PRACTICE MCQs

CLASS 12 PHYSICS (TERM - I)

ELECTRIC POTENTIAL AND CAPACITANCE

BY

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Question 1:
Which of the following is a non-conservative force?
(a) Gravitational force
(b) Magnetic force between two magnetic poles
(c) Coulomb force between two stationary charges
(d) Frictional force

Answer: (d) Frictional force
Conservative force is a force that obeys the rule that the total work done in moving a particle between two points is independent of the path taken.

Question 2:
$W_{RP} = U_p - U_R = \Delta U$
What does the above equation represent?
(a) Electric potential energy difference between two points
(b) Electric kinetic energy difference between two points
(c) Electrostatic field
(d) None of the above

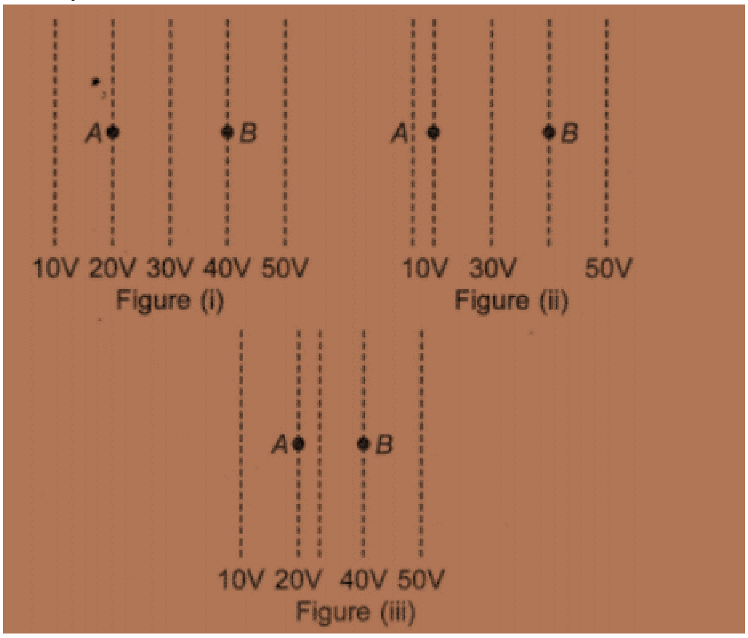
Answer: (a) Electric potential energy difference between two points
Electric potential energy difference between two points is the work required to be done by an external force in moving (without accelerating) charge q from one point to another for electric field of any arbitrary charge configuration.

Question 3:
The work done in bringing a unit positive charge from infinite distance to a point at distance x from a positive charge Q is W. Then the potential φ at that point is:
(a) (WQ/x)
(b) W
(c) (W/x)
(d) WQ

Answer: (b) W
Electric potential at a point in an electric field is defined as the work done in bringing a unit positive charge from infinity to that point.
Or, V = (W/q)

As magnitude of charge 1.Therefore, electric potential at that point will be equal to the workdone
Therefore, φ = W

Question 4:
Figures show some equipotential lines distributed in space. A charged object is moved from point A to point B.



(a) The work done in Fig. (i) is the greatest.
(b) The work done in Fig. (ii) is least.
(c) The work done is the same in Fig. (i), Fig.(ii) and Fig. (iii).
(d) The work done in Fig. (iii) is greater than Fig. (ii) but equal to that in Fig. (i).

Answer: (c) The work done is the same in Fig. (i), Fig.(ii) and Fig. (iii).
$W_{electrical} = -\Delta U = -q\Delta V - q(V_{initial} - V_{final})$
Here initial and final potentials are same in all three cases and the same charge is moved, so work done is same in all three cases.

Question 5:
The capacitance of earth, viewed as a spherical conductor of radius 6408 km is:
(a) 1420 µF
(b) 712 µF
(c) 680 µF
(d) 540 µF

Answer: (b) 712 µF
Capacitance of a conducting sphere of radius R, $C = 4\pi\varepsilon_0 R$

$4\pi\varepsilon_0 = (1)/(9 \times 10^9)$
Here, R = 6408 km
= 6408×10^3m
Or C = $(6408\times10^3)/(9\times10^9)$
= 712µF
This shows that farad is a very large unit of capacitance.

