BOARD OF INTERMEDIATE EDUCATION, KARACHI

INTERMEDIATE EXAMINATION, 2025 (ANNUAL)

Date: 14.05.2025
04:40 p.m. to 5:00 p.m.

PHYSICS PAPER – I
(Science General Group)
(For Fresh Candidates)

Max. Marks : 17
Time: 20 Minutes

According to New Book

SECTION 'A'
(MULTIPLE CHOICE QUESTIONS) – (M.C.Qs.) (Marks : 17)

Note:
i) This section consists of 17 part questions and all are to be answered. Each question carries 1 mark.
ii) Do not copy the part questions in your answerbook. Write only the answer in full against the proper number of the question and its part.
iii) The use of scientific calculator is allowed. All notation are used in their usual meanings.

1. Select the correct answer for each from the given options:

i) If $\hat{i}, \hat{j}$ and $\hat{k}$ are unit vectors then $(\hat{i} \times \hat{j})$ is equal to:
* zero * 1 * $\hat{j}$ * $\hat{k}$

ii) The quantity having the same unit in different systems of unit is:
* Mass * Time * Length * Temperature

iii) If the average velocity of a body is equal to the instantaneous velocity, the body is said to be moving with:
* Uniform Velocity * Uniform Acceleration
* Variable Velocity * Variable Acceleration

iv) This force is also called 'Self Adjusting' force:
* Tension * Frictional force * Weight * Thrust

v) One radian is equal to:
* 0.017^o * 35.7^o * 57.3^o * 0.117^o

vi) The turning effect of a force about the axis of rotation is called:
* Momentum * Inertia * Orbital velocity * Torque

vii) Work done by centripetal force is:
* Maximum * Negative * Zero * Infinite

viii) The minimum velocity required for an object to escape earth's gravitational field is approximately:
* $11.2\,km/s$ * $5\,km/s$ * $15.3\,km/s$ * $9.8\,km/s$

ix) This is associated with law of conservation of energy in fluids:
* Archimede's principle * Pascal's Principle
* Bernoulli's principle * Equation of continuity

x) The flux through an area $\vec{A}$ in a uniform electric field $\vec{E}$ is maximum when the angle between $\vec{E}$ and $\vec{A}$ is:
* 0^o * 30^o * 60^o * 90^o

xi) The charging of a capacitor through a resistance follows:
* Coulombs law * Exponential law * Power law * Inverse square law

xii) Reciprocal of resistance is called:
* Resistivity * Conductance * Resonance * Capacitance

xiii) A particle is executing Simple Harmonic Motion, the particle has a maximum velocity when it is:
* At maximum displacement * At equilibrium position
* At half the amplitude * At one quarter the amplitude

xiv) For constructive interference, the path difference between two coherent waves must be:
* $\left(m+\frac{1}{2}\right)\lambda$ * $\frac{1}{4}m\lambda$ * $m\lambda$ * $\frac{m\lambda}{2}$

xv) The process of superimposing signal frequency onto a carrier wave is called:
* Modulation * Detection * Transmission * Reception

xvi) The speed of sound in air at STP is 332 m/s. If the air pressure becomes double at the same temperature, the speed of sound will be:
* 1382 m/s * 664 m/s * 332 m/s * 166 m/s

xvii) The SI unit of surface tension is:
* N * $\frac{N}{m}$ * $\frac{N}{m^2}$ * $\frac{m}{N}$

----------XXXXXXXXXX----------

BOARD OF INTERMEDIATE EDUCATION, KARACHI

INTERMEDIATE EXAMINATION, 2025 (ANNUAL)

PHYSICS PAPER – I

(Science General Group)

(For Fresh Candidates)

Date: 14.05.2025
02:00 p.m. to 04:40 p.m.

