STANSW

School Name/logo

Trial Higher School Certificate 2001

PHYSICS

Time allowed : 3 hours plus 5 minutes Reading time.
Approved calculators may be used.

Instructions to Candidates :

This Examination paper has **TWO** sections as follows;

Section I. - CORE

This section has **TWO** Parts, all questions should be attempted.
Suggested time - Allow about 2 hours 15 minutes to complete this section.

Part A - Multiple Choice questions
Questions 1 to 15. (1 mark each - 15 marks)

Part B - Written Response questions
Questions 16 to 26. (Marks as shown - 60 marks)

The **CORE** is worth a TOTAL of **75** marks.
Answer Part A questions by marking your choice in the appropriate place on the Multiple Choice Answer sheet provided.
Answer Part B questions by writing your answers in the spaces provided within the Questions of this Paper.

Section II. - OPTIONS

Candidates should attempt only ONE OPTION from the questions below.
Each **OPTION** question is worth a TOTAL of **25** marks.
All Parts of the Option question chosen should be attempted.
Suggested time - Allow about 45 minutes to complete this section.

Question 27 - Geophysics
Question 28 - Medical Physics
Question 29 - Astrophysics
Question 30 - Quantum to Quarks
Question 31 - Age of Silicon

Answer the OPTION question chosen in the OPTION ANSWER BOOKLET provided.

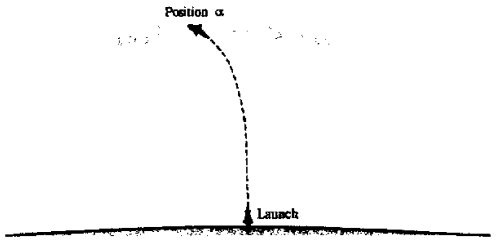
A sheet of **Equations and Relevant Physical constants**, and a **Periodic Table**, have been included for your use. Found at the end of the paper, these should be removed for use during the examination.

Section I - CORE

Part A - Multiple Choice

Answer these questions by selecting the alternative that BEST answers the question asked and marking your choice with a X in the appropriate place in the CORE Answer Booklet

1. A rocket is launched and during the early stage of its flight into orbit followed a path, initially vertical, but then tipping to the west, as shown in the diagram below,



During the time the rocket travelled from the launch site to the Position α shown, the thrust from the rocket engines was controlled to produce a constant acceleration of the rocket in the direction that it was heading. When the human passengers on board the rocket are considered, which of the following statements is correct?

A. The ***g*** -forces experienced by the passengers will remain constant after launch while the rocket travels to Position α .

B. The path of the rocket is tipped over to the west to gain the speed from the earth's rotation

C. As the path of the rocket tilts from the vertical the ***g*** -forces experienced by the passengers will begin to reduce.

D. As the path of the rocket tilts over to the west the gain in speed due to the earth's rotation will increase the ***g*** -forces experienced by the passengers.

2. Although humans have been successful in travelling to the Moon, even though the technology and requirements are understood, space missions to even the closest objects are proving difficult. What is a significant problem for distant space missions involving human passengers that needs to be overcome ?

A. communication systems need to be improved to ensure they are reliable

B. rocket systems need to be developed to enable much higher speeds to be obtained

C. life-support systems to keep humans alive for extended times must be developed

D. all of the above are significant problems which must be overcome for extended space travel

3. During astronaut training, much of the preparation is done using special equipment while underwater in deep pools. What is the main reason this training is done?

A. to simulate the weightless environment encountered while in orbit.

B. to reduce the large mass of the space suits and equipment used.

C. so that the trainees have no surfaces to provide a reaction force to their actions.

D. the water stops the effects of gravity from acting on the trainees

4. Two satellites X and Y are in near circular orbits around the earth. The satellites are identical in mass but satellite X is in a low-earth orbit while satellite Y is in an orbit with a radius 10 times larger than X. When considering the speed and the gravitational potential energy of the two satellites, which of the following statements is correct?

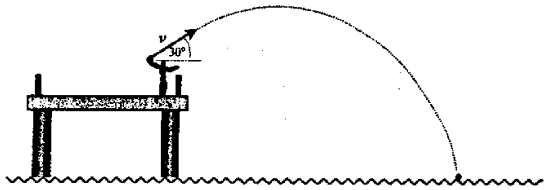
A. satellite X has a higher speed, but less gravitational potential energy than satellite Y.

