QB365

Model Question Paper 1

12th Standard CBSE

Physics

Reg.No. :

Time : 02:00:00 Hrs

Total Marks : 100

Section-A

1) At a particular point, electric field depends upon 1

(a) Source charge Q only (b) test charge q_o only (c) both Q and q_0 (d) neither Q nor q_o

2) The SI unit of electric field intensity is 1

(a) N (b) N/C (c) C/m^2 (d) N/m^2

3) Electric field due to a single charge is 1

(a) asymmetric (b) cylindrically symmetric (c) spherically symmetric (d) None of the above

4) At a given distance from the centre of electic dipole, field intensity on axial line is k times the field intensity on equatorial line, where K= 1

(a) 2 (b) 3 (c) 4 (d) 1

5) The electric field at a point is 1

(a) always continuous (b) continuous if there is no charge at that point

(c) discontinuous only if there is a negative charge at that point

(d) discontinuous if there is a charge at that point

6) The magnetic field at a perpendicular distance of 2 cm from an infinite straight current carrying conductor is $2X10^{-6}$ T. The current in the wire is 1

(a) 0.1 A (b) 0.2 A (c) 0.4 A (d) 0.8 A

7) A positive charge is moving towards an observer. The direction of magnetic induction lines is 1

(a) clockwise (b) anticlockwise (c) right (d) left

8) If a copper wire carries a direct current, the magnetic field associated with the current will be 1

(a) only outside the wire (b) only inside the wire (c) both inside and outside the wire

(d) neither inside nor outside the wire

9) A coil of wire has an area of 600 sq. cm and has 500 turns. If it carries 1.5 A current, its magnetic dipole moment is 1

(a) 5 Am^2 (b) 15 Am^2 (c) 30 Am^2 (d) 45 Am^2

10) A long straight wire of radius a carries a steady current i. The current is uniformly distributed across its cross-section. The ratio of the magnetic field at a/2 and 2 a is 1

(a) 1/2 (b) 1/4 (c) 4 (d) 1

Section-B

11) What is the cause of charging? 1

12) What do you mean by additivity of electric charge? **1**

13) What do you mean by conservation of electric charge? **1**

14) Is the total charge of the universe conserved? **1**

15) Why does an ebonite rod get negatively charged on rubbing with fur? **1**

16) Two equal balls having equal positive charge q coulombs are suspended by two insulating string of equal length.what would be the effect on the force when a plastic sheet is inserted between the two? **1**

17) Which orientation of an electric dipole in a uniform electric field would correspond to stable equilibirum? **1**

18) Is electric current a vector or scalar quantity? Explain. **1**

19) Why is a meter bridge also called a slide wire bridge? **1**

20) When is Wheatstone Bridge most sensitive? **1**

Section-C

21) Dielectric constant of a medium is unity. What will be its primitivity? **2**

22) An attractive force of 5N is acting between two charges of +2 μC and -2 μC placed at some distance. If the charges are mutually touched and placed again at the same distance, what will be the new force, between them? **2**

23) Two point charges of +2 μC and +6 μC repel each other with a force of 12N. If each is given an additional charge of -4 μC what will be the new force? **2**

24) Define electric flux. Write its SI unit.A charge q is enclosed by a spherical surface of radius R. If the radius is reduced to half, how would the electric flux through the surface change? **2**

25) The separation between the plates of a charged capacitor is to be increased. Explain when work done will be more in case battery is removed after charging the capacitor or battery remains connected. **2**

26) What will be the electric field intensity at the centre of a uniformly charged circular wire of linear charge density? **2**

27) plot a graph showing the variation of coulomb's force(F) versus $1/r^2$, where r is the distance between the two charges of each pair of charges(1 μC, 2 μC) and (1 μC -3 μC).Interpret the graphs obtained. **2**

28) Deduce Coulomb's law from Gauss' law. **2**

29) Two point charges q_1 and q_2 are located at points (a, 0,0) and (0, b, 0) respectively. Find the electric field due to both these charges at the point (0, 0, c) **2**

30) Two wires A and B are formed from the same material with the same mass. The diameter of wire A is half of diameter of wire B. If the resistance of wire A is 32 Ω find the resistance of wire B. **2**

31) Write the relation for the force $\vec{F}$ acting on a charge carrier q moving with a velocity $\vec{v}$ through a magnetic field $\vec{B}$ in vector notation. Using this relation, deduce the conditions under which this force will be (i) maximum (ii) minimum. **2**