Max. Marks : 68
Time: 2 hours 40 Minutes

According to New Book

SECTION 'B'

(SHORT-ANSWER QUESTIONS) (36 Marks)

NOTE: Answer any Nine part questions from this section. All part questions carry equal marks. Draw diagrams where necessary. Use of scientific calculator is allowed.

2. i) Prove that following equations are dimensionally correct:

   - $T = 2\pi\sqrt{\frac{l}{g}}$
   - $F = \frac{mv^2}{r}$

   ii) What is angle of repose? Derive relation between angle of friction and angle of repose.

   iii) State and prove work-energy equation / theorem.

   iv) Derive equation of continuity.

   v) At what angle the horizontal range of projectile become equal to its vertical range? Prove mathematically.

   vi) A car has been sounding a $4\,k\,Hz$ tone. What frequency will be detected by a stationary listener as the car approaches him at $50\,km/h$? (speed of sound in air = 1200 km/h)

   vii) A parallel plate capacitor consists of two plates with an area of $0.1\,m^2$ each separated by $0.002\,m$. The capacitor is filled with dielectric material having a relative permittivity (ϵ_r) of 4. Calculate the capacitance of the capacitor. $\left(\epsilon_0 = 8.85\times10^{-12}\,\frac{C^2}{N\cdot m^2}\right)$

   viii) A tank $4m$ long, $3m$ wide and $2m$ deep is filled to the brim with the paraffin of $density = 800\,kg/m^3$. Calculate the pressure on the base. $(g = 10\,m/s^2)$

   ix) A machine gun fires 10 bullets per second into a target. Each bullet weigh $30\,gram$ and had a speed of $1500\,m/s$. Find the force necessary to hold the gun in its position.

   x) A body of mass $5\,gram$ oscillating as a simple pendulum. Calculate the time period of the pendulum, if its length is $1.2m$.

   xi) What is meant by interference of light? Write three conditions of interference of light.

   xii) Define Electric Flux. Prove that the net electric flux through a closed surface is equal to $\frac{1}{\epsilon_o}$ time the total charge enclosed in the surface.

   xiii) A 20 meter length of cable has a cross-sectional area of 1mm² and a resistance of 5 ohms. Calculate the resistivity of the cable.

   xiv) Calculate the value of one of the two equal charges if they repel one another with a force of $0.15\,N$, when situated $40\,cm$ apart in a vacuum. (Coulomb's constant for vacuum is 9×10^9 N.m² / C²)

SECTION 'C' (DETAILED-ANSWER QUESTIONS) (32 Marks)

NOTE: Answer any Two questions from this section. All questions carry equal marks. Draw diagrams where necessary.

3. a) Define Projectile Motion. Derive mathematical equations for the following:
   i) Time to reach maximum height ii) Range of the projectile

   b) Define Simple Harmonic Motion. A particle is moving in a circle with constant speed. Prove that its projection performs Simple Harmonic Motion (SHM) along one of the diameter of the circle.

4. a) State and prove law of conservation of linear momentum.

   b) Define capacitance of a capacitor. Derive mathematical relations for capacitance of parallel plate capacitor when:
   i) air is present between its plates ii) A dielectric slab is present between its plate

5. a) What is diffraction of light? How a diffraction grating is used to determine the wavelength of monochromatic light. Derive the relevant mathematical expression.

   b) Explain Newton's formula for the speed of sound in air. Why the speed of sound in air from Newton's formula was not in good agreement with the experimental value? How did Laplace correct it? Explain.

