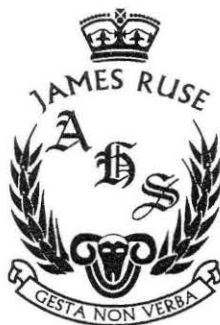


JAMES RUSE AGRICULTURAL HIGH SCHOOL



2008

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 calculators may be used

Total marks – 100

Section I Pages 2 – 21

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 22 – 23

25 marks

- Attempt all parts of this question 28
- Allow about 45 minutes for this section

Section 1
75 marks

Part A – 15 marks

Attempt Questions 1-15

Allow about 30 minutes for this part

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample: $2 + 4 =$ (A) 2 (B) 6 (C) 8 (D) 9
A B C D

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A B C D

If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word **correct** and drawing an arrow as follows.

A B C D
correct

1. If Earth began to shrink but its mass remained the same, what would happen to the value of g on Earth's surface?
 - (A) It would remain constant
 - (B) It would increase
 - (C) It would be halved
 - (D) It would decrease

2. Which of the following principles of physics explain the launch of a rocket?
 - (A) Newton's first law of motion and the law of conservation of momentum
 - (B) Newton's second law of motion and the law of conservation of momentum
 - (C) Newton's third law of motion and the law of conservation of momentum
 - (D) Newton's second and third laws of motion and the law of conservation of momentum

3. Two satellites, A and B, of the same mass are in circular orbit around the Earth. The distance of satellite B from the Earth's centre is twice that of satellite A. What is the ratio of the force acting on B to that acting on A?
 - (A) 1 : 4
 - (B) 1 : 2
 - (C) There is no force on the satellites because they are in free fall.
 - (D) It depends on the mass of the satellites.

4. If the escape velocity of a rocket from the surface of the Earth is v_e , then what would be the escape velocity of the same rocket from the surface of a planet whose acceleration due to gravity, as well as radius, are 4 times that of the Earth ?
 - (A) $4 v_e$
 - (B) $16 v_e$
 - (C) v_e
 - (D) $v_e/4$

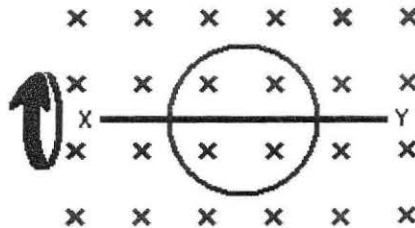
5. Which one of the following systems would most closely resemble an inertial reference frame?
- (A) A weather balloon descending at constant velocity.
 - (B) A rocket undergoing uniform acceleration.
 - (C) A train rounding a turn at constant speed.
 - (D) An orbiting space station.

6. Some eddy currents will be generated in all of the following situations. Which application is most likely to use these eddy currents for electromagnetic braking?
- (A) Galvanometers
 - (B) Loudspeakers
 - (C) Maglev trains
 - (D) Transformers

7. A single circular loop of wire, radius 5.0 cm, is lying in the plane of this piece of paper, as shown in the diagram. It is glued to plastic axle X - Y, which is also in the plane of the paper. A uniform magnetic field, of strength 10.0 Tesla extends into the paper, as shown. The plastic axle X-Y rotates on its own axis X-Y, through 360° .

What will be the change in flux through the circular loop?

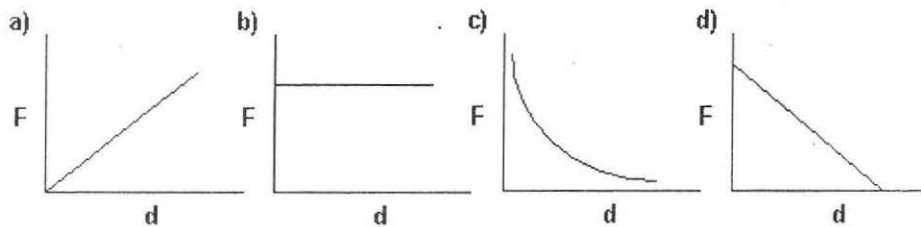
- (A) 0 Wb
- (B) 0.25 Wb
- (C) 0.5 Wb
- (D) 50.0 Wb



