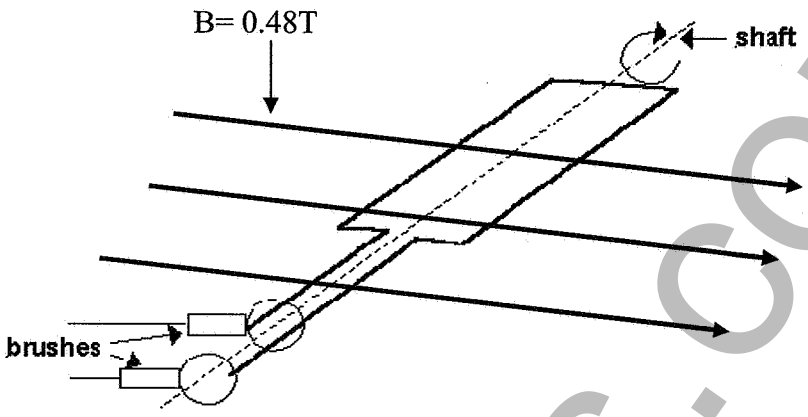
Marks

Question 21 (5 marks)

A flat rectangular coil with 900 turns in a magnetic field B as shown in the diagram.



The coil has sides of 40cm and 16 cm, an area of 6.4×10^{-2} m^2 and carries a current of 10A.

(a) Is this an AC or DC motor? Justify your answer. **1**

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(b) Calculate the magnitude of the maximum force on the longer side of the coil. **2**

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(c) Calculate the torque required to achieve this rotation. **2**

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Marks

Question 22 (4 marks)

Explain why the apparent inconsistent behaviour of cathode rays caused debate as to whether they were charged particles or electromagnetic waves. **4**

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Marks

Question 23 (4 marks)

Superconductors have the potential to revolutionise electricity production and use.

(a) Identify ONE other use of superconductors. **1**

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(b) Identify ONE advantage of using superconductors. **1**

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(c) Explain why magnetic levitation has not been widely used in the transport industry. **2**

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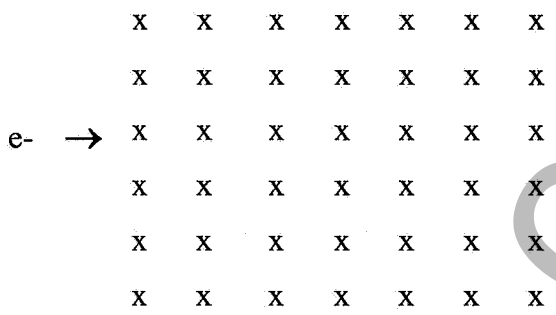
Marks

Question 24 (3 marks)

An electron is fired into a magnetic field, as shown in the diagram below.

(a) On the diagram, sketch the path followed by the electron once it enters the magnetic field. **1**



(b) If the magnetic field has a strength of 0.05T and the velocity of the electron is 300 ms^{-1}, calculate the force experienced by the electron once it enters the magnetic field. **2**

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Marks

Question 25 (4 marks)

The manufacturer of a small DC motor makes the following claim: **4**

"The torque of the DC motor is a constant 1.5 Nm."

Analyse this claim with reference to the structure of a simple DC motor.

Include a labelled diagram of a DC motor in your answer.