32) A rectangular coil of sides 'l' and 'b' carrying a current I is subjected to a uniform magnetic field $\vec{B}$ acting perpendicular to its plane. Obtain the expression for the torque acting on it. **2**

Section-D

33) What is the force between two small charged spheres having charges of 2×10^{-7}C and 3×10^{-7}C placed 30 cm apart in air? **3**

34) In a Van de Graff type generator, a spherical metal shell is to be a $15 \times 10^6 V$ electrode. The dielectric strength of the gas surrounding the electrode is $5 \times 10^7 Vm^{-1}$. What is the minimum radius of the spherical shell required? (You will learn from this exercise why one cannot build an electrostatic generator using a very small shell which requires a small charge to acquire a high potential?) **3**

35) A charge of magnitude Q is divided into two parts q and (Q-q) such that the two parts exert maximum force on each other. Calculate the ratio Q/q. **3**

36) A water droplet of radius 1 micron in Millikan oil drop apparatus is first held stationary under the influence of an electric field of intensity $5.1 \times 10^4 NC^{-1}$. How many excess electrons does it carry? Take e=$1.6 \times 10^{-19} C$, $g = 9.8 ms^{-2}$ and density of water = $10^3 kgm^{-3}$ **3**

37) When $1X10^{12}$ electrons are transferred from one conductor to another, a potential difference of 10 V appears between the conductors. Find the capacitance of the two conductors. **3**

38) Eight identical spherical drops, each carrying a charge 1 nC are at a potential of 900 V each. All these drops combine together to form a single large drop. Calculate the potential of this large drop.
(Assume no wastage of any kind and take the capacitance of a sphere of radius r as proportional to r). **3**

39) A storage battery of a car has an e.m.f. of 12V. If the internal resistance of the battery is 0.4Ω, what is the maximum current that can be drawn from the battery? **3**

Section-E

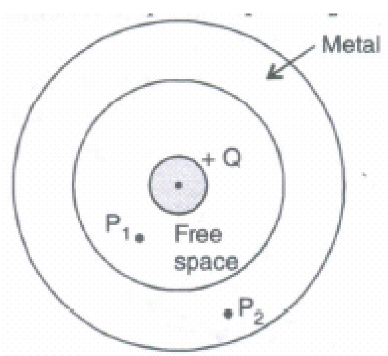
40) (a) Define electric flux. Write its S.I. unit. **5**

(b) Using Gauss's law, prove that the electric field at a point due to a uniformly charged infinite plane sheet is independent of the distance from it.

(c) How is the field directed if (i) the sheet is positively charged, (ii) negatively charged?

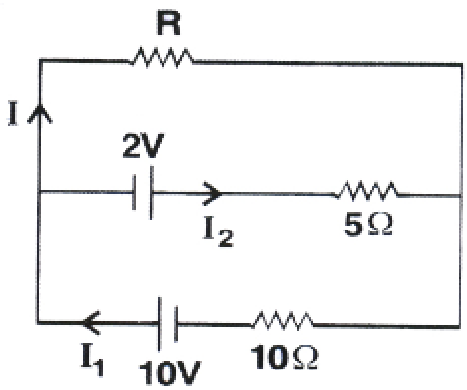
41) (a) Define electric flux. Write its S.1.unit. **5**

(b) A small metal sphere carrying charge +Q is located at the centre of a spherical cavity inside a large uncharged metallic spherical shell as shown in the figure. Use Gauss's law to find the expressions for the electric field at points P_1 and P_2



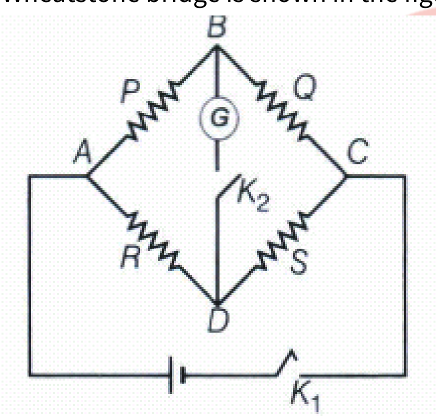
(c) Draw the pattern of electric field lines in this arrangement

42) Two cells of voltages 10V and 2V and internal resistances 10Ω and 5Ω respectively, are connected in parallel with the positive end of 10V battery connected to negative pole of 2V battery. Find the effective voltage and effective resistance of the combination. **5**



43) A room has AC run for 5 hours a day at a voltage of 220 V. The wiring of the room consists of Cu of 1mm radius and a length of 10m. Power consumption per day is 10 commercial units. What fraction of it goes in the joule heating in wires? What fraction of it goes in the joule heating in wires? What would happen if the wiring is made of aluminium of the same dimensions? **5**

44) The unknown resistance of a conductor can be determined by Wheatstone bridge. The standard form of Wheatstone bridge is shown in the figure. It can be shown when the bridge is balanced. **5**



$\frac{P}{Q} = \frac{R}{S}$ or $S = \frac{Q}{P}R$

Knowing P,Q and R, unknown resistance S can be calculated.