B. satellite X has a higher speed, and more gravitational potential energy than satellite Y.

C. satellite Y has a higher speed, but less gravitational potential energy than satellite X.

D. satellite Y has a higher speed, and more gravitational potential energy than satellite X.

5. A ball is thrown from a bridge at v ms^{-1} , at angle of 30° to the horizontal, and travels out over the river below, landing in the water. The ball followed a path as shown in the diagram below,



The ball was recorded to take 2.5 seconds from when thrown, till it hit the water, travelling horizontally a distance 22.5 m. Considering this, which of the following is closest to, v , the speed the ball was thrown? $s = ut + \frac{1}{2}at^2$

$22.5 = v\cos 30° \times 2.5 + 0$

$v = 10.4$ ms^{-1}

A. 7.8 ms^{-1}

B. 9.0 ms^{-1}

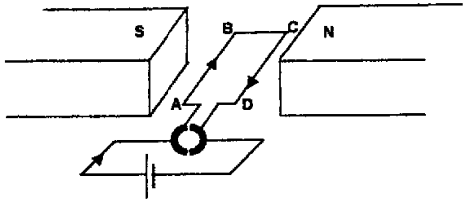
C. 10.4 ms^{-1}

D. 18.0 ms^{-1}

6. The following diagram is of a simple electric motor with a single loop forming a rectangular coil. Information on the motor is provided.

Current in loop = 5.0 A Magnetic field strength = 1.0×10^{-2} T

AB = CD = 0.080 m BC = 0.020 m



If the coil is viewed from this side, which of the following conclusions about this motor is correct?

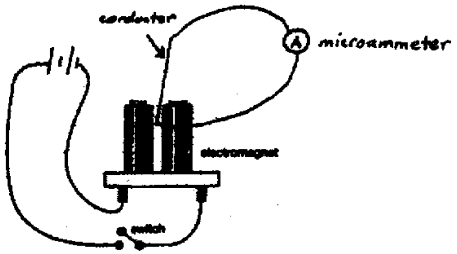
A. The torque is 4.0×10^{-5} Nm and a maximum when the loop is in the position shown.

B. The torque is kept uniform at 8.0×10^{-5} Nm due to the split ring commutator.

C. The maximum value of the turning effect of the force is 8.0×10^{-5} Nm clockwise.

D. The current causes a maximum turning effect of 4.0×10^{-5} Nm clockwise.

7. During a classroom experiment a student placed a conductor attached by leads to a microammeter, between the poles of an electromagnet. The student sketched the set-up, as shown below.



At the moment the electromagnet is switched on, which of the following would have been noticed by the student?

A. a current flows in the circuit for a brief time while the flux cutting the conductor is changing.

B. no current flows, as there is no relative movement between the conductor and the field.

C. a current flows while the magnet is operating because the conductor is in a magnetic field.

D. no current flows because of the angle between the magnetic flux and the conductor.

8. When the north pole of a magnet is moved towards the open end of a solenoid that is part of a closed circuit, this open end of the solenoid behaves like the north pole of a magnet. Which of the following provides the best explanation as to why a north pole formed?

A. Faraday's Law

B. Lenz's Law

C. The Law of Conservation of Momentum

D. The Motor Effect

9. A transformer is designed so that 240 volts AC is attached to the terminals of the primary coil with 3000 volts AC being supplied across the terminals of the secondary coil. When considering this transformer, which of the following statements is correct?

A. this is an example of a step-up transformer.

B. this transformer is impossible as transformers need DC voltages to operate.

C. there would be more coils in the primary than the secondary.

D. less than 3000 volts would be supplied when a circuit is attached to the secondary coil due to heat losses occurring in the attached circuit.

10. Which of the following actions could be used to demonstrate the production of alternating current?

A. Move a wire that is part of a closed circuit, down through a magnetic field.

B. Move a solenoid that is part of a closed circuit, vertically up and down.

C. Spin a piece of wire in a magnetic field that is changing.

D. Move a magnet in and out of a solenoid that is part of a closed circuit.

11. Which of the following correctly identifies Einstein's contribution to the concept that energy is absorbed and emitted as quanta.

