Exercise-3

Marked Questions can be used as Revision Questions.

PART - I : JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

1. If there are n capacitors of capacitance C in parallel connected to V volt source, then the energy stored is equal to : **[AIEEE-2002, 4/300]**

(1) CV (2) $\frac{1}{2}nCV^2$ (3) CV^2 (4) $\frac{1}{2n}CV^2$

2. Capacitance (in F) of a spherical conductor having radius 1m, is : **[AIEEE-2002, 4/300]**

(1) 1.1×10^{-10} (2) 10^{-6} (3) 9×10^{-9} (4) 10^{-3}

3. The work done in placing a charge of 8×10^{-18} coulomb on a condenser of capacity 100 micro-farad is : **[AIEEE-2003, 4/300]**

(1) 16×10^{-32} joule (2) 3.1×10^{-26} joule (3) 4×10^{-10} joule (4) 32×10^{-32} joule

4. A fully charged capacitor has a capacitance 'C'. It is discharged through a small coil of resistance wire embedded in a thermally insulated block of specific heat capacity 's' and mass 'm'. If the temperature of the block is raised by 'ΔT', the potential difference 'V' across the capacitance is : **[AIEEE-2005, 4/300]**

(1) $\sqrt{\frac{2mC\Delta T}{s}}$ (2) $\frac{mC\Delta T}{s}$ (3) $\frac{ms\Delta T}{C}$ (4) $\sqrt{\frac{2ms\Delta T}{C}}$

5. A parallel plate capacitor is made by stacking n equally spaced plates connected alternatively. If the capacitance between any two adjacent plates is 'C', then the resultant capacitance is : **[AIEEE-2005, 4/300]**

(1) (n – 1)C (2) (n + 1) C (3) C (4) nC

6. A battery is used to charge a parallel plate capacitor till the potential difference between the plates becomes equal to the electromotive force of the battery. The ratio of the energy stored in the capacitor and the work done by the battery will be **[AIEEE-2007, 3/120]**

(1) 1 (2) 2 (3) 1/4 (4) 1/2

7. A parallel plate condenser with a dielectric of dielectric constant *K* between the plates has a capacity *C* and is charged to a potential *V* volts. The dielectric slab is slowly removed from between the plates and then reinserted. The net work done by the system in this process is **[AIEEE-2007, 3/120]**

(1) $\frac{1}{2}(K-1)CV^2$ (2) $CV^2(K-1)/K$ (3) $(K-1)CV^2$ (4) zero

8. A parallel plate capacitor with air between the plates has a capacitance of 9 pF. The separation between its plates is 'd'. The space between the plates is now filled with two dielectrics. One of the dielectrics has dielectric constant $k_1 = 3$ and thickness d/3 while the other one has dielectric constant $k_2 = 6$ and thickness 2d/3. Capacitance of the capacitor is now : **[AIEEE-2008, 3/105]**

(1) 45 pF (2) 40.5 pF (3) 20.25 pF (4) 1.8 pF

9. Let C be the capacitance of a capacitor discharging through a resistor R. Suppose t_1 is the time taken for the energy stored in the capacitor to reduce to half its initial value and t_2 is the time taken for the charge to reduce to one-fourth its initial value. Then the ratio t_1/t_2 will be **[AIEEE-2010, 8/144]**

(1) 1 (2) $\frac{1}{2}$ (3) $\frac{1}{4}$ (4) 2

10. A resistor 'R' and 2μF capacitor in series is connected through a switch to 200 V direct supply. Across the capacitor is a neon bulb that lights up at 120 V. Calculate the value of R to make the bulb light up 5s after the switch has been closed. (log102.5 = 0.4) **[AIEEE - 2011, 4/120, –1]**

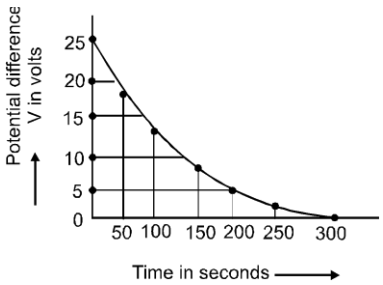
(1) $1.3 \times 10^4\ \Omega$ (2) $1.7 \times 10^5\ \Omega$ (3) $2.7 \times 10^6\ \Omega$ (4) $3.3 \times 10^7\ \Omega$