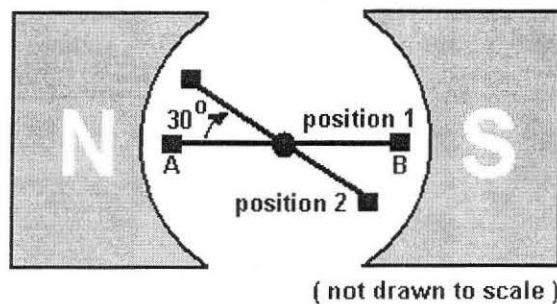
8. A technician has to install a small ventilation fan for the toilet in an underground tunnel. The fan will need to operate continuously for 5 years without maintenance. What will be the best motor to choose for this fan ?
- (A) A DC motor.
 - (B) A Faraday motor.
 - (C) An AC induction motor.
 - (D) An AC motor with long life brushes.

9. In a laboratory physics experiment students set up two long parallel wires. The current through each wire and the length of the two wires is kept constant throughout the experiment. A balance is set up to measure the magnetic force of attraction/repulsion between the wires, and the scale calibrated to eliminate the reading created by gravity. As the distance (d) between the wires is varied, the force (F) is recorded.

Which one of the following graphs best represents the results obtained?



10. In this diagram we are looking at the end of the plastic axle, in a side view of the rectangular coil A - B, of a model electric motor. The coil started at position 1, in line with the magnetic field lines and has turned through 30° to position 2 as shown.

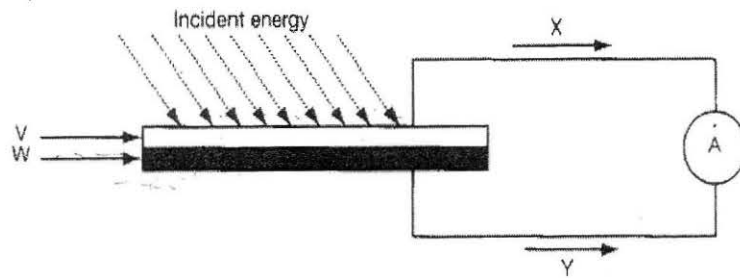


The coil has 50 turns of wire, the area of the rectangular coil is 0.40 m^2 , and there is a DC current of 3.6 A flowing in the coil. The magnetic field strength between the magnetic poles is uniform at 0.035 T .

What then is the magnitude of the respective torques, on the coil, at position 1 and position 2?

- (A) 0 Nm and 2.52 Nm
 (B) 2.52 Nm and 2.18 Nm
 (C) 2.52 Nm and 1.26 Nm
 (D) 0 Nm and 1.26 Nm

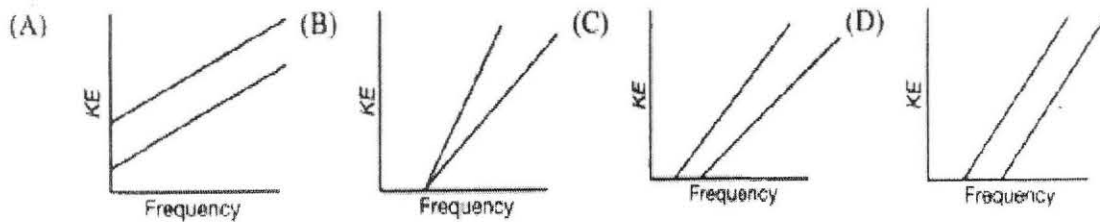
11. Use this diagram to answer the question below