Question 6:
What is the surface known as which has a constant value of potential at all points on the surface?
(a) Radial surface
(b) Equipotential
(c) Equikinetic
(d) Equiplanar

Answer: (b) Equipotential surface
For a single charge q, the potential is given by, $V = (1/4\pi\varepsilon_0)\ (q/r)$
This shows that V is a constant if r is constant. Thus, equipotential surfaces of a single point charge are concentric spherical surfaces centred at the charge.

Question 7:
Three capacitors 2µF, 3µF and 6µF are joined in series with each other.
The equivalent capacitance is-
(a) 1/2µF
(b) 1µF
(c) 2µF
(d) 11µF

Answer: (b) 1µF
$(1/C_{series}) = (1/C_1) + (1/C_2) + (1/C_3)$
$(1/C_{series}) = (1/2) + (1/3) + (1/6)$
$= (3+2+1)/(6)$
$= (6/6)$
= 1µF

Question 8:
When the field inside the cavity is always zero. What is it known as?
(a) Electrostatic influence
(b) Electrostatic shielding
(c) Electrostatics
(d) Electrical shielding

Answer: (b) Electrostatic shielding
Whatever be the charge and field configuration outside, any cavity in a conductor remains shielded from outside electric influence: the field inside the cavity is always zero. This is known as electrostatic shielding. The effect can be made use of in protecting sensitive instruments from outside electrical influence.

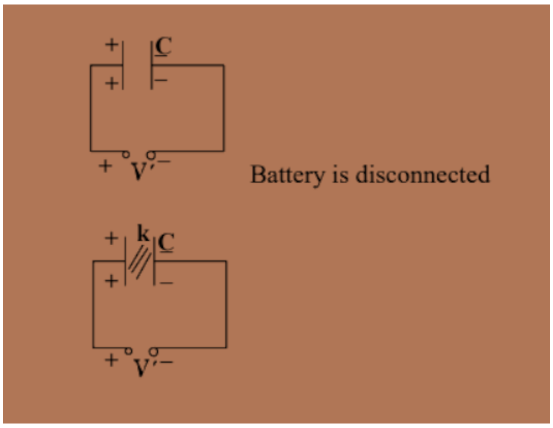
Question 9:
Which of the following is not used as dielectric or insulating material between the parallel conductive plates of the capacitor?
(a) Mica
(b) Ceramic
(c) Plastic
(d) Metals

Answer: (d) Metals
Most of the metals are conductors not insulating materials. They allow any charge to pass through them leaving no potential difference between the plates and hence no stored energy.

Question 10:
A capacitor plates are charged by a battery with 'V' volts. After charging battery is disconnected and a dielectric slab with dielectric constant 'K' is inserted between its plates, the potential across the plates of a capacitor will become
(a) Zero
(b) V/2
(c) V/K
(d) KV

Answer: (c) V/K

Q = Charge remains constant
C′ = KC
Q′ = C′V′
Q = C′V′
Q = KCV′
V′ = Q/(KC)
= V/K



Question 11:

The electrostatic potential on the surface of a charged conducting sphere is 100 V. Two statements are made in this regard

S_1: At any point inside the sphere, electric intensity is zero.
S_2: At any point inside the sphere, the electrostatic potential is 100 V.
Which of the following is a correct statement?

(a) S_1 is true but S_2 is false.
(b) Both S_1& S_2 are false.
(c) S_1 is true, S_2 is also true and S_1 is the cause of S_2.
(d) S_1 is true, S_2 is also true but the statements are independent.

Answer: (c) S_1 is true, S_2 is also true and S_1 is the cause of S_2.