COMPUTER SCIENCE (GENERAL GROUP)

PHYSICS PAPER-1 2025

SECTION -B [SOLUTIONS]

(i) Prove that the following equation is dimensionally correct

* $T = 2\pi\sqrt{\frac{m}{K}}$ * $F = \frac{mv^2}{r}$

SOLUTION

$$T = 2\pi\sqrt{\frac{m}{K}}$$

$$[T] = 2\pi\sqrt{\frac{[m]}{[K]}} \quad \ldots\ldots\ldots\ldots (i)$$

Dimension of spring constant K

$$[F] = [K][x]$$

$$[MLT^{-2}] = [K][L]$$

$$[ML^{-2}] = [K]$$

Putting the value of K in equation (i)

$$[T] = 2\pi\sqrt{\frac{[M]}{[MT^{-2}]}}$$

$$[T] = 2\pi\sqrt{\frac{1}{[T^{-2}]}}$$

$$[T] = 2\pi\sqrt{[T^2]} = 2\pi[T]$$

2π *has no dimension*

$$[T] = [T]$$

we have [L.H.S] = [R.H.S]
Hence, the given equation is dimensionally correct.

SOLUTION

$$[F] = \frac{[m][v^2]}{[r]}$$

$$[MLT^{-2}] = \frac{[m][(LT^{-1})^2]}{[L]}$$

$$[MLT^{-2}] = \frac{[m][L^2T^{-2}]}{[L]}$$

$$[MLT^{-2}] = \frac{[m][LT^{-2}]}{[L]}$$

$$[MLT^{-2}] = [m][LT^{-2}]$$

$$[MLT^{-2}] = [MLT^{-2}]$$

we have [L.H.S] = [R.H.S]
Hence, the given equation is dimensionally correct

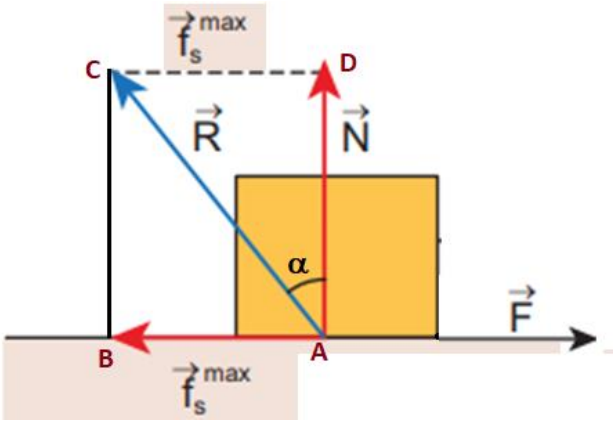
(ii) What is angle of a repose? drive relation between angle of friction and angle of a repose

Ans **THE ANGLE OF REPOSE**

The angle of repose is defined as the minimum angle made by an inclined plane with the horizontal such that an object placed on the inclined surface just begins to slide.

RELATION BETWEEN ANGLE OR FRICTION AND ANGLE OF REPOSE

The angle made by the resultant of the normal reaction and limiting friction with the normal reaction is called the angle of friction



Consider a triangle ADC

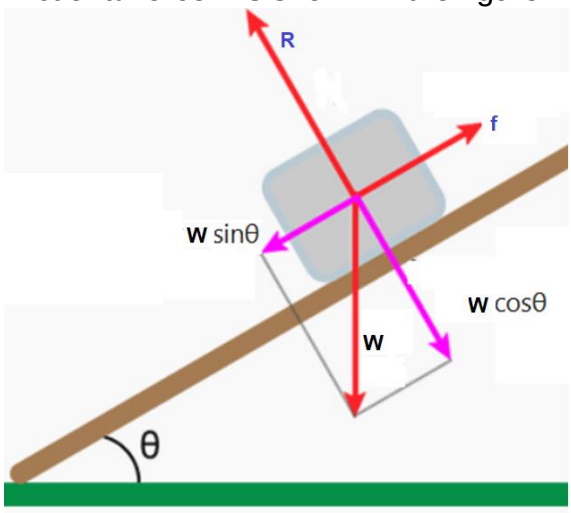
$$tan\,\alpha = \frac{CD}{AD}$$

$$tan\,\alpha = \frac{f}{N} \quad \{ N = R \}$$

$$tan\,\alpha = \frac{f}{N} \quad \{ N = \frac{f}{N} \}$$

$$tan\,\alpha = \mu \quad \{ \mu = \frac{f}{N} \}$$

Consider the plane makes an angle θ with the horizontal, the body just begins to move. Let 'R' be the normal reaction of the body and 'f ' be the frictional force. As shown in the figure