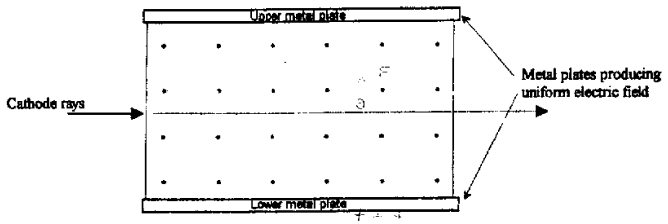
A. The discovery of the photoelectric effect.

B. The discovery that photoelectrons are emitted by incandescent black bodies.

C. The proposal that incandescent black bodies emit quanta of energy.

D. The explanation of the photoelectric effect.

12. A beam of cathode rays in an evacuated chamber, passes into a region travelling perpendicular to a uniform magnetic field that acts vertically OUT of the page as shown below. The metal plates shown produce a uniform electric field that also acts perpendicular to the path of the cathode rays.



The beam of cathode rays is observed to pass straight through the region, as shown by the dashed arrow. Considering the path of the Cathode rays, which of the following statements is correct?

A. these Cathode rays have no electric charge as they are not deflected by the fields
B. the magnetic and electric fields are equal in strength
C. the electric field is acting vertically into the page
D. the lower metal plate is charged positively .

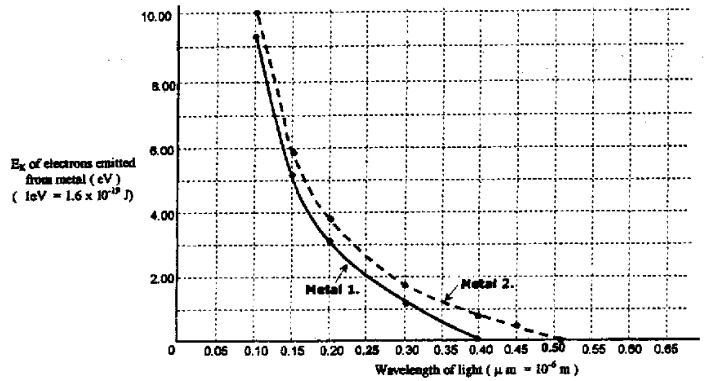
13. Which of the following gives the main reason why X-rays, rather than UV or visible light, are normally used to investigate crystal structure.

A. X-rays can pass easily through crystals
B. The atomic separation in crystals is usually larger then the wavelength of X-rays
C. Each X-ray photon has more energy than in the case of either UV or visible light
D. Electrons can more easily be released from atoms by X-rays.

14. Which of the following is correct for a p-type semiconductor and describes how it is different from an n-type semiconductor ?

A. a p-type has positive holes as the major charge carrier.
B. a p-type has negative electrons as the major charge carrier.
C. a p-type uses extrinsic conduction rather than intrinsic conduction.
D. a p-type contains similar numbers of positive holes and free electrons.

15. The following graph shows results collected on the kinetic energy of electrons that were emitted from TWO metals as the wavelength of the light source was changed.



Considering the graph, which of the following statements is correct?

A. the greater the kinetic energy of the electrons the shorter their wavelength
B. the work-function for Metal 1. is greater than for Metal 2.
C. the intensity of the light used for Metal 2. was greater than the intensity used with Metal 1.
D. the slope of the line represents Planck's constant.

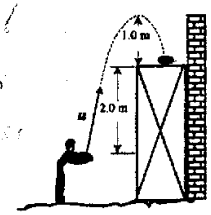
End of Part A

Answer these questions in the space provided. The space can be used as a guide to the length of the expected answer with a little more than sufficient space provided for most questions. Where calculations are involved, show all essential working.

16. **4 marks**

A 5.0 kg sand bag is thrown at u ms^{-1}, at 72° to the horizontal, up onto a scaffold. The platform of the scaffold is 2.0 m above the point where the bag was thrown. The bag rose 1.0 m above the scaffold and then landed 1.235 s after being thrown, coming to rest on the scaffold platform, as shown in the diagram below. (Effects due to friction can be neglected)

horizontal vertical



explain gravity

a. Explain how the information provided can be used to determine the magnitude of u, the speed the sand bag was thrown? **3 marks**

Using the total distance ... 3m and ...

... the speed of u can be calculated.