The electrostatic potential on the surface of a charged conducting sphere =100V if we consider option (c)it is only true as inside the sphere, electric intensity =0 and electrostatic potential =100V

Question 12:

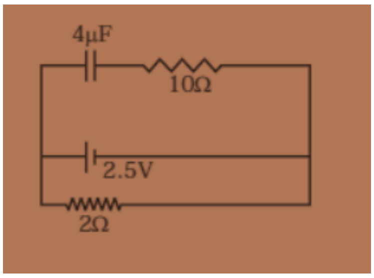
On moving a charge of 20 coulomb by 2 cm, 2 J of work is done, then the potential difference between the points is

(a) 0.1 V
(b) 8 V
(c) 2 V
(d) 0.5 V

Answer: (a) 0.1 V

The potential difference between two points in an electric field is,
$(V_A - V_B) = (W/q_0)$
where W is work done by moving charge q0 from point A and B.
So, $(V_A - V_B) = (2/20) = 0.1$ V

Question 13:
A capacitor of 4 μF is connected as shown in the circuit (Fig). The internal resistance of the battery is 0.5 Ω. The amount of charge on the capacitor plates will be
(a) 0
(b) 4μC
(c) 16 μC
(d) 8 μC



Answer: (d) 8 μC
Current in the lower arm of the circuit,
I = (2.5V)/(2Ω+0.5Ω) = 1A,
Potential difference across the internal resistance of cell = (0.5Ω) (1A) = 0.5V
And potential difference across the 4μF capacitor = 2.5V − 0.5V = 2V
Charge on the capacitor plates, Q = CV = (4μF) (2V) = 8μC

Question 14:

If the distance between parallel plates of a capacitor is halved and dielectric constant is doubled then the capacitance will become: -
(a) Half
(b) Two times
(c) Four times
(d) Remains the same

Answer: (c) Four times
$C = (K\varepsilon_0 Ad) \propto (K/d)$
Therefore, $(C_1/C_2) = (K_1/K_2) \times (d_2/d_1)$
Now distance is halved k id doubled = (K/2K) × (d/2)/(d) = (1/4)
Therefore, $C_2 = 4C_1$

Question 15:

The electrostatic force between the metal plates of an isolated parallel plate capacitor C having a charge Q and area A, is
(a) proportional to the square root of the distance between the plates.
(b) linearly proportional to the distance between the plates.
(c) independent of the distance between the plates.
(d) inversely proportional to the distance between the plates.

Answer: (c) independent of the distance between the plates.
For isolated capacitor Q = Constant
Force between plate = $(Q^2/2A\varepsilon_0)$

Question 16:
A positively charged particle is released from rest in a uniform electric field. The electric potential energy of the charge
(a) remains a constant because the electric field is uniform.
(b) increases because the charge moves along the electric field.
(c) decreases because the charge moves along the electric field.
(d) decreases because the charge moves opposite to the electric field.

Answer: (c) decreases because the charge moves along the electric field.
The positively charged particle experiences electrostatic force along the direction of electric field, hence moves in the direction of electric field. Electric potential decreases in the direction of electric field. Thus, positive work is done by the electric field on the charge.

$W_e = -\Delta U$
$= -q\Delta V$
$= q(V_{in} - V_f)$

Hence electrostatic potential energy of the positive charge decreases.

Question 17:
In which of the following forms is the energy stored in capacitor?
(a) Charge
(b) Potential
(c) Capacitance
(d) Electric Field

Answer: (d) Electric Field

A charged capacitor stores energy in the electrical field between its plates. As the capacitor is being charged, the electrical field builds up. When a charged capacitor is disconnected from a battery, its energy remains in the field in the space between its plates.

Assertion Reasoning Based Questions

In the following questions from 18 - 23 a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(a) Both assertion and reason are true and the reason is the correct explanation of assertion.

(b) Both assertion and reason are true but the reason is not the correct explanation of assertion.

(c) Assertion is true but reason is false.

(d) Assertion is false but reason is true.

Question 18:

Assertion: For any charge configuration, equipotential surface through a point is normal to the electric field at that point

Reason: If the field were not normal to the equipotential surface, it would have non-zero component along the surface. To move a unit test charge against the direction of the component of the field, work would have to be done. But this is in contradiction to the definition that there is no potential difference between any two points on the surface and no work is required to move a test charge on the surface. The electric field must, therefore, be normal to the equipotential surface at every point.

Answer: (a) Both assertion and reason are true and reason is the correct explanation of assertion.

Question 19:

Assertion: Inside a conductor, electrostatic field is zero.

