TEST

JEE Mains PYQS Electric Potential and Capacitance (Physics Master Academy)

**QUESTIONS**

SECTIONS

1. Section A - 30 Questions

**Section 1 : Section A - 30 Questions**

SECTION INSTRUCTIONS

This section contains 35 qs. Each qs ic compoulsary. 4 marks for every correct answer, - 1 for every incorrect answer.

**1**

1 Two thin coaxial rings, each of radius 'a' and having charges +Q and – Q respectively are separated by a distance of 's'. The potential difference between the centres of the two rings is:

- $\frac{Q}{2\pi\varepsilon_0}\left[\frac{1}{a}+\frac{1}{\sqrt{s^2+a^2}}\right]$
- $\frac{Q}{4\pi\varepsilon_0}\left[\frac{1}{a}+\frac{1}{\sqrt{s^2+a^2}}\right]$
- $\frac{Q}{4\pi\varepsilon_0}\left[\frac{1}{a}-\frac{1}{\sqrt{s^2+a^2}}\right]$
- $\frac{Q}{2\pi\varepsilon_0}\left[\frac{1}{a}-\frac{1}{\sqrt{s^2+a^2}}\right]$

Correct: +4 · Incorrect: -1

**2** 27 similar drops of mercury are maintained at 10V each. All these spherical drops combine into a single big drop. The potential energy of the bigger drop is___times that of a smaller drop.

- 213
- 243
- 203

- None of these

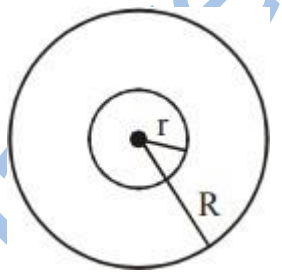
Correct: +4 · Incorrect: -1

**3** Concentric metallic hollow spheres of radii R and 4R hold charges $Q_1$ and $Q_2$ respectively . Given that surface charge of densities of the concentric spheres are equal, the potential difference V(R) – V(4R) is

- $\frac{3Q_1}{16\pi\varepsilon_0 R}$
- $\frac{3Q_2}{4\pi\varepsilon_0 R}$
- $\frac{Q_2}{4\pi\varepsilon_0 R}$
- $\frac{3Q_1}{4\pi\varepsilon_0 R}$

Correct: +4 · Incorrect: -1

**4** A charge Q is distributed over two concentric conducting thin spherical shells radii r and R (R > r). IF the surface charge densities on the two shells are equal, the electric potential at the common centre is




- $\frac{1}{4\pi\varepsilon_0}\frac{(R+r)}{2(R^2+r^2)}Q$
- $\frac{1}{4\pi\varepsilon_0}\frac{(2R+r)}{(R^2+r^2)}Q$
- $\frac{1}{4\pi\varepsilon_0}\frac{(R+2r)}{2(R^2+r^2)}Q$
- $\frac{1}{4\pi\varepsilon_0}\frac{(R+r)}{(R^2+r^2)}Q$

Correct: +4 · Incorrect: -1

**5** A uniformly charged ring of radius 3a and total charge q is placed in xy plane centered at origin. A point charge q is moving towards the ring along the z axis and has sped v at z = 4a. The minimum value of v such that it crosses the origin is

- $\sqrt{\frac{2}{m}}\left(\frac{4}{15}\frac{q^2}{4\pi\varepsilon_0 a}\right)^{1/2}$
- $\sqrt{\frac{2}{m}}\left(\frac{1}{5}\frac{q^2}{4\pi\varepsilon_0 a}\right)^{1/2}$
- $\sqrt{\frac{2}{m}}\left(\frac{2}{15}\frac{q^2}{4\pi\varepsilon_0 a}\right)^{1/2}$
- $\sqrt{\frac{2}{m}}\left(\frac{1}{15}\frac{q^2}{4\pi\varepsilon_0 a}\right)^{1/2}$

Correct: +4 · Incorrect: -1

**6** A solid conducting sphere, having a charge Q, is surrounded by an uncharged conducting hollow spherical shell. Let the potential difference between the surface of the solid sphere and that of the outer surface of the hollow shell be V. If the shell is now given a charge of – 4Q, the new potential difference between the same two surfaces is