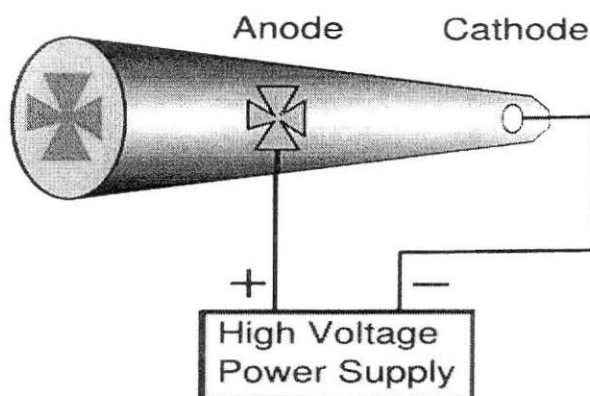
Assume that V is an n-type of semiconductor.

Which choice best describes what the arrows X and Y represent?

- (A) X = conventional current flow
Y = electron flow
- (B) X = electron flow
Y = conventional current flow
- (C) X = electron flow
Y = positive hole flow
- (D) X = positive hole flow
Y = electron flow
12. Which graph best shows the relationship between the kinetic energy of photoelectrons and the frequency of the incident radiation for two different metals?



13. Which statement best accounts for superconductivity?
- (A) Magnetic levitation allows electrons to move freely in the conduction bands
 - (B) Below the critical temperature the lattice vibrations are insignificant and do not interfere with the flow of electrons.
 - (C) Cooper pairs have no energy and cannot transfer energy to the lattice during collisions
 - (D) The Cooper pairs collide with lattice ions but do not lose energy during these collisions
14. Which of the following statements correctly describes the electric field strength in the region around an isolated electron in space?
- (A) The field is directed radially towards the electron and gets weaker near the electron.
 - (B) The field is directed radially towards the electron and gets stronger near the electron.
 - (C) The field is directed radially away from the electron and gets stronger near the electron.
 - (D) The field is directed radially towards the electron and is uniform at all distances.
15. In a first hand investigation that you performed, you used a discharge tube containing a Maltese Cross. You would have observed an image similar to the one shown below.



Which of the following statements is a valid conclusion from the observations made for this Maltese Cross investigation?

- (A) Cathode rays pass through glass
- (B) Cathode rays pass through metals
- (C) Cathode rays are charged particles
- (D) Cathode rays travel in straight lines

SECTION 1 (Continued)

PART B 60 Marks

Attempt Questions 16-27

Allow about 1 hour and 45 minutes for this part.

Answer the questions in the spaces provided.

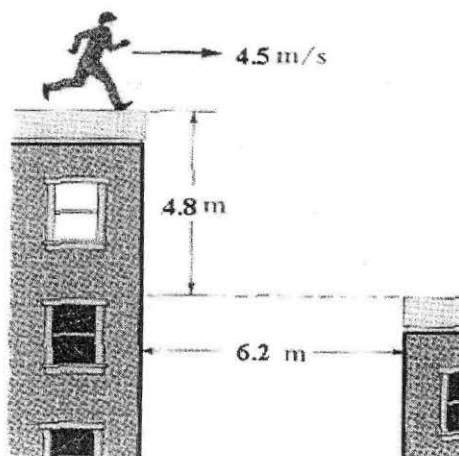
Show all relevant working in questions involving calculations.

Question 16 (3 marks)

Marks

A movie stuntman is to run across a roof top and then horizontally off it, to land on the roof of the next building, as shown.

Before he attempts the jump, he wisely asks you to determine whether it is possible.

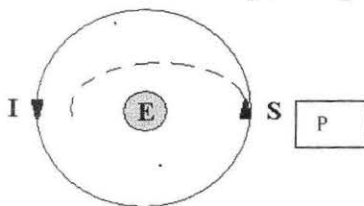


Can he make the jump if his maximum horizontal rooftop speed is 4.5 ms^{-1} ? Justify with calculations.

Question 17 (7 marks)

Marks

Two small spaceships, each with mass $m = 2\,000\text{ kg}$, are in the circular orbit, at an altitude of 400 km . Igor, the commander of one of the ships, arrives at a fixed point in the orbit 90 s ahead of Sally, the commander of the other spaceship. ($r_{\text{earth}} = 6.4 \times 10^6\text{ m}$).