11. Combination of two identical capacitors, a resistor R and a dc voltage source of voltage 6V is used in an experiment on a (C – R) circuit. It is found that for a parallel combination of the capacitor the time in which the voltage of the fully charged combination reduces to half its original voltage is 10 second. For series combination the time needed for reducing the voltage of the fully charged series combination by half is : **[AIEEE 2011, 11 May ; 4/120, –1]**

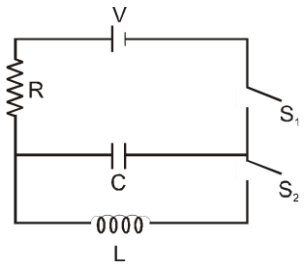
(1) 10 second (2) 5 second (3) 2.5 second (4) 20 second

12. The figure shows an experimental plot discharging of a capacitor in an RC circuit. The time constant τ of this circuit lies between : **[AIEEE 2012, ; 4/120, –1]**

(1) 150 sec and 200 sec
(2) 0 and 50 sec
(3) 50 sec and 100 sec
(4) 100 sec and 150 sec



13. In an LCR circuit as shown below both switches are open initially. Now switch S_1 is closed, S_2 kept open. (q is charge on the capacitor and τ = RC is Capacitive time constant). Which of the following statement is correct ? **[JEE(Main)-2013, ; 4/120, –1]**



(1) Work done by the battery is half of the energy dissipated in the resistor

(2) At $t = \tau$, $q = CV/2$

(3) At $t = 2\tau$, $q = CV(1 - e^{-2})$

(4) At $t = \frac{\tau}{2}$, $q = CV(1 - e^{-1})$

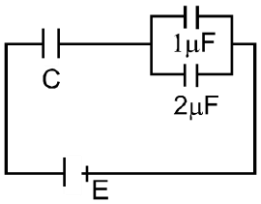
14. Two capacitors C_1 and C_2 are charged to 120 V and 200 V respectively. It is found that by connecting them together the potential on each one can be made zero. Then : **[JEE(Main)-2013, ; 4/120, –1]**

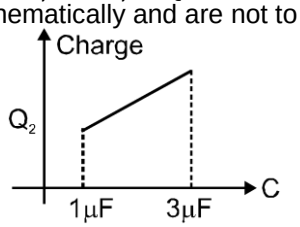
(1) $5C_1 = 3C_2$ (2) $3C_1 = 5C_2$ (3) $3C_1 + 5C_2 = 0$ (4) $9C_1 = 4C_2$

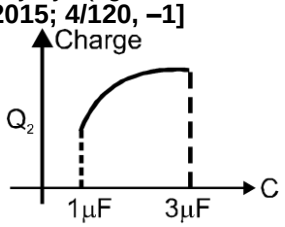
15. A parallel plate capacitor is made of two circular plates separated by a distance of 5 mm and with a dielectric of dielectric constant 2.2 between them. When the electric field in the dielectric is 3×10^4 V/m, the charge density of the positive plate will be close to : **[JEE(Main)-2014 ; 4/120. –1]**

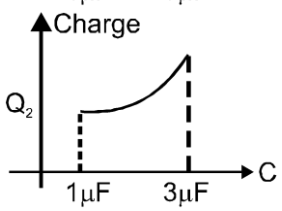
(1) $6 \times 10^{-7} C/m^2$ (2) $3 \times 10^{-7} C/m^2$ (3) $3 \times 10^4 C/m^2$ (4) $6 \times 10^4 C/m^2$

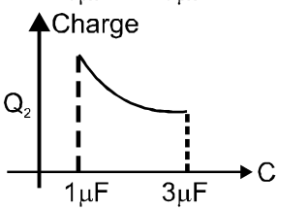
16. In the given circuit, charge Q_2 on the 2μF capacitor changes as C is varied from 1μF to 3μF. Q_2 as a function of 'C' is given properly by : (figures are drawn schematically and are not to scale) **[JEE(Main)-2015; 4/120, –1]**



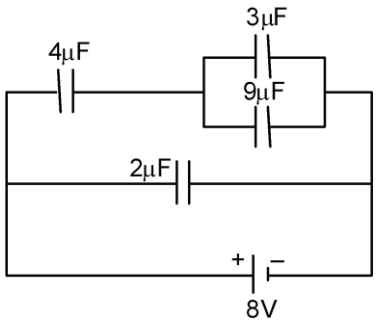
(1)


(2)


(3)


(4)


17. A combination of capacitors is set up as shown in the figure. The magnitude of the electric field, due to a point charge Q (having a charge equal to the sum of the charges on the 4μF and 9μF capacitors), at a point distance 30 m from it, would equal : **[JEE(Main)-2016; 4/120, –1]**

