

14. Draw a labelled diagram showing an electric dipole making angle  $\theta$  with uniform electric field  $E$ . Derive an expression for the torque experienced by the dipole.

18. A  $900 \mu\text{F}$  capacitor is charged by a  $100\text{V}$  battery. How much electrostatic energy is stored by the capacitor? The capacitor is disconnected from the battery and connected to another  $900 \mu\text{F}$  capacitor. What is the energy stored by the system?

19. The current flowing through a conductor is given by  $I = neAVd$ .

i) Identify each term in the equation

ii) Obtain an expression for  $vd$  if current flowing through the conductor of length  $l$  has its ends maintained at a potential difference of  $V$  volts.

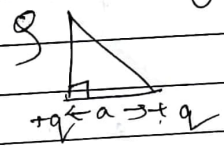
20. If the potential in the region of space around the point  $(-1\text{m}, 2\text{m}, 3\text{m})$  is given by  $V = 10x^2 + 5y^2 - 3z^2$  Volt, calculate the three components of electric field at this point.

13. A region of space has electric field  $\vec{E} = +200\hat{i}$  for  $x > 0$  and  $\vec{E} = -200\hat{i}$  for  $x < 0$ . A right circular cylinder of length 0.2 and radius 0.05 has its centre at the origin and its axis along  $x$ -axis. Show that face is at  $x = 0.10$  and the other is  $-0.1$ .

(All units are in S.I.)

- i. What is the net outward flux through each flat face?
- ii. What is the net flux through the curved surface?
- iii. What is the net outward flux through the cylinder?
- iv. What is the net charge inside the cylinder?

14. 3 charges  $Q, +q, +q$  are placed at the vertices of a right angled isosceles triangle as shown in the figure. What is the value of  $Q$  for which the net electrostatic energy of the configuration is zero?



15. Derive an expression for energy stored in a capacitor.

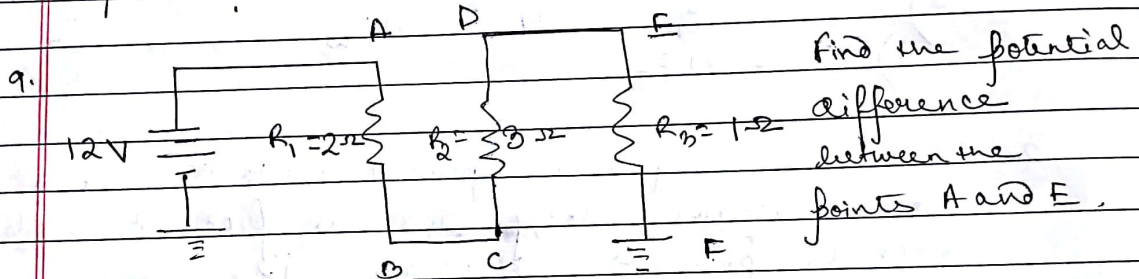
16. Derive an expression for electric field and electric potential for a conducting sphere of radius  $R$  carrying a charge  $Q$  at a distance  $r$  from its centre, such that  $r < R$ .



6. A wire of resistance  $1\ \Omega$  is stretched by  $10\%$ . The resistance of the elongated wire is
- a)  $1.1\ \Omega$     b)  $11.1\ \Omega$     c)  $1.21\ \Omega$     d)  $13.1\ \Omega$ .

7. State Gauss's law

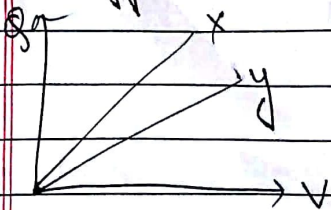
8. A capacitor is connected to a battery. If we move the plates further apart, what work will be done against the electrostatic attraction between the plates, what will be the effect on the energy of the capacitor?



10. The metre bridge works on the principle of \_\_\_\_\_.
- \_\_\_\_\_

11. A potentiometer with lower potential gradient will be more \_\_\_\_\_.

12. The following graph shows the variation of charge  $Q$  with potential  $V$  for 2 capacitors X and Y. Which of the two has more electrostatic energy stored at the same potential?



Answer any 5 from 1-6, any 5 from 7-12, and all from 12-22.

$$[5 \times 1 + 5 \times 1 + 10 \times 3 = 40]$$

- An imaginary, spherical surface  $S$  of radius  $r$  is centred at the origin. A positive charge  $+q$  is originally at the origin and the electric flux through the surface is  $\Phi_E$ . 3 additional charges are now added along  $x$ -axis:  $-3q$  at  $x = -\frac{r}{2}$ ,  $+5q$  at  $x = \frac{r}{2}$  and  $+4q$  at  $x = \frac{3r}{2}$ . The flux through  $S$  is now:
  - $3\Phi_E$
  - $4\Phi_E$
  - $6\Phi_E$
  - $7\Phi_E$
- Relative permittivity of water is 81. If  $\epsilon_w$  and  $\epsilon_0$  are permittivities of water and vacuum respectively, then:
  - $\epsilon_0 = 3\epsilon_w$
  - $\epsilon_0 = 81\epsilon_w$
  - $\epsilon_w = 9\epsilon_0$
  - $\epsilon_w = 81\epsilon_0$
- When a dipole is placed with its dipole moment vector along external field, it is stable when its potential energy is
  - minimum
  - maximum
  - zero
  - NOT
- A circular disc of radius  $r$  is held parallel to a uniform field of strength  $E$ . Net electric flux linked with the disc is
  - 0
  - $E \times \pi r^2$
  - $E \times 2\pi r$
  - $E \times 4\pi r^2$
- An air filled parallel plate capacitor has a capacitance of  $10^{-12} \text{ F}$ . The separations of the plates is doubled, and wax is inserted between them, which doubles the capacitance. The dielectric constant of that is:
  - 2
  - 3
  - 4
  - 8