Read the above passage and answer the following questions.

(i) Name any two applications of Wheatstone bridge.

(ii) What is the practical utility of the post office box in day to day life?

45) Kumaran wanted to pay electricity bill that day. He realized that the consumption shown by the meter was unbelievably low. He thought that the -meter must have been faulty. He wanted to check the meter. But unfortunately, he did not have any idea as to how to do this. There came his friend Subhash to help him. He told Kumaran to run only the electric heater rated 1kW in his house for some time keeping other appliances switched off. He also calculated the power consumed in kilowatt hour and compared the value with the meter. Kumaran as happy and thanked Subhash for his timely help and the knowledge. **5**

(1)What are the values displayed by the friends?

(2) Express kWh in joules. Find the resistance of the heater.

46) Based on the previous knowledge learnt in the class, two students of class XII (A and B) were asked to conduct an experiment in the laboratory using a meter bridge one made of Nichrome and the other one made of Copper, of same length and same diameter, of constant potential difference. The student A could not give explanation for not achieving the result whereas student B, could get the result and was also able to explain. **5**

(a) What made student B to perform successfully?

(b) Give the formula to calculate the rate of heat production.

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Section-A

1) (a) Source charge Q only **1**

2) (b) N/C **1**

3) (c) spherically symmetric **1**

4) (a) 2 **1**

5) (b) continuous if there is no charge at that point **1**

6) (b) 0.2 A **1**

7) (b) anticlockwise **1**

8) (a) only outside the wire **1**

9) (d) 45 Am^2 **1**

10) (d) 1 **1**

Section-B

11) The cause of charging is actual transfer of electrons from one body to the other. **1**

12) **1**

Additivity of charge means the total charge on a system is the algebraic sum (with proper signs) of all individual charges in the system.

13) **1**

Conservation of electric charge means that the total charge on an isolated system remains unchanged with time.

14) Yes, charge conservation is a global phenomenon. **1**

15) This is because electron in fur are less tightly bound than electrons in ebonite rod. **1**

16) **1**

From Coulomb's law electric force between the two charges bodies in a medium $F=\frac{1}{4\pi\varepsilon_0 K}\frac{|q_1q_2|}{r^2}$

where, K=dielectric constant of the medium For vacuum, K=1 For plastic, K>1 Therefore, after insertion of plastic sheet, the force between the two balls will reduce.

17) The dipole is in stable equilibrium when electric dipole is in the direction of electric field. **1**

18) **1**

Electric current is a scalar quantity because it does not follow the laws of vectors addition, i.e., the angle between the wires carrying the current does not affect the total current in the circuit.

19) This is because during the experiment, the jockey is to be slide over the bridge wire. **1**

20) **1**

Wheatstone Bridge is most sensitive when the value of resistances of the four arms of the bridge P, Q, R and S are of the same magnitude.

Section-C

21) We know that dielectric constant of a medium is **2**

$K = \epsilon_r = \frac{\epsilon}{\epsilon_o}$

$\epsilon = K\epsilon_o = 1X8.854X10^{-12}$

=$8.854X10^{-12}C^2N^{-1}m^{-2}$

22) On touching, charges neutralize. Therefore, **2**

F=0

23) q_1=+μC , q_2=+6μC, F=12N **2**

$q_1^{'} = +2 - 4 = -2\mu C; q_2^{'} = +6 - 4 = 2\mu C$

F'=?

$\frac{F'}{F} = \frac{(q_1^{'})(q_2^{'})}{q_1 q_2} = \frac{(-2)(2)}{(2)(6)} = -\frac{1}{3}$

$F' = \frac{-F}{3} = \frac{-12}{3} = -4N$(attractive)

24) **2**

Electric flux over an area in an electric field represents the total number of electric lines of force crossing this area. SI units of electric flux are N m^2 C^{-1} .When R is reduced to half, electric flux through the surface depends only on charge enclosed.

25) **2**

With increase in separation between the two plates, capacity C decreases.