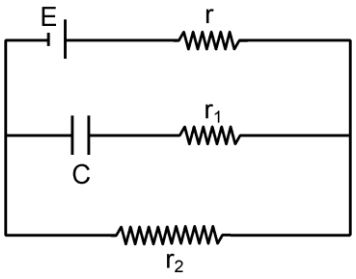


(1) 360 N/C (2) 420 N/C
(3) 480 N/C (4) 240 N/C

18. A capacitance of 2μF is required in an electrical circuit across a potential difference of 1.0 kV. A large number of 1μF capacitors are available which can withstand a potential difference of not more than 300 V. The minimum number of capacitors required to achieve this is : **[JEE(Main) 2017; 4/120,–1]**

(1) 32 (2) 2 (3) 16 (4) 24

19. In the given circuit diagram when the current reaches steady state in the circuit, the charge on the capacitor of capacitance C will be : **[JEE(Main) 2017; 4/120,–1]**



(1) $CE\frac{r_1}{(r_1+r)}$ (2) CE
(3) $CE\frac{r_1}{(r_2+r)}$ (4) $CE\frac{r_2}{(r+r_2)}$

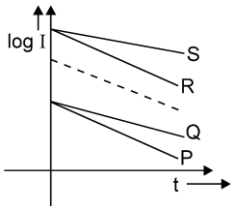
PART - II : JEE (ADVANCED) / IIT-JEE PROBLEMS (PREVIOUS YEARS)

*** Marked Questions may have more than one correct option.**

1. Two identical capacitors have the same capacitance C. One of them is charged to potential V_1 and the other to V_2. The negative ends of the capacitors are connected together. When the positive ends are also connected, the decrease in energy of the combined system is: **[JEE(Scr) 2002' 3/105]**

(A) $\frac{1}{4}C(V_{12} - V_{22})$ (B) $\frac{1}{4}C(V_{12} + V_{22})$ (C) $\frac{1}{4}C(V_1 - V_2)_2$ (D) $\frac{1}{4}C(V_1 + V_2)_2$

2. Dotted line represents the charging of a capacitor with resistance X. If resistance is made 2X then which will be the graph of charging **[JEE Scr. 2004' 3/84]**

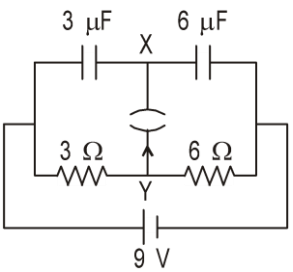


(A) P (B) Q
(C) R (D) S

3. An uncharged capacitor of capacitance 4μF, a battery of emf 12 volt and a resistor of 2.5 MΩ are connected in series. The time after which $V_C = 3V_R$ is (take $\ell n2 = 0.693$) **[JEE Scr. 2005' 3/84]**

(A) 6.93 seconds (B) 13.86 seconds
(C) 7 seconds (D) 14 seconds

4. A circuit is connected as shown in the figure with the switch S open. When the switch is closed, the total amount of charge that flows from Y to X is **[JEE 2007' 3/81]**



(A) 0 (B) 54 μC
(C) 27 μC (D) 81 μC

5. A parallel plate capacitor C with plates of unit area and separation d is filled with a liquid of dielectric constant K = 2. The level of liquid is $\frac{d}{3}$ initially. Suppose the liquid level decreases at a constant speed V, the time constant as a function of time t is **[JEE' 2008 ; 3/163]**

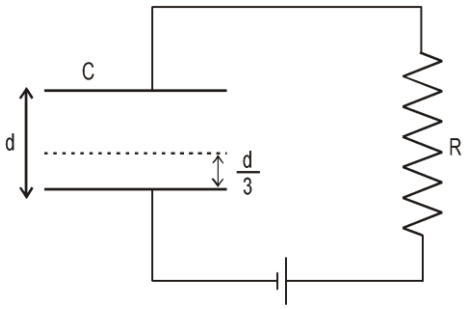
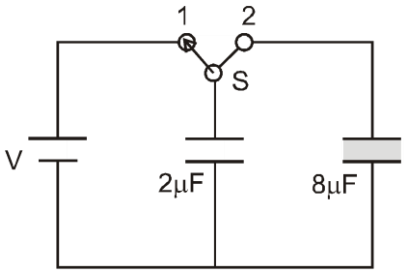


Figure :

(A) $\frac{6\varepsilon_0 R}{5d+3Vt}$ (B) $\frac{(15d+9Vt)\varepsilon_0 R}{2d^2-3dVt-9V^2t^2}$

