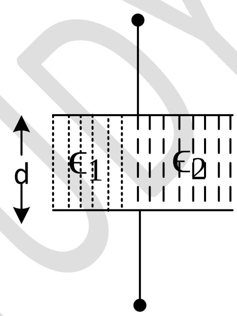
Basics of Network Theory (Part-I)

1. One coulomb charge is equal to the charge on
   (a) 6.24×10^{18} electrons
   (b) 6.24×10^{24} electrons
   (c) 6.24×10^{18} atoms
   (d) none of the above

2. The correct relation between energy and charge is
   (a) Energy = voltage / charge
   (b) Charge = Energy x voltage
   (c) Energy = voltage $(\text{charge})^{0.5}$
   (d) Energy = voltage x charge

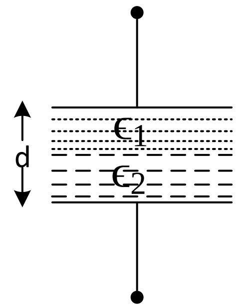
3. A parallel plate capacitor has plate area A and distance between the plates is d. It has two dielectrics each of thickness d and area 0.5 A. The dielectric constants are ϵ_1 and ϵ_2. The total capacitance is given by the equation



   (a) $C = \frac{0.5 \epsilon_0 A}{d}(\epsilon_1 + \epsilon_2)$
   (b) $C = \frac{\epsilon_0 A}{d}(\epsilon_1 + \epsilon_2)$
   (c) $\frac{1}{C} = \frac{d}{2 \epsilon_0 A}\left(\frac{1}{\epsilon_1} + \frac{1}{\epsilon_2}\right)$
   (d) $\frac{1}{C} = \frac{d}{\epsilon_0 A}\left(\frac{1}{\epsilon_1} + \frac{1}{\epsilon_2}\right)$

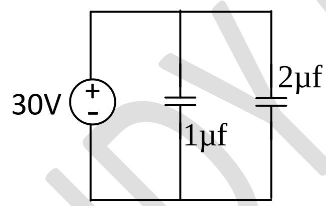
4. Two capacitor each of capacitance C and breakdown voltage V are joined in series. The capacitance and breakdown voltage of the combination is
   (a) 0.5 C and 2 V
   (b) 0.5 C and 0.5 V
   (c) C and V
   (d) 2 C and 2 V

5. The distance between the plates of a parallel plate capacitor is d. The dielectric is in two part, each of equal thickness but dielectric constants ϵ_1 and ϵ_2 respectively. The total capacitance will be proportional to



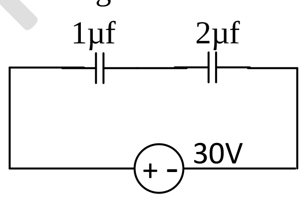
(a) $\frac{\epsilon_1 \epsilon_2}{\epsilon_1+\epsilon_2}$
(b) $\epsilon_1 - \epsilon_2$
(c) $\frac{\epsilon_1}{\epsilon_2}$
(d) $\epsilon_1 \epsilon_2$

6. Two capacitors of 1 μF and 2μF capacitance are connected in parallel across a 30 V dc battery. After the capacitors have bean charged, the charges across the two capacitors will be



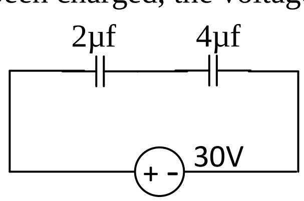
(a) 30 μC each
(b) 60 μC each
(c) 30 μC and 60 μC respectively
(d) 60 μC and 30 μC respectively

7. Two capacitors of 1 μF and 2 μF are connected in series across a 30 V dc battery. After the capacitors have been charged, the charges across the two capacitors will be



(a) 10 μC each
(b) 20 μC each
(c) 10 μC and 20 μC
(d) 20 μC and 10 μC

8. Two capacitors of 2 μF and 4 μF capacitance are connected in series across a 30 V dc battery. After the capacitors have been charged, the voltage across them will be



(a) 15 V each
(b) 10 V and 20 V respectively
(c) 20 V and 10 V respectively
(d) 30 V each

9. In a practical voltage source, the terminal voltage
   (a) cannot be less than source voltage
   (b) cannot be higher than source voltage
   (c) is always less than source voltage
   (d) is always equal to source voltage