When battery is removed, charge Q and electric field E=$\frac{\sigma}{\epsilon_o}$=$\frac{Q}{A\epsilon_o}$

Would remain constant. But when battery remains connected, V is constant. Q(=CV) decreases and hence E decreases. Clearly, more work is required to be done in the first case.

26) **2**

A uniformly charged circular wire can be considered to be subdivided into pairs of diametrically opposite elements. The electric field intensity at the centre of wire due to each of the pairs is zero, therefore the electric field intensity due to the entire circular wire will be zero. (1+1)

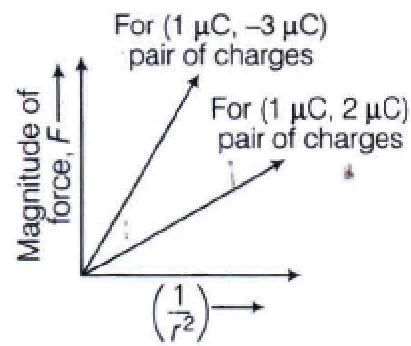
27) **2**

According to Coulomb's law, the magnitude of force acting between two stationary point charges is given by

$$F=\left(\frac{q_1q_2}{4\pi\varepsilon_0}\right)\left(\frac{1}{r^2}\right)$$

For give q_1 q_2 , $F \propto \frac{1}{r^2}$

slope of $F-\frac{1}{r^2}$,graph depends on q_1q_2 is higher for second pair



$\therefore$ slope of $F-\frac{1}{r^2}$ graph corresponding to second pair

(1μC-3μC) is greater.higher the magnitude of product of charges q_1 and q_2 ,higher will be the slope.

28) **2**

According to Gauss' theorem,

E. dS E.

$\int_s \quad = \frac{q}{\varepsilon_0} \Rightarrow$

$4\pi r^2=\frac{q}{\varepsilon_0}$ (1) $\therefore$ $E=\frac{q}{4\pi\varepsilon_0 r^2}$ If a charge q_0 is kept on the surface, then F = E$\times$ q_0 $==\frac{qq_0}{4\pi\varepsilon_0 r^2}$, which is Coulomb's law. (1)

29) We have $\overrightarrow{E_{net}}=\overrightarrow{E_1}+\overrightarrow{E_2}$ **2**

$=\frac{1}{4\pi\epsilon_0}\frac{q_1}{q_1^3\vec{r_1}}\frac{1}{4\pi\epsilon_0}\frac{q_2}{q_2^3\vec{r}}$

where $\overrightarrow{r_1}=-a\hat{i}-c\hat{k}$

and $\overrightarrow{r_2}=-b\hat{j}-c\hat{k}$

$\overrightarrow{E_{net}}=[\frac{q_1(-a\hat{i}-c\hat{k})}{(a^2+c^2)^{3/2}}+\frac{q_2(-b\hat{j}+c\hat{k})}{(b^2+c^2)^{3/2}}]$

30) Volume of A = volume of B; **2**

$\frac{l_A}{l_B}=\frac{D_B^2}{D_A^2}=4$

Resistance, $R=\frac{\rho l}{A}=\frac{\rho l}{(\pi D^2/4)}\ or\ R\propto\frac{l}{D^2}$

$\frac{R_B}{R_A}=\frac{l_B}{l_A}\times\frac{D_A^2}{D_B^2}=\frac{1}{4}\times\frac{1}{4}=\frac{1}{16}$

or $R_B=\frac{R_A}{16}=\frac{32}{16}=2\,\Omega$

31) **2**

$$\vec{F}=q\left(\vec{v}\times\vec{B}\right)$$

$$or \quad \left|\vec{F}\right|=q\left|\vec{v}\times\vec{B}\right|=qvBsin\theta$$

(i) F will be maximum, when $sin\theta=1 \quad or \quad \theta=90^o$, i.e., the charged particle is moving perpendicular to the direction of magnetic field.

(ii) F will be minimum, when $sin\theta=0 \quad or \quad \theta=0^o \quad or \quad 180^o$ i.e., the charged particle is moving parallel to the direction of magnetic field.

