

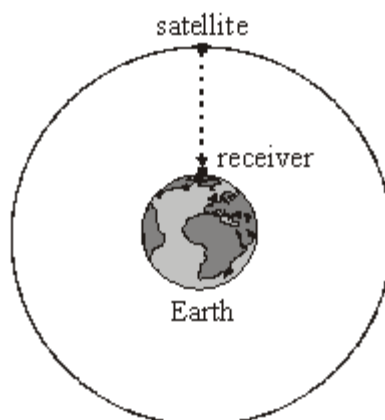
Name of the Student: _____

Max. Marks : 22 Marks

Time : 22 Minutes

Q1.

The Global Positioning System (GPS) is a system of satellites that transmit radio signals which can be used to locate the position of a receiver anywhere on Earth.



- (a) A receiver at sea level detects a signal from a satellite in a circular orbit when it is passing directly overhead as shown in the diagram above.

- (i) The microwave signal is received 68 ms after it was transmitted from the satellite. Calculate the height of the satellite.

- (ii) Show that the gravitational field strength of the Earth at the position of the satellite is 0.56 N kg^{-1} .

mass of the Earth = $6.0 \times 10^{24} \text{ kg}$
mean radius of the Earth = 6400 km

(b) For the satellite in this orbit, calculate

(i) its speed,

(ii) its time period.

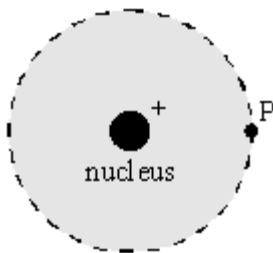
(5)

(Total 9 marks)

Q2.

The mass of the nucleus of an isolated copper atom is 63 u and it carries a charge of +29 e. The diameter of the atom is 2.3×10^{-10} m.

P is a point at the outer edge of the atom.



(a) Calculate

(i) the electric field strength at P due to the nucleus,

(ii) the gravitational potential at P due to the nucleus.

(5)

- (b) Draw an arrow on the above diagram to show the direction of the electric field at the point P.

(1)

(Total 6 marks)

Q3.

Both gravitational and electric field strengths can be described by similar equations written in the form

$$a = \frac{bc}{d^2}.$$

- (a) Complete the following table by writing down the names of the corresponding quantities, together with their SI units, for the two types of field.

symbol	<i>gravitational field</i> quantity SI unit		<i>electrical field</i> quantity SI unit	
a	gravitational field strength			
b			$\frac{1}{4\pi\epsilon_0}$	m F ⁻¹
c				
d				

(4)

- (b) Two isolated charged objects, A and B, are arranged so that the gravitational force between them is equal and opposite to the electric force between them.

- (i) The separation of A and B is doubled without changing their charges or masses. State and explain the effect, if any, that this will have on the resultant force between them.

- (ii) At the original separation, the mass of A is doubled, whilst the charge on A and the mass of B remain as they were initially. What would have to happen to the charge on B to keep the resultant force zero?

(3)

(Total 7 marks)