

JAMES RUSE AGRICULTURAL HIGH SCHOOL

2003

TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

Physics

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black or blue pen
- Draw diagrams using pencil
- Board-approved calculator may be used
- A data sheet, formulae sheets and Periodic Table are provided at back of this paper
- Write your Student Number at the top of page 8

Total marks – 100

Section I Pages 2-19

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 16-28
- Allow about 1 hour and 45 minutes for this part

Section II Page 20

25 marks

- Attempt Questions 29
- Allow about 45 minutes for this section

Section I (total marks 75)

Part A (total marks 15)

Attempt Questions 1-15

Allow about 30 minutes for this part

Use the multiple choice sheet for your answers

1. A satellite is orbiting 300 km above the surface of the Earth. What is its acceleration due to the gravity of the Earth?
(A) 8.97 ms^{-2}
(B) 9.80 ms^{-2}
(C) 6.13 ms^{-2}
(D) zero (weightless)
2. A new space shuttle can operate with or without a booster rocket attached. The thrusts provided by the Space shuttle and booster are 10 000 N and 8000 N respectively. When operated without a booster rocket attached, the uniform acceleration is 1.0 ms^{-2} , whilst the acceleration of the Space Shuttle with booster is 1.5 ms^{-2} .

What is the mass of the booster rocket?

- (A) 2000 kg
(B) 4000 kg
(C) 10 000 kg
(D) 12 000 kg

3. Two masses M_1 and M_2 (each with radius R metres) are separated by a distance of d metres, the distance d being very much greater than R . The following statements refer to the gravitational attractive force between them.

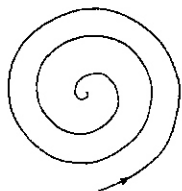
- (i) the force is proportional to M_1
(ii) the force is proportional to M_2
(iii) the force is inversely proportional to R^2
(iv) the force is inversely proportional to d^2

Which statements are true?

- (A) (i), (ii) and (iii)
(B) (ii) and (iii)
(C) (i) and (iii)
(D) (i), (ii) and (iv)

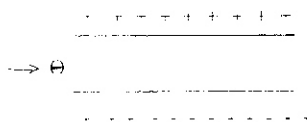
4. The following statements refer to man-made, artificial satellites in orbit around earth. Which one is an accurate statement?
- (A) It is possible to have a satellite travelling at either a high speed or at a low speed in a given orbit.
- (B) Only circular orbits (and not elliptical ones) are possible for artificial satellites.
- (C) A satellite in a large diameter circular orbit will always have a longer period of revolution about the earth than will a satellite in a smaller circular orbit.
- (D) The velocity required to keep a satellite in a given orbit depends on the mass of the satellite.
5. A space ship travels away from Earth at $0.8c$. When 20 years have elapsed on Earth, how many years does the Earth observer determine go by on the space ship?
- (A) 7.2 years
- (B) 12 years
- (C) 20 years
- (D) 33.3 years
6. Many electrical appliances in Australian homes are connected to the mains domestic power supply using a transformer. What is the best explanation for this?
- (A) Transformers isolate the appliance from the mains electricity and no fuses are required.
- (B) Transformers reduce the cost of the appliance.
- (C) The transformer adjusts the voltage to that required by the appliance.
- (D) The transformer is used to increase the electrical power supplied to the appliance.
7. The primary coil of a transformer is connected to 240 volts DC. There are 24 000 turns of wire in the primary winding and 9 000 turns of wire in the secondary. If the transformer is 100 % efficient and has been switched on for a while so that it has reached a stable working temperature, what will be the voltage across the secondary coil?
- (A) 240 volts
- (B) 9 volts
- (C) 0 volts
- (D) 90 volts
8. Two parallel current-carrying conductors are spaced 25 mm apart. DC currents of 3.0 A and 4.0 A are flowing in opposite directions in the conductors. One conductor is 1.0 m long. The magnetic force between the conductors is 8.0×10^{-5} N.
- What is the minimum length of the other conductor to produce this force?
- (A) 0.02 m
- (B) 0.41 m
- (C) 0.83 m
- (D) 1.00 m
9. A student sets up a vertical aluminium tube and finds a cylindrical magnet that fits easily inside the tube. When the magnet is dropped down through the centre of the tube, it takes much longer to fall than expected.
- What is the best explanation for this observation?
- (A) The student treated the aluminium tube so that it is a superconductor.
- (B) The student treated the aluminium tube so that it is delayed by magnetic "friction" due to it being a semi-conductor.
- (C) The magnet is delayed by magnetic "friction" due to magnetic induction of currents in the aluminium.
- (D) The magnet is delayed by air friction inside the aluminium tube.
10. Which one of the following changes can increase the sensitivity of a galvanometer?
- (A) Decreasing the number of turns in the moving coil of the galvanometer.
- (B) Decreasing the number of turns in the torsion springs that supply the restoring force for the meter movement.
- (C) Decreasing the field strength of the permanent magnet around the meter movement.
- (D) Increasing the mass of the pointer to alter its momentum.