Here

W sinθ = f

mg sinθ = f .....(i)

W cosθ = R

mg cosθ = R .....(ii)

Dividing equation (i) by (ii)

$$\frac{mg\,\sin\theta}{mg\,\cos\theta} = \frac{f}{R}$$

$$\frac{\sin\theta}{\cos\theta} = \frac{f}{R} \quad \{\mu = \frac{f}{R}\}$$

$$\tan\theta = \mu \quad \{ \tan\alpha = \mu \}$$

$$\tan\theta = \tan\alpha$$

$$\theta = \alpha$$

The angle of repose is equal to the angle of friction

(iii) State and prove work energy equation/ theorem

Ans

WORK ENERGYEQUATION /THEOREM:

It states that the total work done on the body is equal to the change in kinetic energy

Consider a body of mass m moving with initial velocity v_1 after travelling through displacement S its final velocity becomes v_2 under the effect of force F.

As we know that

$$2\,a\,S = v_f^2 - v_i^2$$

$$a = \frac{v_f^2 - v_i^2}{2\,S}$$

hence external force acting on the body is

$$F = m\,a$$

$$F = m\left(\frac{v_f^2 - v_i^2}{2\,S}\right) \ldots\ldots (i)$$

Therefore, work done on the body by an external force is

$$W = F\,S \ldots\ldots\ldots\ldots (ii)$$

Substituting the expression for force from equation (i) in equation (ii)

$$W = m\left(\frac{v_f^2 - v_i^2}{2\,S}\right) S$$

$$W = m\left(\frac{v_f^2 - v_i^2}{2}\right)$$

$$W = \frac{1}{2}\,m\left(v_f^2 - v_i^2\right)$$

$$W = \frac{1}{2}\,m\,v_f^2 - \frac{1}{2}\,m\,v_i^2$$

$$W = (K.E)_f - (K.E)_i$$

$$W = \Delta(K.E)$$

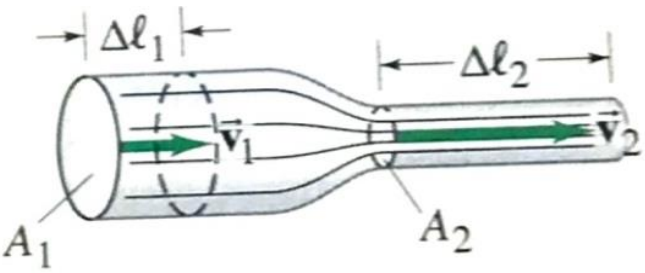
(iv) Drive equation of a continuity

Ans EQUATION OF A CONTINUITY

In fluid dynamics the equation of continuity based upon law of conservation of mass and it is stated as;

"When the fluid is flowing through a pipe then its total rate of mass flow at any instant and at any cross sectional area of pipe remains same"

DERIVATION:



Suppose a steady laminar flow of a fluid through an enclosed tube or pipe as shown in figure the speed of the fluid varies with the diameter of the tube variation. The mass flow rate is given by.

$$Mass\ flow\ rate = \frac{\Delta m}{\Delta t} - - - -(i)$$

The volume of a fluid passing through area 'A_1' in a time 'Δt' is '$A_1\ \Delta\ \ell_1$', where '$\Delta\ \ell_1$' is the distance the fluid moves in time 'Δt'. The velocity of fluid passing through 'A_1', is v_1. Then the mass flow rate. By the definition of density

$$\rho_1 = \frac{\Delta m_1}{\Delta V_1}$$

$$\Delta m_1 = \rho_1\ \Delta V_1$$

$$\Delta m_1 = \rho_1\ A_1\ \Delta\ell_1 - - - -(ii)$$

From average velocity.