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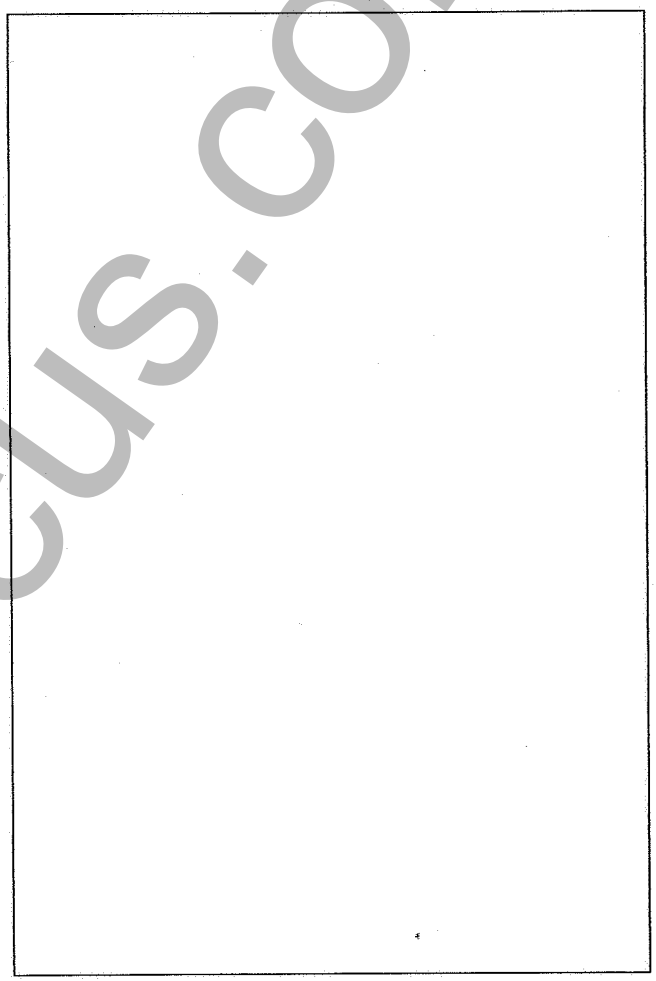

Marks

Question 26 (6 marks)

(a) Explain why transformers are used to transmit electricity to our homes. **2**

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(b) A student constructed and tested a model transformer and the following results were obtained. **2**

Primary Voltage	Primary current	Secondary Voltage	Secondary current
12V	0.05A	6V	0.2mA

Calculate the power lost from of this transformer.

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(c) Identify a feature of a modern transformer that would reduce this power loss and outline the physics principles involved. **2**

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Marks

Question 27 (8 marks)

(a) Describe how Hertz produced the photoelectric effect. **2**

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(b) Explain the contribution of Planck and Einstein to explaining black body radiation. **3**

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(c) In an experiment some physics students were using ultraviolet light (wavelength 300 nm) to see if they could produce photoelectrons.

(i) Calculate the energy of a photon of ultraviolet light. **2**

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(ii) Explain how this photon could produce a photoelectron. **1**

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Marks

Question 30 – Astrophysics (25 marks)

(a) (i) Calculate the distance to a star that has an annual parallax of 0.25 arcseconds. **2**

(ii) Use a diagram to explain how parallax works in determining the distance to stars. **3**

(b) (i) During your studies, you undertook an experiment that allowed you to observe spectra of different objects. Briefly describe the investigation and the objects observed. **2**

(ii) Explain the difference between absorption, emission and continuous spectra. **4**

(c) Analyse how advances in technology have allowed for greater understanding of the universe. **7**

(d) (i) Explain the difference between stars that use the PP chain and the CNO cycle for their energy source. **2**

(ii) Explain and justify the need for FOUR different groups of binary stars. **2**

(iii) Describe the process used to determine the distance to Cepheid variables. **3**

Marks

Question 31 – Quanta to Quarks (25 marks)

(a) De Broglie was the first to propose the wavelike nature of matter.

(i) Use the de Broglie wave equation to calculate the wavelength of an electron with velocity 6.2×10^6 ms^{-1}. **2**

(ii) Explain how the results of the Davisson and Germer experiment support the de Broglie hypothesis. **3**

(b) In your study of Quanta to Quarks, you performed a first-hand investigation to observe the visible components of the hydrogen spectrum.

(i) Describe the experiment you performed, making sure that you identify key apparatus in your description. **2**

The hydrogen spectrum was highly significant in the development of the Bohr model of the atom. This in turn led to a mathematical description of the hydrogen spectrum by the Rydberg equation.

$$\frac{1}{\lambda} = \mathcal{R}\left(\frac{1}{{n_f}^2} - \frac{1}{{n_i}^2}\right)$$

(ii) Qualitatively explain the relationship between the values n_f and n_i in the table and Bohr's postulates. **4**

Use a diagram to assist your explanation.

(c) OPAL is Australia's new fission reactor. OPAL relies on the fission of uranium to generate neutrons. These neutrons are channelled into beams so that scientific research using neutron scattering can be undertaken. **7**

Explain the basic principles of OPAL and analyse the importance of neutron scattering experiments for society and the environment. Refer to at least one example of a nuclear fission reaction in your response.

Question 31 continues on page 35