10. An ideal current source has
   (a) infinite source resistance
   (b) zero source resistance
   (c) large value of source resistance
   (d) finite value of source resistance

11. Kirchhoff's laws are applicable to
   (a) dc only
   (b) as sinusoidal wave only
   (c) dc and ac sinusoidal waves
   (d) all wave shapes

12. When determining Thevenin's resistance of a circuit
   (a) all sources must be open circuited
   (b) all sources must be short circuited
   (c) all voltage sources must be open circuited and all current sources must be short circuited
   (d) all sources must be replaced by their internal resistances

13. A source is delivering maximum power to a resistance through a network. The ratio of power delivered to the source power
   (a) is always 0.5
   (b) may be 0.5 or less
   (c) may be 0.5 or less or more
   (d) may be 0.5 or more

14. Three resistance of 15Ω each are connected in delta. The resistance of equivalent star will have a value of
   (a) 12Ω
   (b) 5Ω
   (c) 5/3Ω
   (d) 45Ω

15. Two voltage are $v_1 = 100 \sin(\omega t+15^0)$ and $v_2 = 60 \cos \omega t$, then

(a) v_1 is leading v_2 by 15^0
(b) v_1 is leading v_2 by 75^0
(c) v_2 is leading v_1 by 75^0
(d) v_2 is leading v_1 by 15^0

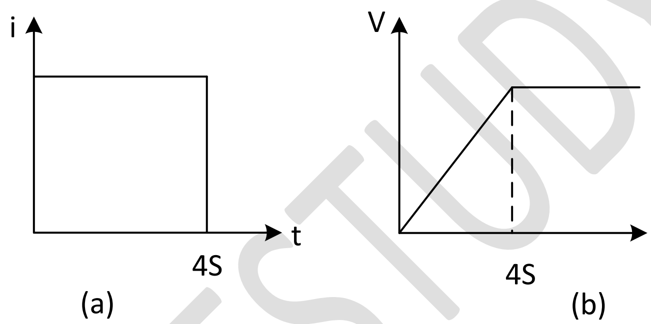
16. In a purely inductive circuit the current …….the voltage by …..

(a) lags, 0^0
(b) leads, 90^0
(c) lags, 90^0
(d) lags, 45^0

17. In a purely capacitive circuit, the current …..the voltage by …….

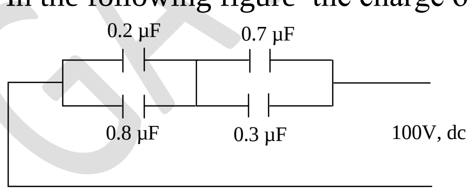
(a) lags, 0^0
(b) leads, 90^0
(c) lags, 90^0
(d) lags, 45^0

18. The current wave shape shown in figure (a) is applied to a circuit element. The voltage across the element is shown in figure (b). The element is



(a) R
(b) L
(c) C
(d) semi conductor

19. In the following figure the charge on 0.8 μF capacitor is



(a) 100 μC
(b) 50 μC
(c) 40 μC
(d) 20 μC

20. A bulb rated at 60W, 120V is used for 30 minutes. The charge associated with this operation is
    (a) 3600 C
    (b) 900 C
    (c) 7200 C
    (d) 60C

Answer with Explanation

1. (a)
   Note that one Ampere of current flowing for 1 second transports 1 coulomb of charge.
   A single electron has a charge of 1.602×10^{-19}coulomb. A collection of

   $^{1}/_{1.6021 \times 10^{-19}}$electrons or 6.2415×10^{18} electrons have a charge of 1 coulomb

2. (d)
   $Energy = V \times I \ \times t$ And $q = \int_{-\infty}^{t} idt$
   So $Energy = voltage \ \times charge$

3. (a)
   Since the capacitors formed are in parallel
   So,
   $C_1 = \in_0 \in_1 \frac{0.5A}{d}, \quad C_2 = \frac{\in_0 \in_2 \ 0.5A}{d}$
   $C = C_1 + C_2 = \frac{0.5 \in_0 A}{d}(\in_1 + \in_2)$

4. (a)
   Since the capacitors are in series, that total capacitance is 50% and breakdown voltage of the combination = 2V