$0 = (u^2 ...) - 2 \times ... \times 3$

$58.8 = u^2 \sin^2 72°$

b. Calculate the horizontal distance travelled by the sand bag in being thrown onto the scaffold platform? **1 mark**

horizontal ...

$s = ut$

$= 8.1 \times \cos 72° \times 1.235$

$\therefore s = 3.1$ m

Write your answer in the Space provided.

17. **7 marks**

A particular low-earth orbit satellite has a mass of 1.12 tonne, (1 tonne $= 10^3$ kg) and completes a near circular orbit of the Earth at an average distance of 778 km above the Earth's surface. (You are supplied the radius and mass of the Earth on the ***Equations*** and ***Constants Sheet***.)

a. Explain how the speed of this satellite as it orbits the Earth could be determined and calculate the value. **3 marks**

b. Compare the gravitational potential energy and motion of this satellite, with one of similar mass, but in a circular ***Geostationary*** orbit. **4 marks**

18. **5 marks**

The *Luminiferous ether* (aether) had been inferred by the ancient Greeks and proved a difficult subject, much discussed by various great thinkers and scientists. In an attempt to solve the problem and verify the existence of the ether, Albert Michelson designed special equipment to perform an experiment in 1887 with Edward Morely. It was a theory proposed by Albert Einstein in 1905, that seemed to finally provide a solution.

Explain why the ether was proposed and outline the Michelson and Morley experiment, describing the result, and the proposal by Einstein that seemed to offer a solution?

The ether was the medium to carry light

19. **4 marks**

An early NASA scientist decided to expose himself to high *g*-forces to explore the effects. A small rocket engine produced thrust for a short time to propel a vehicle, of mass 1280 kg including the scientist, along a horizontal railway track. By increasing the thrust of the rocket, the scientist was able to change the magnitude of the *g*-forces experienced, with the results yielding some important details.

a. During one trial, the rocket engine consumed fuel at a uniform rate of 32.2 kg per second, expelling the exhaust gas at 2340 ms^{-1}. Assuming the vehicle is released with the rocket producing full thrust, explain how to determine the average acceleration over the first second, and calculate the number of *g*'s of acceleration experienced by the scientist. 2 marks

b. Outline ONE benefit that may have come from this research and explain why this information may prove very useful to future humans. 2 marks

20. **5 marks**

a. Outline, by using a labelled diagram, a simple experiment that would allow you to demonstrate the motor effect in the school laboratory. 3 marks

b. Describe the application of the motor effect in a galvanometer. 2 marks

21. **4 marks**

Explain why electricity is usually generated and transmitted as alternating current.

22. **7 marks**

Transformers play an important role in modern electrical systems. A particular transformer has an input of 10 kV with 50000 turns in the primary coil. The output from the secondary coil, containing 12000 turns, is 2000 V.

a. The above example is not an *ideal* transformer, i.e. it is not 100% efficient in transforming the electrical energy. Calculate the output you would expect if it was 100% efficient? 1 mark

$V_P = n_P$ 10000 : 50000 $V_S = 2000$

$\frac{V_S}{n_S} = \frac{V_S}{12000}$

b. Explain why most transformers are not ideal and describe a technique used to improve the efficiency of modern transformers. 3 marks

c. Consider the following statement regarding the use of transformers;

"It is now possible to concentrate the generation of power to a few remote power stations and still benefit from all the electrical appliances associated with 21st century living."

Evaluate the statement and outline reasons why this situation is now possible. 3 marks

23. **4 marks**

The majority of modern motors are AC induction motors.

Describe the principles by which an induction motor operates and outline a reason why they have become the most common motors in general use.

24. **5 marks**

J.J. Thomson used a cathode ray tube to determine the charge/mass ratio of the electrons making up a cathode ray.

a. Describe the role of the fluorescent screen in a cathode ray tube. 1 mark

b. Outline how Thomson used the cathode ray tube in his experiment to determine the charge/mass ratio of the electron. 4 marks

Section I - CORE Part B - Written Response questions
Write your answer in the Space provided.