- -2V
- 2V
- 4V
- V

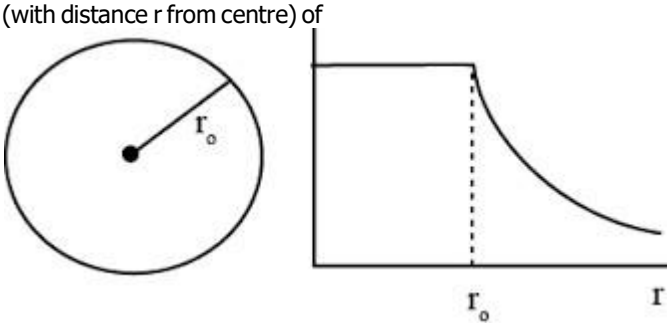
Correct: +4 · Incorrect: -1

**7** The electric keld in a region is given by $\vec{E}$ = (Ax + B)
$\hat{i}$
, where E is in $NC^{-1}$ and x is in metres. The values of constants are A = 20 SI unit and B = 10 SI unit. If the potential at x = 1 is $V_1$ and at x = -5 is $V_2$, then $V_1 - V_2$ is

- 320V
- -48V
- 180V
- -520V

Correct: +4 · Incorrect: -1

**8** The given graph shows variation (with distance r from centre) of




- Electric keld of a uniformly charge sphere
- Potential of a uniformly charged spherical shell
- Potential of a uniformly charged sphere
- Electric keld of a uniformly charged spherical shell

Correct: +4 · Incorrect: -1

**9** Two electric dipoles A, B with respective dipole moments, $\vec{d}_A = -4qa\hat{i}$ and $\vec{d}_B = -2qa\hat{i}$ are placed on the x axis with a separation R, as shown in kgure


The distance from A at which both of them produce the same potential is

- $\frac{R}{\sqrt{2}+1}$
- $\frac{\sqrt{2}R}{\sqrt{2}+1}$
- $\frac{R}{\sqrt{2}-1}$
- $\frac{\sqrt{2}R}{\sqrt{2}-1}$

Correct: +4 · Incorrect: -1

**10** Consider two charged metallic spheres $S_1$ and $S_2$ of radii $R_1$ and $R_2$ respectively. The electric kelds $E_1$ (on $S_1$) and $E_2$ (on $S_2$) on their surfaces such that $E_1/E_2 = R_1/R_2$. Then the ratio of $V_1$ (on $S_1$)/$V_2$(on $S_2$) of the electrostatic potentials on each sphere is

- $R_1/R_2$
- $(R_1/R_2)^2$
- $(R_2/R_1)$
- $(R_1/R_2)^3$

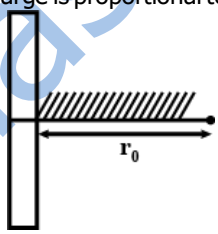
Correct: +4 · Incorrect: -1

**11** There is a uniform electrostatic keld in a region. The potential at various points on a small sphere centred at P, in the region, is found to vary between in the limits 589.0V to 589.8V. What is the potential at a point on the sphere whose radius vector makes an angle of 60° with the direction of the keld?

- 589.5V
- 589.2V
- 589.4V
- 589.6V

Correct: +4 · Incorrect: -1

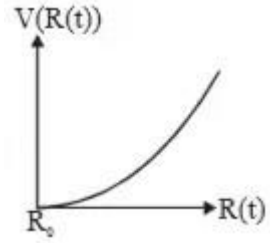
**12** A positive charge is released from rest at a distance $r_0$ from a positive line charge with uniform density. The speed (v) of the point charge as a function of instantaneous distance r from line charge is proportional to

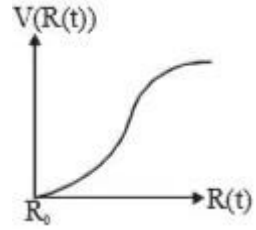


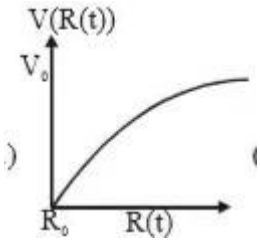

- $v \propto e^{+r/r_0}$
- $v \propto \sqrt{\ln\left(\frac{r}{r_0}\right)}$
- $v \propto \ln\left(\frac{r}{r_0}\right)$
- $v \propto \left(\frac{r}{r_0}\right)$

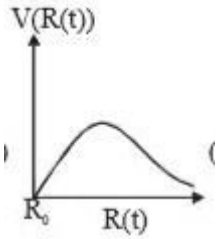
Correct: +4 · Incorrect: -1

**13** There is a uniform spherically symmetric surface charge density at a distance $R_0$ from the origin. The charge distribution is initially at rest and starts expanding because of mutual repulsion. The kgure that represents best the speed V(R(t) of the distribution as a function of its instantaneous radius R(t) is

○ 

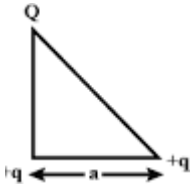

○ 


○ 


○ 


Correct: +4 · Incorrect: -1

**14** Three charges Q, +q and +q are placed at the vertices of a right angle isosceles triangle as shown below. The net electrostatic energy of the conkguration is zero, if the value of Q is