5. (a)
The combination is equal to two capacitors C_1 and C_2 in series.

$$C_1 = \in_0 \in_1 \frac{A}{0.5d}, \qquad C_2 = \frac{\in_0 \in_2 A}{0.5d}, \quad C = \frac{C_1 C_2}{C_1 + C_2} \propto \frac{\in_1 \in_2}{\in_1 + \in_2}$$

6. (c)
$Q = C.V$
$Q_1 = 1 \times 10^{-6} \times 30 = 30\mu c,\ \ Q_2 = 2 \times 10^{-6} \times 30 = 60\mu c$

7. (b)
Since the capacitors are in series charge will be same total capacitance

$$= \frac{1 \times 2}{2+1} = \frac{2}{3} CV = \frac{2}{3} \times 30 = 20\mu c$$

8. (c)
Since the capacitors are in series the charge will be same capacitance $C = \frac{2 \times 4}{6} = \frac{4}{3} \mu f$

$q = CV = \frac{4}{3} \times 30 = 40\mu c$

$V_{C_1} = \frac{1}{C_1} \int idt = \frac{q}{C_1} = \frac{40}{2} = 20V$

$V_{C_2} = \frac{q}{C_2} = \frac{40}{4} = 10V$

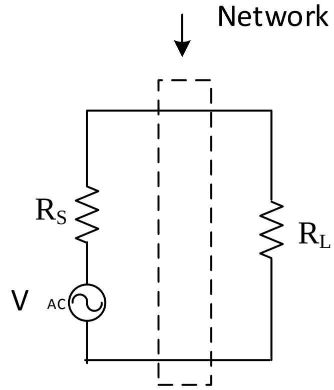
9. (b)

10. (a)

11. (d)

12. (d)

13. (b)



Maximum power is delivered to load when $R_s = R_L = R$If the network is lossless then

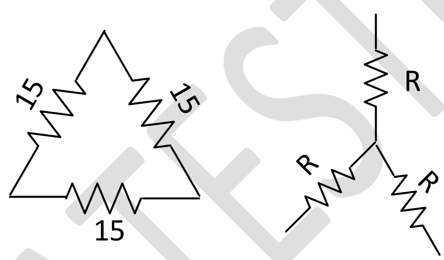
$I = \frac{V}{2R}$ power delivered $I^2R = \frac{V^2}{4R^2}.R = \left(\frac{V^2}{4R}\right)$

Source power $= V.I$

$$= V.\frac{V}{2R} = \frac{V^2}{2R}$$

Ratio of power delivered to load $= \frac{V^2/_{4R}}{V^2/_{2R}} = \frac{1}{2}$

14. (b)



$$R = \frac{15 \times 15}{45} = 5\Omega$$

15. (c)

$V_1 = 100\, sin(\omega t + 15^0)$, $V_2 = sin(\omega t + 90^0)$.Hence V_2 is leading V_1 by (90-15)=75^0

16. (c)

Since $V_L = L\frac{di}{dt} = j\omega L\,.\,i$ voltage leads the current by 90^0

or current lags by 90^0.

17. (b)

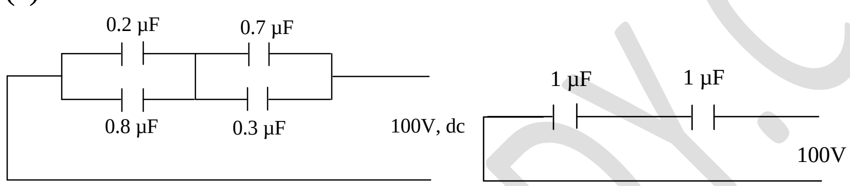
Since $i = C\frac{dv}{dt} = j\omega cv$ current leads the voltage by 90^0

18. (c)

When a current pulse is applied to a capacitor, the voltage rises linearly and becomes constant at the end of a pulse

$$V_c = \frac{1}{C}\int idt$$

19. (c)



Each of parallel combination of capacitors is equal to 1μf. The voltage across each capacitor is 50 V. Charge on $0.8\mu f = 0.8 \times 50 = 40\mu c$

20. (b)

$$Q = \int idt = it = \frac{60}{120} \times 30 \times 60 = 900c$$