11. A bubble chamber is an instrument containing liquid hydrogen that permits the paths of charged particles to be observed. Bubbles are formed along the path followed by a charged particle as it collides with molecules of hydrogen. The diagram represents a bubble chamber photograph of a moving electron that is spiralling in a plane towards the centre under the influence of a force due to a constant magnetic field.



What must be the direction of the magnetic field?

- (A) Out of the page.
 (B) Into the page.
 (C) Towards the centre of the spiral.
 (D) Opposite to the direction of motion of the electron.
12. An electron enters an area between two parallel plates. The plates have a potential difference of 100 V and are 0.5 cm apart.



What is the electrostatic force acting on the electron?

- (A) 1.6×10^{-15} N towards the negative plate
 (B) 3.2×10^{-17} N towards the positive plate.
 (C) 3.2×10^{-15} N towards the negative plate.
 (D) 3.2×10^{-15} N towards the positive plate.

13. The table shows some electric properties of two materials X and Y.

	X	Y
Density of charge carriers	9×10^{28}	1×10^{16}
Resistivity	2×10^{-8}	3×10^3
Temperature co-efficient of resistivity	$+4 \times 10^{-3}$	-70×10^{-3}

+ indicates resistivity increases with temperature

- indicates resistivity decreases with temperature

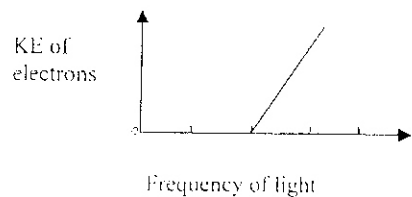
What could the two materials X and Y represent?

- (A) Copper and Silicon
 (B) Silicon and Copper
 (C) Iodine and Copper
 (D) Silicon and Iodine

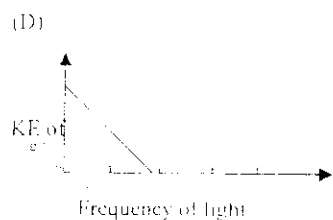
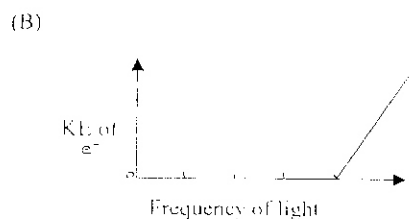
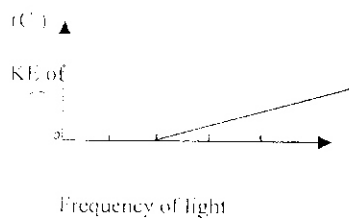
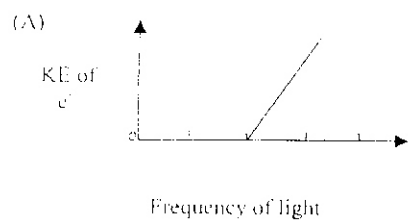
14. Which statement about cathode rays is incorrect?

- (A) Cathode rays are made visible by the flash of light emitted when they hit a fluorescent screen
 (B) Cathode rays are used in oscilloscopes to measure time and picture electrical waveforms.
 (C) Cathode rays are used to produce images in television picture tubes
 (D) The properties of cathode rays depend on the material of the cathode

15. In a photoelectric effect experiment, the following graph was obtained using zinc metal.



Which of the graphs would be obtained with an identical experiment in which only the metal used on the cathode was changed?



Section 1 (continued)

Student Number

Part B - 60 marks

Attempt Questions 16-26

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

Question 16 (5 marks)

Marks

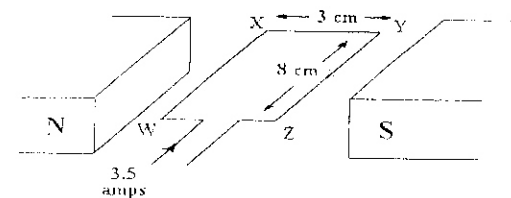
A projectile is fired from the top of a 200 m high tower with an initial velocity of 40 ms^{-1} in the horizontal direction.

- (a) Find the velocity of the projectile 3 seconds after launch. 3
 (b) How long will it take to reach the ground? 2

Question 17 (5 marks)

Marks

A student is investigating the torque on a current carrying loop of wire in a magnetic field. The single loop of wire, W X Y Z, has dimensions 3.0 cm x 8.0 cm and is set up as shown in the diagram. A conventional current of 3.5 A flows clockwise through the loop and the magnetic field strength between the magnets is 0.76 T.



- (a) Determine the magnitude and direction of the magnetic force on conductor Y-Z. 2

- (b) Calculate the magnitude of the torque on the coil in this position when the plane of the loop is 30° to the horizontal. 1



- (c) Explain the origin of this torque. 2

Marks

Question 18 (3 marks)

Silicon is the preferred semi-conductor material used in transistors today rather than germanium. Explain giving reasons why this is the case.

Question 19 (6 marks)

Three parts of the DC motor are listed.