Reason: When there is no current inside or on the surface of the conductor, the electric field is zero everywhere inside the conductor.

Answer: (a) Both assertion and reason are true and reason is the correct explanation of assertion.

Question 20:
Assertion: At the surface of a charged conductor, electrostatic field is normal to the surface at every point
Reason: For a conductor without any surface charge density, field is zero even at the surface

Answer: (b) Both assertion and reason are true but the reason is not the correct explanation of assertion.

Question 21:
Assertion: The interior of a conductor cannot have excess charge in the static situation.
Reason: When the conductor is charged the excess charge resides on the interior of the conductor.

Answer: (c) Assertion is true but reason is false

Question 22:

Assertion: A comb run through one's dry hair attracts small bits of paper.
Reason: Comb gets charged by friction. The molecules in the paper get polarised by the charged comb resulting in the net force of attraction.

Answer: (a) Both assertion and reason are true and reason is the correct explanation of assertion.

Question 23:

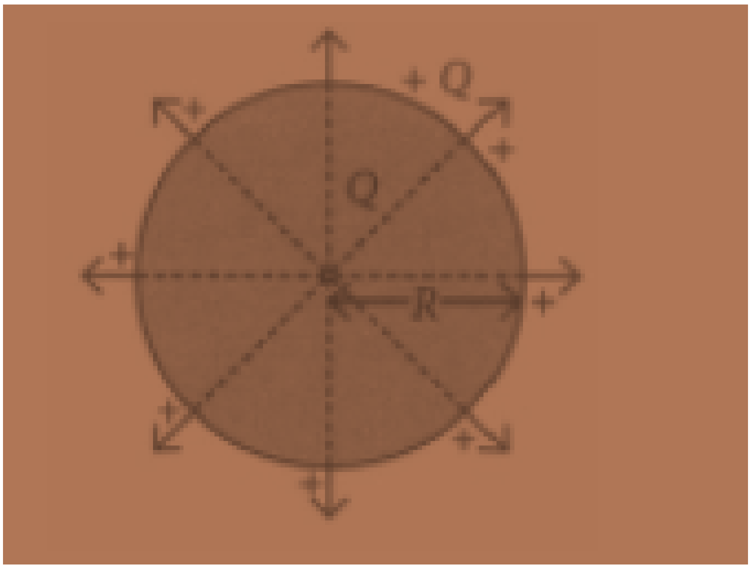
Assertion: Special rubber tyres of aircraft are made slightly conducting.

Reason: To enable them to conduct charge (produced by friction) to the ground; as too much of static electricity accumulated may result in spark and result in fire.

Answer: (a) Both assertion and reason are true and reason is the correct explanation of assertion.

Case Study Based Questions

Question 24:
The electrical capacitance of a conductor is the measure of its ability to hold electric charge. An isolated spherical conductor of radius R. The charge Q is uniformly distributed over its entire surface. It can be assumed to be concentrated at the centre of the sphere. The potential atany point on the surface of the spherical conductor will be $V=(1/4\pi\varepsilon_0)(Q/R)$.
Capacitance of the spherical conductor situated in vacuum is
$C = (Q/V)$
$= (Q)/[(1/4\pi\varepsilon_0)(Q/R)]$
or $C = 4\pi\varepsilon_0 R$ Clearly, the capacitance of a spherical conductor is proportional to its radius.
The radius of the spherical conductor of 1F capacitance is $R = 1/4\pi\varepsilon_0$. C and this radius are about 1500 times the radius of the earth ($\sim 6\times 10^3$ km).



1) If an isolated sphere has a capacitance 50 pF. Then radius is
(a) 90 cm

(b) 45 cm
(c) 45 m
(d) 90 m

2) How much charge should be placed on a capacitance of 25 pF to raise its potential to $l0^5$ V?
(a) 1 μC
(b) 1.5 μC
(c) 2 μC
(d) 2.5 μC

3) Dimensions of capacitance is
(a) $[ML^{-2}T^4A^2]$
(b) $[M^{-1}L^{-1}T^3A^1]$
(c) $[M^{-1}L^{-2}T^4A^2]$
(d) $[M^0L^{-2}T^4A^1]$

4) Metallic sphere of radius R is charged to potential V. Then charge q is proportional to
(a) V
(b) R
(c) both V and R
(d) none of these.