$$\Delta l_1 = v_1\ \Delta t$$

Substitute in equation (1).

$$\Delta m_1 = \rho_1\ A_1\ v_1\ \Delta t$$

$$\frac{\Delta m_1}{\Delta t} = \rho_1\ A_1\ v_1 - - - -(iii)$$

similarly

$$\frac{\Delta m_2}{\Delta t} = \rho_2\ A_2\ v_2 - - - -(iv)$$

The mass flow rate through A_1 and A_2 must be equal.

$$\frac{\Delta m_1}{\Delta t} = \frac{\Delta m_2}{\Delta t}$$

From equation (iii) and (iv)

$$\rho_1\ A_1\ v_1 = \rho_2\ A_2\ v_2$$

If the fluid is incompressible which is an excellent approximation for liquids under most circumstances, then $\rho_1 = \rho_2 = \rho$, the equation of continuity is.

$$A_1\ v_1 = A_2\ v_2$$

(v) At what angle the horizontal range of projectile become equal its vertical range? prove a mathematically

Ans The horizontal range is given by

$$R = \frac{v_0^2 \operatorname{Sin} 2\theta}{g} \qquad \text{----------(i)}$$

The maximum height attained by the projectile is given by

$$h_{max} = \frac{v_0^2 \operatorname{Sin}^2 \theta}{2g} \qquad \text{---------- (ii)}$$

According to the given condition

maximum height of the projectile = horizontal range of the projectile

$$h_{max} = R$$

$$\frac{v_0^2 \operatorname{Sin}^2 \theta}{2g} = \frac{v_0^2 \operatorname{Sin} 2\theta}{g}$$

$$\frac{v_0^2 \operatorname{Sin}\theta \operatorname{Sin}\theta}{2g} = \frac{v_0^2 \, 2 \operatorname{Sin}\theta \cos\theta}{g}$$

$$\frac{\operatorname{Sin}\theta}{2g} = \frac{2\cos\theta}{g}$$

$$\frac{\operatorname{Sin}\theta}{2} = 2\cos\theta$$

$$\frac{\operatorname{Sin}\theta}{\cos\theta} = 4$$

$$\operatorname{Tan}\theta = 4$$

$$\theta = \tan^{-1}(4)$$

$$\theta = \tan^{-1}(4)$$

$$\theta = 75.96^0$$

(vi) A car has been sounding a 4KHz tone. What frequency will be deducted by a stationary listener as the car approach him at 50 km/h ? [speed of sound in air = 1200 km/h]

DATA

f = 4 KHz
f = 4000 Hz
f' = ?
V_s = 50 km/h towards the listner
V = 1200 km/h

SOLUTION:

For the apparent frequency heard by the stationary listener when a car approach him

$$f' = \left(\frac{V}{V - V_s}\right) v$$

$$f' = \left(\frac{1200}{1200 - 50}\right) \times 4000$$

$$f' = \left(\frac{1200}{1150}\right) \times 4000$$

$$f' = \left(\frac{1200 \times 4000}{1150}\right)$$

$$f' = \left(\frac{4800000}{1150}\right)$$

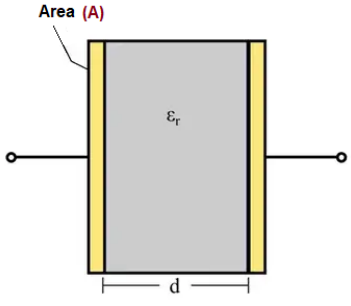
$$f' = 4173.91\ Hz$$

$$f' = 4174\ Hz$$

(vii) A parallel plate capacitor consists of two plates with an area of 0.01 m^2 each, separated by a distance of 0.002 m. The capacitor is filled with a dielectric material having a relative permittivity (ϵ_r) of 4. Calculate the capacitance of this capacitor

Data:

$A = 0.01\ m^2$
$d = 0.002\ m$
$\epsilon_r = 4$
$C = ?$



SOLUTION:

$$C = \frac{A\ \epsilon_0\ \epsilon_r}{d}$$

$$C = \frac{(0.01)\ (8.854 \times 10^{-12})\ (4)}{0.002}$$

$$C = \frac{3.54 \times 10^{-13}}{0.002}$$

$$C = 1.77 \times 10^{-10}$$

$$C = 177 \times 10^{-12}$$

$$C = 177 \times pF$$

(viii) A tank 4 m long, 3 m wide, and 2 m deep is filled to the brim with paraffin (density 800 kg/m³). Calculate the pressure on the base? What is the thrust on the base?

Data:

L = 4 m
w = 3 m
d = h = 2 m
P = ?
F = ?

SOLUTION:

For "P".
By the pressure of fluid.

$$P = \rho g h$$
$$P = 800 \times 9.8 \times 2$$
$$P = 15680 \text{ Pa}$$

For "F".
By the definition of pressure.

$$P = F / A$$
$$F = P A = P (L \times w)$$
$$F = 15680 (4 \times 3)$$
$$F = 188160 \text{ N}$$

(ix) A machine gun fires 10 bullets per second at a target. Each bullet weighs 30 gm and has a speed of 1500 m/sec. Find the force necessary to hold the gun in position.

Data:

$number\ of\ bullets\ n = 10$

t = 1 second

mass of each bullet $m_1 = 30\ g$

$$m_1 = \frac{30}{1000} = 0.03\ kg$$

(mass of 10 bullets) m
$$= 10 \times 0.03$$

$m = 0.3$ kg

Initially velocity of the bullets V_i
$$= 0$$

final velocity of the bullets

$V_f = 1500$ m/s

$F = ?$

SOLUTION:

Acceleration of the bullets

$$a = \frac{V_f - V_i}{t}$$

$$a = \frac{1500 - 0}{1}$$

$a = 1500$ m/s²

$F = m\,a = 0.3 \times 1500$

$F = 450$ N

(x) What is the period of a simple pendulum of a 6.0 kg mass oscillating on a 4.0 m long string?

DATA	SOLUTIONS
m = 5.0 g $L = 1.2\ m$ **T =?**	$T = 2\pi\sqrt{\frac{L}{g}}$ $T = 2\pi\sqrt{\frac{1.2}{9.8}}$ $T = 2\pi\sqrt{0.1224}$ $T = 2.1986\ s$ $T = 2.2\ s$

(xi) What is meant by the interference of light? Write three conditions of interference of light

Ans **DEFINITION**

When two waves of light superpose each other under suitable conditions, they reinforce each other at some points and cancel their effects at other points. This is called interference.

CONDITIONS OF INTERFERENCE

Interference occurs whenever two waves come together, but certain conditions need to be fulfilled to produce an observable interference.

1 The waves should be monochromatic; they should be of a single wavelength.
2. *The distance between the screen and the source must be large.*
3 *The two sources of light should be coherent.*

(xii) Define Electric flux. Prove that the net electric flux through a closed surface is equal to $\frac{1}{\varepsilon_0}$ times the total charge enclosed in the surface.

Ans **DEFINITION-**

Electric flux is defined as the total number of **electric field lines** passing through a vector area is called electric flux or "The scalar product of electric intensity E and vector area A"..

$$\Delta\Phi = EA$$

UNIT:

SI unit of electric flux is N /m²/C

FLUX THROUGH CLOSED SURFACE DUE TO CHARGE ENCLOSED IN THE SURFACE

Consider a hollow sphere of radius 'r '. Let a positive point charge 'q' is placed at the center of a sphere.