- i) State the function of each part and
 - ii) explain why you would or would not expect to find this part in an AC motor:
- a) Split ring commutator
 - b) Coils of wire forming the rotor
 - c) Permanent magnets forming the stator

Question 20 (4 marks)

- (a) Outline Newton's concept of escape velocity and explain the concept in terms of mass of the planet and the radius of the planet. 3
- (b) The table shows the gravitational field constant on a number of planets in Newtons per kilogram. 1

Earth	9.8
Mars	3.7
Jupiter	24.3
Pluto	0.7

Give the ratio of the forces on an object of mass 2.0 kg on Jupiter's surface and Earth's surface.

Marks

Question 21 (3 marks)

Our school is situated close to a major electrical power distribution network. The transmission lines have structural features that have a specific purpose and increase their efficiency. For each feature listed, describe how this is achieved.

- (a) Electrically isolated from supporting structures: 1
- (b) Protected from lightning strikes: 1
- (c) Designed to transmit large amounts of electrical power with minimum power loss: 1

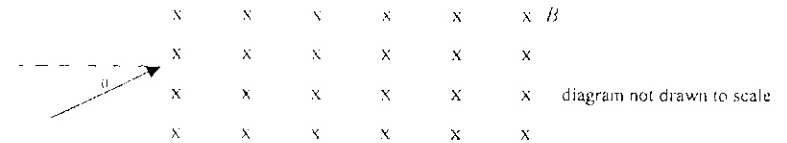
Question 22 (7 marks)

A certain substance has a work function of 2.2 eV. It is lit with two separate beams of light, blue light with wavelength 450 nm and orange light with wavelength 650 nm.

- (a) Explain the concept of a "threshold frequency" as it applies to the photoelectric effect. 2
- (b) Which of these two beams is more likely to cause photoemission of electrons from the surface of the substance? Account for your choice qualitatively. 2
- (c) Use appropriate calculations to justify your choice in (b) above. 3

Question 23 (4 marks)

A positively charged particle of mass m , enters a uniform magnetic field (B) as shown in the diagram, as if from the 8 o'clock position on a clock face. The direction of its path is in the plane of this page.



- (a) Calculate the value of θ . 1
- (b) As it enters the field, in which direction does the magnetic force act on the particle? (use clock-face numbers) 1
- (c) Find the charge to mass ratio of a particle moving with a velocity of $3 \times 10^6 \text{ ms}^{-1}$ moving in a field of 0.75 T in a radius of 4 cms. 2

Question 24 (3 marks)

- (a) Calculate the mass of an electron when it has a speed of $0.98c$ in an accelerator used for cancer therapy. 1

- (b) A rectangular painting measures 1.00 m high and 1.50 m wide. It is hung on the side wall of a space ship which is moving past the Earth at a speed of $0.9c$.



- (i) What are the dimensions of the painting according to the captain of the spaceship? 1
- (ii) What are the dimensions as seen by an observer on the Earth? 1

Question 25 (3 marks)

The development of space exploration has been greatly assisted by the contributions of pioneers like Tsiolkovsky, Oberth, Goddard, O'Neill and von Braun.

Select ONE of these pioneers and outline the significance of their contributions.

Question 26 (4 marks)

Eddy currents are produced in many electrical devices.

Outline how eddy currents are produced and describe how they are used in electromagnetic braking.

Question 27 (6 marks)

Some students mistakenly believed that superconductivity is simply a dramatic improvement in the normal conduction process. The best normal conductors, such as silver and copper do not become superconducting while some recently discovered ceramic materials can 'superconduct'.

Describe the mechanism of superconductivity in terms of the BCS theory and describe how superconductivity is different to conductivity in metals.

Question 28 (6 marks)

Galileo's analysis of projectile motion included one component of motion that had constant acceleration.

Describe an investigation that you can carry out to show that Galileo's one component did have constant acceleration.

Your answer should include how your results were analysed.

Question 29 --- From Quanta to Quarks (25 marks)

Marks

- (a) The energy distribution of electrons emitted in beta decay posed a problem for physicists.
- (i) What was the nature of the energy distribution? 3
- (ii) Explain why it was regarded a problem. 1
- (iii) Explain how Pauli's neutrino proposal resolved this problem. 1
- (b) Account for the need of the strong nuclear force and describe the properties of this force. 6
- (c) Pauli contributed significantly to the development of atomic theory.
- (i) Identify the name given to the major principle Pauli developed. 1
- (ii) Assess the contribution of Pauli to our understanding of the atom. 3
- (d) Design an investigation that could be used to determine if the emission from a radioactive isotope contains alpha, beta or gamma radiation. 6
- (e) Calculate the de Broglie wavelength of an electron moving with a velocity of $1.2 \times 10^6 \text{ ms}^{-1}$. 1
- (f) The mass of $^{35}_{17}\text{Cl}$ nucleus is 34.96885 amu.
- (i) What is its binding energy? 2
- (ii) What is its binding energy per nucleon? 1

End of paper