(a) Determine the period of the two ships in this circular orbit.

2

(b) Determine the speed of the two ships in this circular orbit.

2

At a point such as P, Sally wanting to get ahead of Igor, fires the rocket engine with an instantaneous burst in the forward direction, reducing her speed by 1.00% . After she executes her burn, Sally will follow the elliptical orbit shown dashed.

(c) What is the speed of her ship immediately after the burn?

1

Marks
1

(d) What is the kinetic energy of her ship immediately after the burn?

(e) What is the potential energy of her ship immediately after the burn?

1

Question 18 (8 marks)

Assume you are travelling away from Earth at speed $0.5c$.

(a) Predict what changes if any, would you notice in your heartbeat, your mass, height, or width. 4

Heartbeat:

Mass:

Height:

Width:

(b) Predict what observers on Earth using telescopes would say about your heartbeat, mass, height and width? Outline a reason for your prediction. 4

Heartbeat:

Reason:

Mass:

Reason:

Height:

Reason:

Width:

Reason:

Question 19 (3 marks)

Orbiting satellites can undergo orbital decay.

- (a) Define "orbital decay". 1
- (b) List TWO factors that may contribute to the changing rate of orbital decay of a satellite. 2

Question 20 (3 marks)

During a Physics experiment a group of students were required to plug a school power pack into the 240 V AC power socket. Unfortunately the teacher assumed that the students knew how to turn the power switch "on", so the power pack did not work at first. But this small problem was soon corrected and the students were able to draw 12 V, 4.5 A, from the DC output of the transformer unit.

- (a) Calculate the power output of the transformer. **1**
- (b) Calculate the input current, from the 240 V AC power point going into the transformer. **1**
- (c) The power pack has either a solid state or a thermionic device inside it. Identify the role of this device. **1**

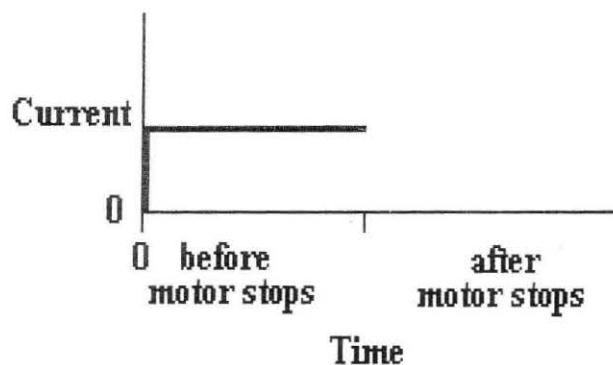
Question 21 (3 marks)

A builder buys a new cordless rechargeable DC battery drill. He reads the manufacturer's instructions which say that when the drill jams, or sticks, and the drill stops turning, the drill should be turned off immediately. The builder charges the battery fully and starts to drill a very large hole.

Soon the drill jams and the DC drill motor stops turning. The builder reasons that since the Motor is not turning, it is not using power, so he leaves it turned "on". He is wrong. The motor becomes hot and starts smoking.

- (a) The sketch graph below shows current flowing into the DC drill motor before the drill stops turning. 1

Complete the graph, in the answer space, showing current after the drill stops turning.



- (b) Explain why the drill motor overheats after it jams and stops turning. 2

Question 22 (4 marks)

An electron gun is used to produce a beam of electrons in a television set. Field coils around the television tube then steer the electrons onto the TV screen. Assume the path is circular. The electrons are travelling at a speed of $1.5 \times 10^8 \text{ ms}^{-1}$ and the radius of the circular path is 50 cm.