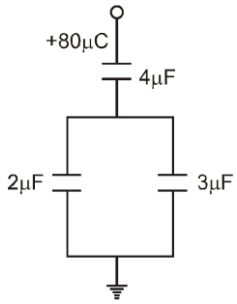
(C) $\frac{6\varepsilon_0 R}{5d-3Vt}$ (D) $\frac{(15d-9Vt)\varepsilon_0 R}{2d^2+3dVt-9V^2t^2}$

6. A 2μF capacitor is charged as shown in figure. The percentage of its stored energy dissipated after the switch S is turned to position 2 is **[JEE' 2010 ; 3/160, –1]**



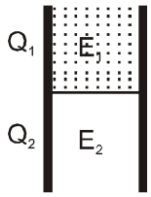
(A) 0%
(B) 20%
(C) 75%
(D) 80%

7. In the given circuit, a charge of +80 μC is given to the upper plate of the 4μF capacitor. Then in the steady state, the charge on the upper plate of the 3μF capacitor is : **[IIT-JEE-2012, Paper-2; 3/66, –1]**



(A) +32 μC
(B) +40 μC
(C) +48 μC
(D) +80 μC

8. A parallel plate capacitor has a dielectric slab of dielectric constant K between its plates that covers 1/3 of the area of its plates, as shown in the figure. The total capacitance of the capacitor is C while that of the portion with dielectric in between is C_1. When the capacitor is charged, the plate area covered by the dielectric gets charge Q_1 and the rest of the area gets charge Q_2. Choose the correct option/options, igonoring edge effects.



[JEE (Advanced)-2014,P-1, 3/60]

(A) $\frac{E_1}{E_2}=1$ (B) $\frac{E_1}{E_2}=\frac{1}{K}$

(C) $\frac{Q_1}{Q_2}=\frac{3}{K}$ (D) $\frac{C}{C_1}=\frac{2+K}{K}$

Answers

EXERCISE # 1

PART - I

Section (A)

A-1.	(1)	**A-2.**	(2)	**A-3.**	(3)
A-4.	(1)	**A-5.**	(4)	**A-6.**	(1)
A-7.	(2)	**A-8.**	(2)	**A-9.**	(3)

Section (B)

B-1.	(2)	**B-2.**	(4)	**B-3.**	(4)
B-4.	(4)	**B-5.**	(2)		

Section (C)

C-1.	(2)	**C-2.**	(3)	**C-3.**	(4)
C-4.	(2)	**C-5.**	(3)		

Section (D)

D-1.	**(i)** (2)	**(ii)**	(3)	**(iii)**	(1)
D-2.	(3)	**D-3.**	(3)	**D-4.**	(3)
D-5.	(2)				

Section (E)

E-1.	(2)	**E-2.**	(3)	**E-3.**	(1)
E-4.	(1)	**E-5.**	(3)	**E-6.**	(1)
E-7.	(3)	**E-8.**	(1)		

EXERCISE # 2

PART - I

1.	(1)	**2.**	(4)	**3.**	(4)
4.	(3)	**5.**	(4)	**6.**	(4)
7.	**(i)** (1)		**(ii)** (2)	**8.**	(1)
9.	(1)	**10.**	(3)	**11.**	(4)
12.	(2)	**13.**	(3)	**14.**	(1)
15.	**(i)** (1)		**(ii)** (3)	**16.**	(3)
17.	(2)	**18.**	(2)	**19.**	(2)

PART - II

Section (A)

A-1.	(4)	**A-2.**	(4)	**A-3.**	(1)

Section (B)

B-1. (1 → p); (2 → r); (3 → q); (4 → p)

Section (C)

C-1.	(2,3,4)	**C-2.**	(1,2,4)	**C-3.**	(1,3)
C-4.	(2,4)	**C-5.**	(1,2,3)	**C-6.**	(1,3,4)

EXERCISE # 3

PART - I

1.	(2)	**2.**	(1)	**3.**	(4)
4.	(4)	**5.**	(1)	**6.**	(4)
7.	(4)	**8.**	(2)	**9.**	(3)
10.	(3)	**11.**	(3)	**12.**	(4)
13.	(3)	**14.**	(2)	**15.**	(1)
16.	(2)	**17.**	(2)	**18.**	(1)
19.	(4)				

PART - II

1.	(C)	**2.**	(B)	**3.**	(B)
4.	(C)	**5.**	(A)	**6.**	(D)
8.	(A,D)				