○ +q

○ $\frac{-\sqrt{2}q}{\sqrt{2}+1}$

- $\frac{-q}{1+\sqrt{2}}$
- -2q

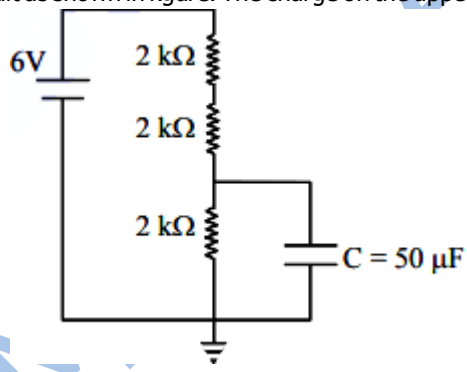
Correct: +4 · Incorrect: -1

**15** A capacitor is connected to a 20V battery through a resistance of 10Ω. It is found that the potential difference across the capacitor rises to 2V in 1 μs. The capacitance of the capacitor is____μF. Given : ln(10/9) = 0.105.

- 9.52
- 0.95
- 0.105
- 1.85

Correct: +4 · Incorrect: -1

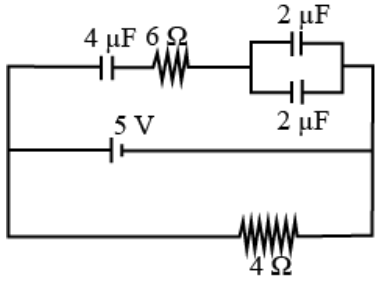
**16** A capacitor of 50μF is connected in a circuit as shown in kgure. The charge on the upper plate of the capacitor is




- 100
- 0
- 75
- 150

Correct: +4 · Incorrect: -1

**17** Calculate the amount of charge in a capacitor of 4μF. The internal resistance of batter is 1Ω:



- 8 μC
- Zero
- 16 μC
- 4 μC

Correct: +4 · Incorrect: -1

**18** The material kled between the plates of a parallel plate capacitor has a resistivity 200 Ωm. The value of capacitance of the capacitor is 2pF. If a potential difference of 410V is applied across the plates of the capacitor, then the value of leakage current flowing out of the capacitor is (given the value of relative permittivity of material is 50)

- 9.0 μA
- 9.0 mA
- 0.9 mA
- 0.9 μA

Correct: +4 · Incorrect: -1

**19** An electron with kinetic energy $K_1$ enters between parallel plates of a capacitor at an dangle '$\alpha$' with the plates. It leaves the plates at angle '$\beta$' with kinetic energy $K_2$. Then the ratio of kinetic energies $K_1$:$K_2$ will be

- $\frac{cos\beta}{sin\alpha}$
- $\frac{cos\beta}{cos\alpha}$
- $\frac{cos^2\beta}{cos^2\alpha}$
- $\frac{sin^2\beta}{cos^2\alpha}$

Correct: +4 · Incorrect: -1

**20** Two equal capacitors are krst connected in series and then in parallel. The ratio of the equivalent capacities in the two cases will be

- 4:1
- 2:1

- 1:4
- 1:2

Correct: +4 · Incorrect: -1

**21** Consider the combination of 2 capacitors $C_1$ and $C_2$ with $C_2>C_1$, when connected n parallel, the equivalent capacitance is 15/4 times the equivalent capacitance of the same connected n series. Calculate the ratio of capacitors $C_2/C_1$.

- 15/4
- 29/15
- 111/80
- None of these

Correct: +4 · Incorrect: -1

**22** Two capacitors of capacitances C and 2C are charged to potential differences V and 2V, respectively. These are then connected in parallel in such a manner that the positive terminal of one is connected to the negative terminal of the other. The knal energy of this conkguration is

- 25/6 $CV^2$
- 3/2 $CV^2$
- Zero
- 9/2 $CV^2$

Correct: +4 · Incorrect: -1

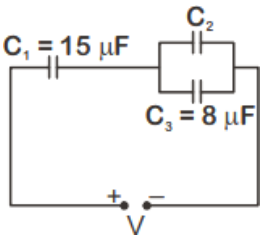
**23** A capacitor C is fully charged with voltage $V_0$. After disconnecting the voltage source, it is connected in parallel with another uncharged capacitor of capacitance C/2. The energy loss in the process after the charge is distributed between the two capacitors is:

- $\frac{1}{2}CV_0^2$
- $\frac{1}{3}CV_0^2$
- $\frac{1}{4}CV_0^2$

○ $\frac{1}{6}CV_0^2$

Correct: +4 · Incorrect: -1

**24** In the circuit in the kgure, the total charge is 750 μC and the voltage across capacitor $C_2$ is 20V. Then the charge on capacitor $C_2$ is