- (a) Calculate the centripetal force on the electrons. 2
- (b) Calculate the magnitude of the magnetic flux density required to produce this radius. 1
- (c) Outline why magnetic coils are used to steer the electron beam in television sets, instead of permanent magnets. 1

Question 23 (8 marks)

Marks

A teacher is about to perform a class demonstration to teach the following dot point from the HSC Physics syllabus:

"Plan, choose equipment or resources for, and perform a first-hand investigation to demonstrate the production of an alternating current."

- (a) Write an equipment list for the teacher. Include a labelled diagram of how the equipment is set up. **3**

- (b) Write a method for the demonstration, listing what will be done with the equipment. **3**

- (c) Sketch and describe the expected results that will demonstrate that AC has been generated. 2

Question 24 (5 marks)

A physics student was conducting an investigation on the photoelectric effect. The student used an infrared laser with a wavelength of 1.55×10^{-6} m for this investigation.

- (a) Calculate the energy of a photon from this laser. 2
- (b) When the laser was shone on a photo-cell, no current was detected. The student increased the intensity of the light but still detected no current. 2
- Explain why this variation failed to produce a current.
- (c) Describe one variable that could be changed so that a current from this photo-cell is observed. 1

Question 25 (5 marks)

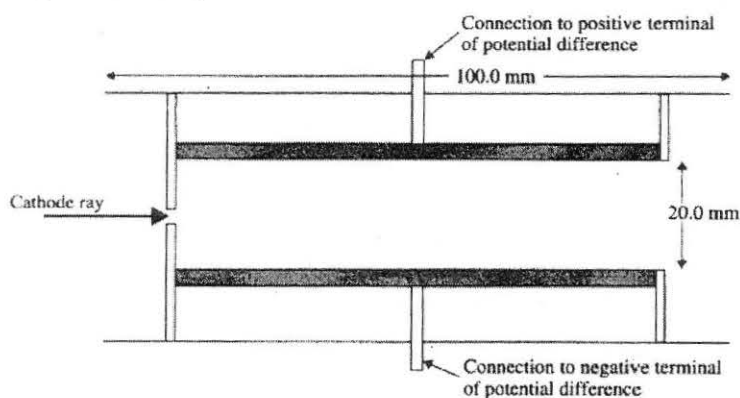
Explain Einstein's contribution to quantum theory and how it relates to black body radiation.

Question 26 (6 marks)

- (a) Name TWO of the three groups of substances that have been identified as exhibiting superconductivity and name an example for EACH group. 2
- (b) Name the group of superconductors with the highest critical temperature. 1
- (c) Outline the BCS theory proposed to explain superconductivity. 3

Question 27 (5 marks)

A pair of parallel plates, 100 mm long and a distance 20 mm apart is set up in an evacuated tube, as shown.



A potential difference is applied to the plates, creating an electric field of 66 NC^{-1} down. A beam of cathode rays, where all the particles are travelling at $6 \times 10^6 \text{ ms}^{-1}$, enter the region between the plates from the left, at a point midway between the plates, as shown in the diagram. (Neglect any effects due to gravity).

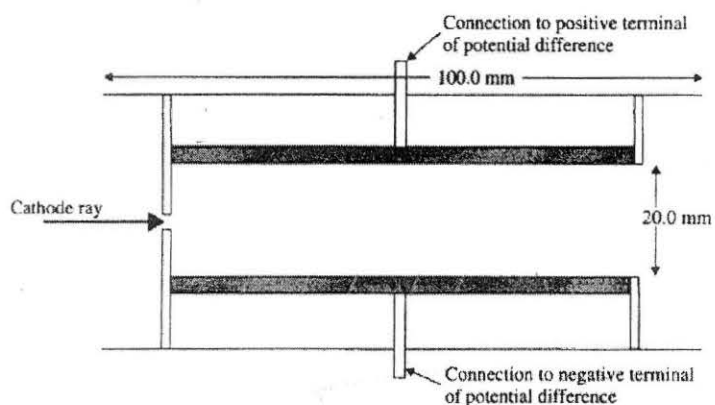
- (a) Calculate the potential difference applied to the plates. 1
- (b) Calculate the force that will act on the particles in the cathode ray as they enter the electric field between the plates. 2

(c) Describe the path of the cathode ray will take as it passes between the plates.