5) If 64 identical spheres of charge q and capacitance C each are combined to form a large sphere. The charge and capacitance of the large sphere is
(a) 64q, C
(b) 16q, 4C
(c) 64q, 4C
(d) 16q, 64C

Answer:

1) (b) 45 cm
Given, C = 50p
$F = 50\times10^{-12}F$,
$V = 10^4V$
$R = (1/4\pi\varepsilon_0)C$
$= 9 \times 10^9 mF^{-1} \times 50\times10^{-12}$ F
$= 45 \times 10^{-2}$ m

= 45 cm

2) (d) 2.5μC

As q = CV

$= 25 \times 10^{-12} \times 10^5$

$= 2.5\ \mu C$

3) (c) $[M^{-1}L^{-2} T^4 A^2]$

Charge on capacitor = C and potential = V

then capacitance C = (Q/V)

Dimensions of charge and potential

Dimension of charge [Q] = [AT]

Potential $[V] = [ML^2T^{-2}]/[Q]$

$[V] = [ML^2T^{-2}Q^{-1}]$

$[C] = [Q]/ [ML^2T^{-2}Q^{-1}]$

$[C] = [M^{-1}L^{-2}T^2Q^2]$

4) (c) both V and R

As charge, q = CV

$= (4\pi\varepsilon_0 R)V$

Therefore, q depends on both V and R

5) (c) 64q, 4C

64 drops have formed a single drop of radius R.

Volume of big drop = Volume of smalls drop.

Therefore, $(4/3)\ \pi R^3 = 64 \times (4/3)\ \pi r^3$

Or R = 4r

So, the total current is

$Q_{total} = 64q$

As C′ = Q/V

And $V = (1/4\pi\varepsilon 0)\ (Q/R)$

$C' = 4\pi\varepsilon_0 R$

$C' = (4\pi\varepsilon_0)4r$

C′ = 4C

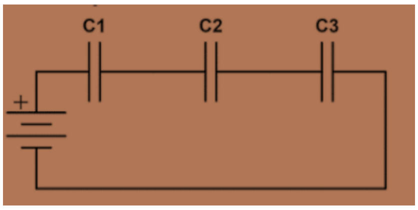
Question 25:

The capacitor is the one which has the ability or capacity to store energy in the form of an electrical charge producing a potential difference across its plates.

There are many different kinds of capacitors. A capacitor consists of two or more parallel conductive plates which are not connected or touching each other, but are electrically separated either by air or by some form of a good insulating material such as waxed paper, mica, ceramic, plastic or some form of a liquid gel as used in electrolytic capacitors. The insulating layer between a capacitors plates is commonly called the Dielectric.

1) Water is not used as a dielectric in a capacitor as
(a) Water is not an electrical insulator
(b) Water is not convenient to us
(c) Water can ruin the apparatus
(d) None of the above

2) In the image given below capacitors are connected in ______.
(a) Parallel
(b) Series
(c) Both parallel and series
(d) Line



3) For capacitors C_1, C_2, C_3, . . . in the parallel combination, the total capacitance C is given by ________.
(a) $C = C_1 + C_2 + C_3 + \dots$
(b) $(1/C) = (1/C_1) + (1/C_2) + (1/C_3)$
(c) $C = C_1 - C_2 - C_3 - \dots$
(d) $(1/C) = (1/C_1) - (1/C_2) - (1/C_3)$

4) What is the value of dielectric constant K for vacuum?
(a) $K = 1$
(b) $K > 1$
(c) $K < 1$
(d) $K = 0$

5) The capacitance C, with dielectric between the plates is $C = (\varepsilon_0 KA/d)$, here the $\varepsilon_0 K$ product is ______.
(a) Permeability of vacuum
(b) Permittivity of vacuum
(c) Permittivity of the medium

(d) Dielectric constant

Answer:

1) (a) Water is not an electrical insulator

2) (b) series

3) (a) $C = C_1 + C_2 + C_3 + \ldots$

4) (a) K = 1

5) (c) Permittivity of the medium

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