32) Equivalent magnetic moment of the coil, **2**

$\bar{m}=IA\hat{n}$

$\vec{m}=Ilb\hat{n}$

($\hat{n}$=unit vector $\perp$ to the plane of the coil)

$\therefore \quad Torque=\vec{m}\times\vec{B}$

=$Ilb\hat{n}\times\vec{B}$

=0

(as $\hat{n}$ and $\vec{B}$ are parallel or antiparallel, to each other)

Section-D

33) Given $q_1 = 2\times10^{-7}$ C, $q_2 = 3\times10^{-7}$ C, **3**

r = 30 cm = 0.3 m

Therefore, Force of repulsion, F = $9\times10^9\times\frac{q_1q_2}{r^2}$

= $9\times10^9\times\frac{2\times10^{-7}\times3\times10^{-7}}{(0.3)^2}=\frac{54\times10^{-5}}{9\times10^{-2}}$

$= \quad 6\times10^{-3}N$

34) $V=Ed=ER$ **3**

$E=5\times10^7Vm^{-1}$

$R=?$

$V=15\times10^6V$

$R=\frac{V}{E}=\frac{15\times10^6V}{5\times10^7Vm^{-1}}=3\times10^{-1}m=30cm$

35) $F=\frac{1}{4\pi\epsilon_0}\frac{q(Q-q)}{r^2}$ **3**

As Q and r are fixed , so F is a function of q

Force F will be maximum, only if $\frac{dF}{dq}$=0 or

$\frac{1}{4\pi\epsilon_0}\frac{d}{dq}[q(Q-q)]$=0

or $\frac{d}{dq}[q(Q-q)]=0 \; or \; q(-1)+(Q-q)=0$

or $Q-2q=0 \; or \; Q=2q$

$\frac{Q}{q}=2$

36) Here r=1 micron =10^{-6}m, E=$5.1\times10^4N/C$ **3**

n=?

From qE=mg

$n=\frac{4}{3}\times\frac{22}{7}\frac{(10^{-6})^3\times10^3\times9.8}{1.6\times10^{-19}\times5.1\times10^4}=5$

37) Given, number of electrons, n=1X10^{12} $\therefore$ Charge transferred, Q=ne=1X10^{12}X1.6X10^{-19} **3**

=1.6X10^{-7} $C\left[\because e=1.6\times10^{-19}C\right]$

Capacitance between two conductors,

$$C=\frac{Q}{v}=\frac{1.6\times10^{-7}}{10}=1.6\times10^{-8}F$$

38) Let the radius of each drop be r. The capacitance C of each drop is kr, where k is a constant. **3**

Also q = CV, V = 900 volt

∴ charge on each drop = q =$(\kappa r\times900)\,C$

∴ Total charge on all the eight drops = Q = 8q = 7200κr

Let R be the radius of the large drop. Then

$\frac{4\pi}{3}r^3=8\times\frac{4\pi}{3}r^3$

$R=(8)^{1/3}r=2r$

∴ Capacitance C' of the large drop = kR= 2kr

∴ potential of the large drop = $\frac{Q}{C'}=\frac{7200\quad kr}{2\quad kr}Volt$

=3600 V

39) Given E=12V, r=0.4Ω, I=? since, $I=\frac{E}{r}=\frac{12}{0.4}=30A$ **3**

Section-E

40) **5**

(a) Electric flux is defined as the number of electric field lines passing through an area normal to the surface.

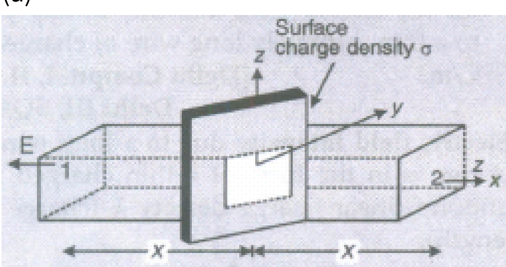
Alternatively

Surface integral of the electric field is defined as the electric flux through a closed surface

$\phi=\oint\vec{E}.\overrightarrow{ds}$

SI unit : $\frac{N.m^2}{C}$ or volt. metre

(a)



Outward flux through the Gaussian surface, is

$2EA=\sigma A/\epsilon_0$

$\therefore\ E=\sigma A/2\epsilon_0$

Vectorically $\vec{E}=\frac{\sigma}{2\epsilon_0}\hat{n},$

where $\hat{n}$ is a unit vector normal to the plane, away from it.

Hence, electric field is independent of the distance from the sheet.

(c) For positively charged sheet $\longrightarrow$ away from the sheet

For negatively charged sheet $\longrightarrow$towards the plane sheet

41) **5**

(a) Electric flux over an area in an electric field represents the total number of electric field lines crossing this area and is given by theproduct of surface area and the component of electric field intensity normal to the area.