1

(d) On the diagram below, sketch the direction of a magnetic field that would be needed to be applied so that the beam of cathode rays travels undeflected.

1



SECTION II

25 marks

Allow about 45 minutes for this section.

Answer this question in a writing booklet.

Show all relevant working in questions involving calculations.

Question 28 From Quanta to Quarks

Marks

(a)



Outline the contribution of Heisenberg to the development of atomic theory.

2

- (b) Modern particle accelerators are very expensive to build and run. Assess their usefulness.

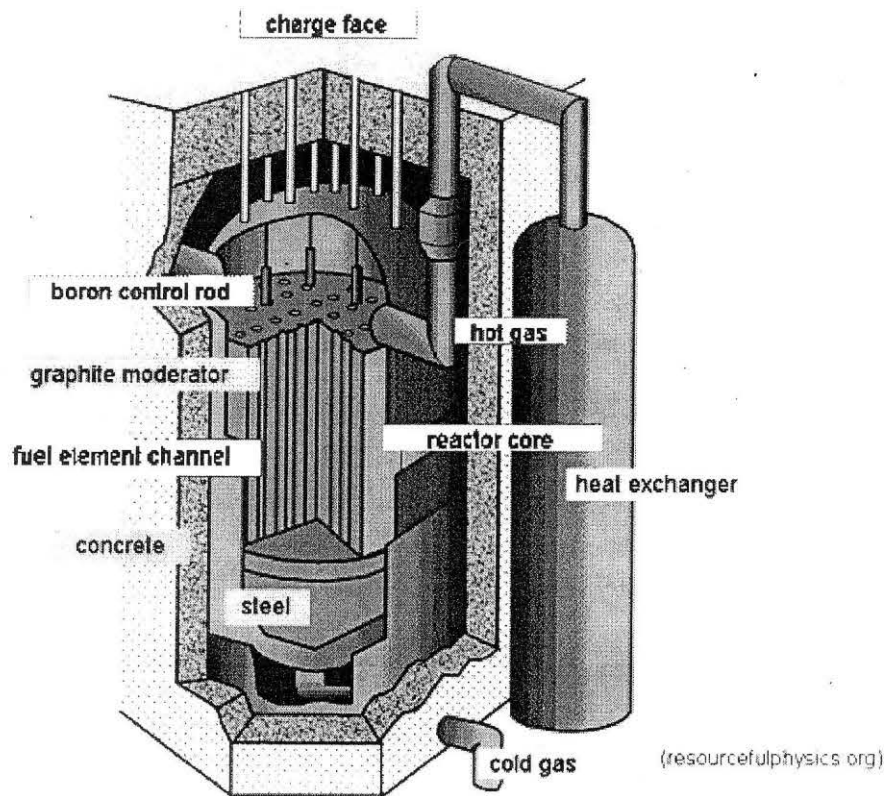
3

- (c) Scientists investigating naturally occurring radioactivity could not explain the properties they observed by simply assuming the nucleus contained protons and electrons.

6

Discuss the prediction and subsequent discovery of the neutron **and** neutrino. Include in your discussion the relevance of the laws of conservation of energy and momentum.

- (d) The figure shows the basic features of a nuclear fission reactor.



- (i) Which part of the nuclear reactor regulates the rate of fission taking place? Justify your answer. 2
- (ii) Neutron beams can be extracted from nuclear reactors. 4

Describe how the neutron can be used as a probe for investigating the nature of matter by referring to the properties of neutrons .

- (e) (i) Calculate the nuclear mass defect of tritium, ${}^3\text{H}_1$. The mass of tritium is 3.016149 u. 2
- (ii) Calculate the binding energy per nucleon of the tritium nucleus. 2
- (f) Discuss the key features and components of the standard model of matter. 4

END OF QUESTION 28