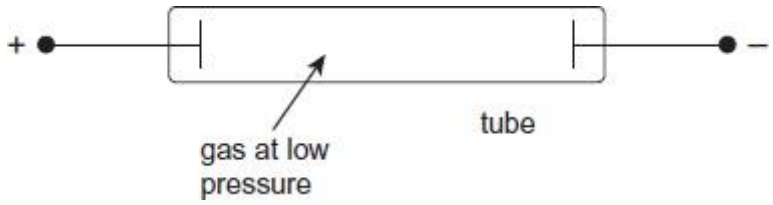
Name of the Student:_____
Max. Marks : 26 Marks **Time : 26 Minutes**

Q1.

The following figure shows a discharge tube containing a gas at low pressure. When a sufficiently high potential difference is applied between the two electrodes in the tube the gas becomes conducting and emits light.



(a) (i) Describe how the charged particles responsible for conduction in the gas are produced.

_____

_____

_____

_____

_____

(2)

(ii) Explain why the gas emits light and why it must be at low pressure.

_____

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_____

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_____

(3)

(b) The charged particles moving towards the negative electrode were initially referred to as positive rays. Explain why their **specific charge** depends on the choice of gas in the tube.

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_____

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_____

(2)

(Total 7 marks)

Q2.

A muon is an unstable particle produced by cosmic rays in the Earth's atmosphere. Muons that are produced at a height of 10.7 km above the Earth's surface, travel at a speed of 0.996c toward Earth, where c is the speed of light. In the frame of reference of the muons, the muons have a half-life of 1.60×10^{-6} s.

(a) (i) Calculate how many muons will reach the Earth's surface for every 1000 that are produced at a height of 10.7 km.

number of muons _____

(3)

(ii) Which of the following statements is correct? Tick (✓) the correct answer.

	✓ if correct
For an observer in a laboratory on Earth, the distance travelled by a muon that reaches the Earth is greater than the distance travelled by a muon in its frame of reference	
For an observer in a laboratory on Earth, time passes more slowly than it does for a muon in its frame of reference	
For an observer in a laboratory on Earth, the probability of a muon decaying each second is lower than it is for a muon in its frame of reference	

(1)

(b) (i) Show that the total energy of an electron that has been accelerated to a speed of 0.98c is about 4×10^{-13} J.

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(2)

(ii) The total energy of an electron travelling at a speed of $0.97c$ is 3.37×10^{-13} J. Calculate the potential difference required to accelerate an electron from a speed of $0.97c$ to a speed of $0.98c$.

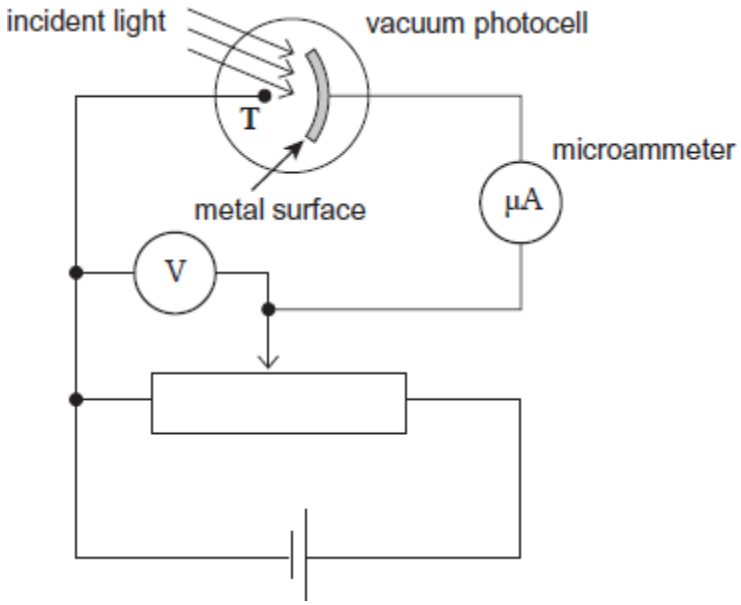
potential difference = _____ V

(1)

(Total 7 marks)

Q3.

The figure below shows a metal surface in a vacuum photocell illuminated by light of a certain frequency. Electrons emitted from the metal surface are collected by terminal **T** in the photocell.



(a) The potential of the metal surface may be changed by adjusting the potential divider. Explain why the microammeter reading decreases when the metal surface is made more

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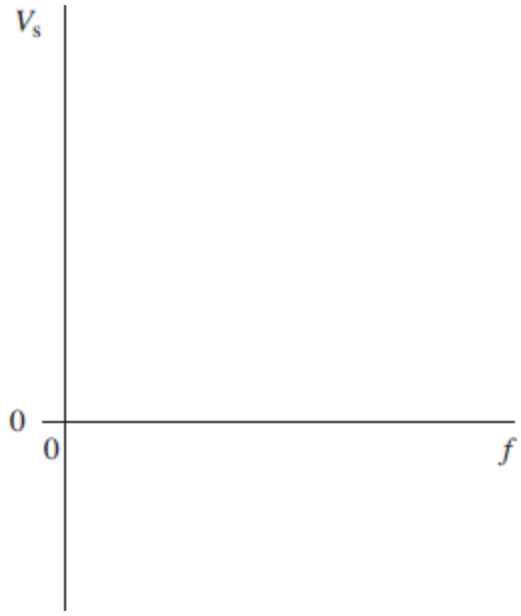
positive relative to **T**.

(3)

(b) The stopping potential V_s is the minimum potential that is applied to the metal surface to reduce the photoelectric current to zero when monochromatic light is incident on the surface. The circuit is used with light of different frequencies to measure the stopping potential V_s when the surface is illuminated at each frequency.

(i) Draw a graph on the axes below to show how V_s varies with the frequency f of the incident light.



(2)

(ii) Use the photoelectric equation $hf = \phi + E_k$ to explain your graph.

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(3)

(c) Using the circuit in the diagram above, the stopping potential was 1.92 V for light of wavelength 418 nm.

Use this information to calculate the work function of the metal surface.
Give an appropriate unit in your answer.

work function _____ unit _____

(4)

(Total 12 marks)

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