Name of the Student:____

Max. Marks : 25 Marks **Time : 25 Minutes**

Q1.

(a) A muon travels at a speed of 0.95*c* relative to an observer.

The muon travels a distance of 2.5×10^3 m between two points in the frame of reference of the observer.

Calculate the distance between these two points in the frame of reference of the muon.

distance = ________________ m

(2)

(b) Measurements of muons created by cosmic rays can be used to demonstrate relativistic time dilation.

State the measurements made and the observation that provides evidence for relativistic time dilation.

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(2)

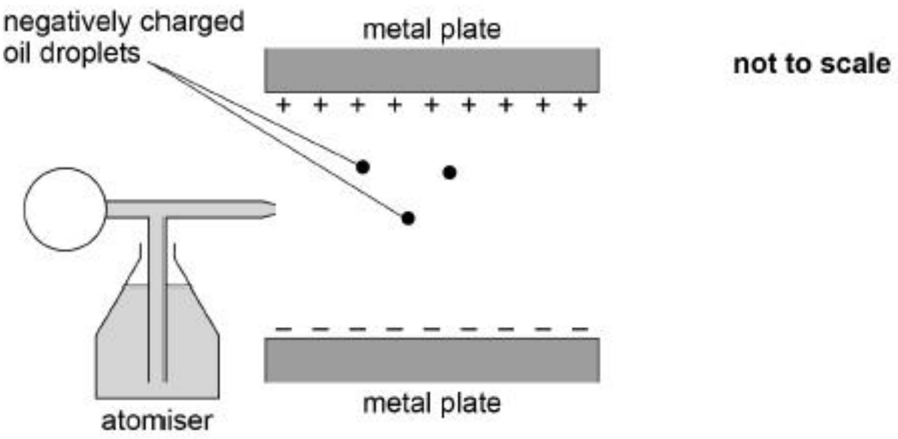
(c) As the muons travel through the atmosphere, their speeds are reduced by interaction with the particles in the air.

Discuss, with reference to relativity, the effect that this reduction of speed has on the rate of detection of the muons on the surface of the Earth.

(3)
(Total 7 marks)

Q2.

The diagram shows an experiment to measure the charge of the electron.



Negatively charged oil droplets are sprayed from the atomiser into the gap between the two horizontal metal plates. A potential difference is applied between the metal plates.

One of the droplets remains stationary.

(a) Identify the forces acting on the stationary droplet.
In your answer you should state the relationship between the forces.

The upthrust on the droplet due to the air it displaces is negligible.

(2)

(b) The potential difference between the plates is changed to zero and the droplet falls at a terminal velocity of 1.0×10^{-4} m s^{-1}.

The density of the oil is 880 kg m^{-3}
The viscosity of air is 1.8×10^{-5} N s m^{-2}

Show that the radius of the droplet is about 1×10^{-6} m.

Assume that the droplet is spherical.

(3)

(c) The potential difference between the plates is restored to its initial value and the droplet becomes stationary.

The charge on the droplet is -4.8×10^{-19} C.

A student suggests that, if the droplet splits into two spheres of equal size, both spheres would remain stationary.

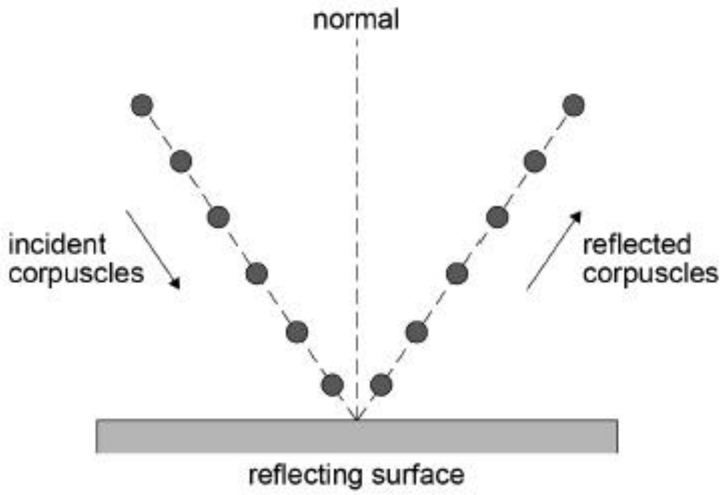
Deduce whether this suggestion is correct.

(3)
(Total 8 marks)

Q3.

Newton used a corpuscular theory of light to explain reflection.

The diagram shows how corpuscles would reflect from a horizontal surface.



(a) What happens to the horizontal and vertical components of the velocity of the corpuscles, according to the theory, when they are reflected?

Tick (✔) **one** box.

Horizontal component of velocity	**Vertical component of velocity**	**Tick the correct box**
Unchanged	Changed	
Changed	Unchanged	
Unchanged	Unchanged	
Changed	Changed	

(1)

(b) Newton used the corpuscular theory to explain the refraction of light at an interface between air and water.

Huygens used the wave theory to explain the refraction of light at the interface.

Discuss the evidence that led to the rejection of Newton's corpuscular theory.

In your answer you should include
- how each theory explains refraction
- how experimental evidence led to the acceptance of the wave theory.

(6)

(c) Light is now known to behave as an electromagnetic wave.

Describe a plane-polarised electromagnetic wave travelling through a vacuum.
You may wish to draw a labelled diagram.

(3)
(Total 10 marks)