The S.1.unit of flux is $Nm^2 C^{-1}$

(b) Let point P_1 is at a distance R from the centre O. S_1 isthe Gaussian surface, then according to Gauss's theorem

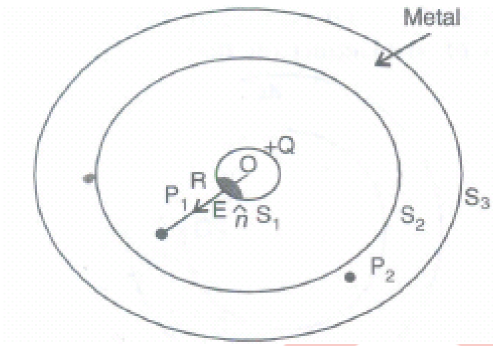
$\oint_s \vec{E}.\overrightarrow{ds} = \oint_s \vec{E}.\hat{n}ds = \frac{q}{\epsilon_0}$

or $E\oint_s ds = \frac{q}{\epsilon_0}$

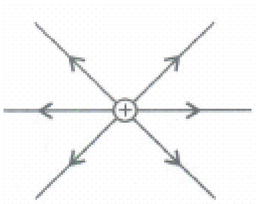
or $E = \frac{q}{\epsilon_0 \times \oint_s ds}$

= $\frac{q}{4\pi\epsilon_0 R^2}$ [As$\oint sds = 4\pi r^2$]

Inside the shell the net charge is zero, so the field is also zero.

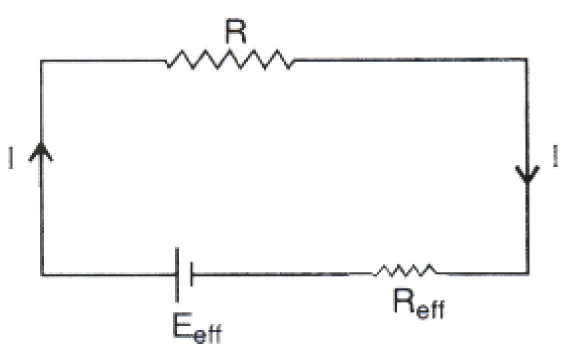


(c) The direction of electric field is shown in figure.



42) **5**

From Kirchhoff's junction rule, we have $I_1 = I + I_2$ ....(i) Applying Kirchhoff's loop rule to outer loop containing 10V cell, we get $10 = IR + 10I_1$ ....(ii) Applying Kirchhoff's loop rule to outer loop containing 2V cell, we get $2 = 5I_2 - RI$ $2 = 5(I_1 - I) - RI$ $4 = 10I_1 - 10I - 2RI$ Subtracting eq (ii) from eq (i), we get $6 = 3RI + 10I$ $2 = I\left(R + \frac{10}{3}\right)$ From Ohm's law, we have $V = I(R + R_{off})$ Comparing eq (iii) and (iv), we get $R_{ef} = \frac{10}{3}\Omega$ If E_{eff} and R_{eff} are the effective voltage and effective internal resistance of the combination, then the equivalent circuit is shown.



43) **5**

Power consumption per day=10 kWh   Time for which ac run per day= 5h

$P=\frac{10}{5}=2kW=2000W=2000Js^{-1}$ $I=\frac{P}{V}=\frac{2000}{220}=\alpha A$ Power loss in copper wire

$P_{cu}=R_{cu}I^2=\rho\frac{l}{A}I^2$ $=1.7\times10^{-8}\times\frac{10}{\pi\times10^{-6}}\times9^2=4Js^{-1}$ Fraction of power loss in Cu wire=

$\frac{4}{2000}$ $=\frac{2}{1000}\times100=2$ Power loss in Al wire $P_{Al}=\frac{\rho_{Al}lI^2}{\pi r^2}=\frac{2.7\times10^{-8}\times10}{\pi\times(10^{-3})^2}\times9^2=6.4Js^{-1}$ Power loss in Al wire=$\frac{6.4}{1000}\times100=0.32\%$

44) **5**

(i) Post office box and meter bridge are two electrical appliances based on the principal of Wheatstone bridge.

(ii) The post office box is used practically in post and telegraph department to locate the snapping of telephone line.

The broken telephone line will touch the ground. Using post office box, resistance S of broken line is determined.

As resistance per unit length of line is known, the length of broken line can be calculated. Therefore, snapping of line is located.

45) (1) Honesty, sharing of knowledge, willingness to help. **5**

(2) 1 kWh=3.6 x 10^6 J,R=V^2/P=48.45Ω

46) **5**

(a) Student B had concentrated in the class room teaching and also had studied again to remember what was taught.

(b) H=I^2Rt