25. **8 marks**

Despite the convincing evidence from the Hertz experiment in 1887, Einstein used Planck's concept of quantised energy to describe a new model for light in his paper on the Photoelectric effect in 1905.

a. Outline the basic features of the model for light that was given convincing support by the Hertz experiment 2 marks

b. Light of wavelength 420 nm produces the emission of photoelectrons from a piece of metal. Describe how Einstein explained the emission of these electrons and calculate the energy per quantum in the light used. 3 marks

c. As part of your studies you researched devices that used the photoelectric effect. For ONE of these devices, outline how it uses the photoelectric effect and evaluate the influence the device is having on the lives of modern humans. 3 marks

26. 7 marks

Our ability to control electrons to produce currents as required, and use them more efficiently, has improved over time. The thermionic devices and valves developed early in the 20th century have been replaced by solid-state devices, and the development of superconductors offers exciting possibilities.

a. Explain TWO advantages of solid state devices that led to them replacing thermionic devices during the second half of the 20th Century. 3 marks

b. Identify how a superconductor is different from the usual conductors and explain why there are still limitations to the use of superconductors. Describe TWO significant advantages that will be gained when we are able to readily use superconductors. 4 marks

Question 30 - Quanta to Quarks

5 marks

a.

The atom was initially conceived as a fundamental, indivisible particle but, with the development of the Rutherford atomic model in 1911 and the modifications to this model by Bohr in 1913, the atom described could no longer be considered as a fundamental particle. Analysis of bright-line emission spectra from elements, gave some support for the modifications Bohr included, but detailed analysis showed further considerations were needed.

i. Outline the basic features of the Bohr-Rutherford atomic model proposed by Bohr. 2 marks

ii. Summarise the support from bright-line spectra for Bohr's model and describe ONE observation that his Bohr-Rutherford model was still unable to explain. 3 marks

4 marks

b.

The most popular model of the atom that emerged by 1932 incorporated the deBroglie hypothesis and Heisenberg's Uncertainty principle, with the deBroglie hypothesis allowing the development of the electron microscope.

i. Explain why the electron microscope can create greater magnification than a light microscope and describe how the magnification of an electron microscope is controlled. 3 marks

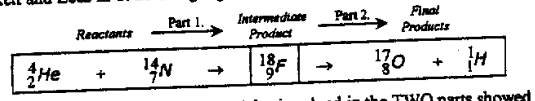
ii. Calculate the wavelength of an electron travelling at 5×10^6 ms^{-1} ? 1 mark

5 marks

c.

Studies of radioactivity and an understanding of the transmutations that occur provided important details on the nucleus of atoms and the forces involved. This information, combined with experiments using particle accelerators, ultimately led to the present "Standard Model" of the atom.

i. The nuclear equation shown below represents a modern interpretation of the first recorded nuclear reaction (artificial transmutation) created by humans. It was recorded by Blackett and Lees in 1925 using high energy α- particles released into nitrogen gas;



Analysis of the rest masses of the particles involved in the TWO parts showed that the total mass of the original Reactants, was less than the mass of the Intermediate Product formed in Part 1, while the total mass of the Final Products formed in Part 2, was just less than the total mass of the original Reactants.

Explain what the masses of the various components indicates about the tendency of Part 1 and Part 2 of the reaction to occur spontaneously. 3 marks

ii. The outcome of the radioactive decay, known as β-minus decay, is that a neutron in the radioactive nucleus becomes a proton, with a β^- particle and an antineutrino being ejected from the nucleus. Describe how the present "Standard Model" of the atom would now explain β-minus decay. 2 marks

Question 30 continues on the next page.

d. **4 marks**

The model of the atom has undergone an evolution from Rutherford's original nuclear model to reach the present "Standard Model", that now sees quarks and leptons as the fundamental particles from which all matter is composed.

Outline the basic points involved in the "Standard Model" that now describes how the nuclear atom is constructed, including in your answer the present view of the interactions involved to create the final form of the nucleus, atom, and the matter that we experience.

e. **7 marks**

Facilities dealing with radioactivity, particularly those harnessing energy from nuclear reactions, have caused concern for some in the "general public", but there are obvious benefits for society from the research reactors, and there is an ever increasing demand for electrical energy.

i. Using a particular radioisotope you have studied, explain how the radioisotope is used to benefit society. 3 marks

ii. Natural radioactive materials release nuclear radiation into the environment. There are THREE forms of natural radioactive emissions. Describe the method for an experiment that could be used to determine how far each of these radioactive emissions can penetrate through air, providing an outline of the results you might expect for each of the THREE forms of natural emissions. 4 marks

End of Question 30.