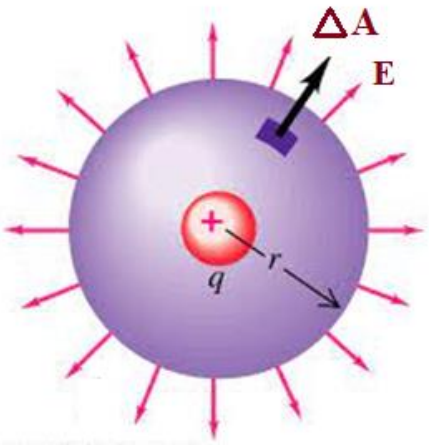
To calculate the flux through the surface of a sphere, the whole surface, is divided in to small area elements i.e., $\Delta A_1, \Delta A_2 \ldots\ldots\ldots, \Delta A_n$

Now, flux through ΔA_1

$$\Phi_1 = \vec{E} \cdot \Delta\vec{A}_1$$

$$\Phi_1 = E \ \Delta A_1 \ \text{Cos}\ 0^o$$

$$\Delta\Phi_1 = E\ \Delta A_1$$



Flux through ΔA_2

$$\Delta\Phi_2 = E\ \Delta A_2$$

similarly Flux through ΔA_n

$$\Delta\Phi_n = E\ \Delta A_n$$

The total flux through the surface of the sphere will be the sum of all fluxes.

$$\Phi = \Delta\Phi_1 + \Delta\Phi_2 + \Delta\Phi_3 + \ldots\ldots\ldots\ldots\ldots + \Delta\Phi_n$$

$$= E\Delta A_1 + E\Delta A_2 + E\Delta A_3 + \ldots\ldots\ldots + E\Delta A_n$$

$$= E\left(\Delta A_1 + \Delta A_2 + \ldots\ldots\ldots + \Delta A_n\right)$$

= E (surface area of sphere)

$= E\ (4\pi r^2)$

$$= \frac{1}{4\pi \in_o} \frac{q}{r^2}\left(4\pi r^2\right)$$

$$E = \frac{1}{4\pi \in_o} \frac{q}{r^2}$$

$$\phi = \frac{1}{\in_o}(q)$$

$$\phi = \frac{1}{\in_o}$$ **(Enclosed charge)**

(xiii) **A 20 m length cable has a cross-sectional area of 1.0 mm^2 and a resistance of 5 Ω. Calculate the resistivity of the cable.**

Data:	**SOLUTION:**
$L = 20\ \text{m}$	$R = \frac{\rho\ L}{A}$
$A = 1\text{mm}^2$	$\rho = \frac{R\ A}{L}$
$A = 1 \times (10^{-3})^2 \text{m}^2$	$\rho = \frac{(5)\ (1 \times 10^{-6})}{20}$
$A = 1 \times 10^{-6}\ \text{m}^2$	$\rho = 2.5 \times 10^{-7}\ \Omega\, m$
$R = 5\ \Omega$	
$\rho = ?$	

(xiv) **Calculate the value of one of two equal charges if they repel one another with a force of 0.15 N when situated 40 cm apart in a vacuum. (Coulomb's constant for vacuum is $9 \times 10^9\ N\ m^2/C^2$)**

Data:

$q_1 = q$

$q_2 = q$

$F = 0.15\ N$

$r = 40\ cm = 0.4\ m$

SOLUTION:

Coulomb force given by:

$$F = \frac{k\ q_1 q_1}{r^2}$$

$$F = \frac{k\ q\ q}{r^2}$$

$$0.15 = \frac{9 \times 10^9\ q^2}{(0.4)^2}$$

$$9 \times 10^9\ q^2 = 0.15 \times (0.4)^2$$

$$9 \times 10^9\ q^2 = 0.024$$

$$q^2 = \frac{0.024}{9 \times 10^9}$$

$$q^2 = 2.66 \times 10^{-12}$$

Taking the square root of both sides

$$\sqrt{q^2} = \sqrt{2.77 \times 10^{-12}}$$

$$q = 1.63 \times 10^{-6}\ C$$

END SECTION B