○ 450 μC

○ 590 μC

○ 160 μC

○ 650 μC

Correct: +4 · Incorrect: -1

**25** A 10 μF capacitor is fully charged to a potential difference of 50V. After removing the source voltage it is connected to an uncharged capacitor in parallel. Now the potential difference across them becomes 20V. The capacitance of the second capacitor is

○ 15 μF

○ 30 μF

○ 20 μF

○ 10 μF

Correct: +4 · Incorrect: -1

**26** Effective capacitance of parallel combination of the capacitors $C_1$ and $C_2$ is 10 μF. When these capacitors are individually connected to a voltage source of 1V, the energy stored in the capacitor $C_2$ is 4 times that of $C_1$. If these capacitors are connected in series, their effective capacitances will be

○ 4.2 μF

○ 3.2 μF

○ 1.6 μF

○ 8.4 μF

Correct: +4 · Incorrect: -1

**27** The parallel combination of two air kled parallel plate capacitors of capacitance C and nC is connected to a battery of voltage V. When the capacitors are fully charged, the battery is removed and after that a dielectric material of dielectric constant K is placed between the two plates of the krst capacitor. The new potential difference of the combined system is

- $\frac{nV}{K+n}$
- V
- $\frac{V}{K+n}$
- $\frac{(n+1)V}{(K+n)}$

Correct: +4 · Incorrect: -1

**28** Voltage rating of a parallel plate capacitor is 500V, the dielectric can withstand a maximum electric keld of $10^6$V/m. The plate area is $10^{-4}m^2$. What is the dielectric constant if the capacitance is 15pF? (given "o = $8.86\times10^{-12}C^2/Nm^2$)

- 3.8
- 8.5
- 4.5
- 6.2

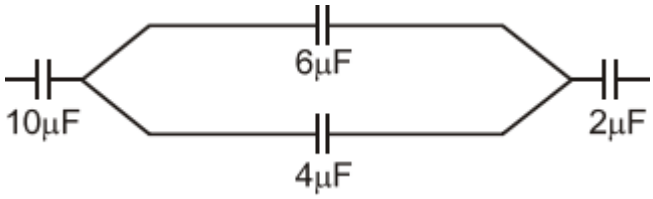
Correct: +4 · Incorrect: -1

**29** A parallel plate capacitor has 1μF capacitance. One of its two plates is given +2μC charge and the other plate +4μC charge. The potential difference developed across the capacitor is

- 3V
- 1V
- 5V
- 2V

Correct: +4 · Incorrect: -1

**30** In the kgure shown below, the charge n the left plate of the 10mF capacitor is – 30 μC. The charge of the right plate of the 6 μF capacitor is




- ○ -12 μC
- ○ +12 μC
- ○ -18 μC
- ○ +18 μC

Correct: +4 · Incorrect: -1

TEST

# JEE Mains PYQS Electric Potential and Capacitance (Physics Master Academy)

## ANSWERS

SECTIONS

1. Section A - 30 Questions

### Section 1 : Section A - 30 Questions

**1** $\frac{Q}{2\pi\varepsilon_0}\left[\frac{1}{a}-\frac{1}{\sqrt{s^2+a^2}}\right]$

**2** 243

**3** $\frac{3Q_1}{16\pi\varepsilon_0 R}$

**4** $\frac{1}{4\pi\varepsilon_0}\frac{(R+r)}{(R^2+r^2)}Q$

**5** $\sqrt{\frac{2}{m}}\left(\frac{2}{15}\frac{q^2}{4\pi\varepsilon_0 a}\right)^{1/2}$

**6** V

**7** 180V

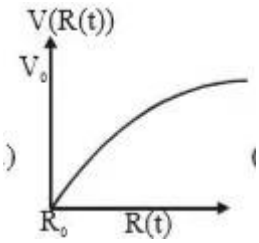
**8** Potential of a uniformly charged spherical shell

**9** $\frac{\sqrt{2}R}{\sqrt{2}-1}$

**10** $(R_1/R_2)^2$

**11** 589.4V

**12** $v \propto \sqrt{\ln\left(\frac{r}{r_0}\right)}$

**13** 


**14** $\frac{-\sqrt{2}q}{\sqrt{2}+1}$

**15** 0.95

**16** 100

**17** 8 μC

**18** 0.9 mA

**19** $\frac{cos^2\beta}{cos^2\alpha}$

**20** 1:4

**21** None of these

**22** 3/2 $CV^2$

**23** $\frac{1}{6}CV_0^2$

**24** 590 μC

**25** 15 μF

**26** 1.6 μF

**27** $\frac{(n+1)V}{(K+n)}$

**28** 8.5

**29** 1V

**30** +18 μC