COVENANT UNIVERSITY NIGERIA

TUTORIAL KIT
OMEGA SEMESTER

PROGRAMME: PHYSICS

COURSE: PHY 121

DISCLAIMER

The contents of this document are intended for practice and leaning purposes at the undergraduate level. The materials are from different sources including the internet and the contributors do not in any way claim authorship or ownership of them. The materials are also not to be used for any commercial purpose.

PHY 121: Electricity and Magnetism I

CONTRIBUTORS: Adewoyin O.O., Joel E.S., Kayode O.T., Abodunrin T.J. and Akinwumi S.A.

1. When we charge a parallel plate capacitor to 20 V, and then disconnect the battery. What happens to the charge and voltage?

   A. The charge stays on the plates indefinitely, and the voltage stays constant at 20 V.

   B. The charge leaks out the bottom quickly, and the voltage goes to 0 V.

   C. The charge jumps quickly across the air gap, and the voltage goes to 0 V.

   D. The charge stays on the plates, but the voltage drops to 0 V.

   E. The charge instantly disappears, but the voltage stays constant at 20 V.

   Model Answer - Use knowledge acquired in your secondary school on Capacitance of capacitor

2. Given these expressions, and e_0 = 8.85 x 10^{-12} $C^2/N\cdot m^2$, what are the units of capacitance?

   $C = \frac{\varepsilon_0 A}{d}$ $C = 2\pi\varepsilon_0 \frac{L}{\ln(b/a)}$ $C = 4\pi\varepsilon_0 \frac{ab}{b-a}$ $C = 4\pi\varepsilon_0 R$

   A. The units are different in the different expressions.

   B. The units are $C^2/N\cdot m^2$.

   C. The units are $C^2/N\cdot m$.

   D. The units are C^2/N.

   E. The units are C/V.

3. What is the equivalent capacitance for three capacitors in series?

   A. $C_{eq} = \frac{C_1C_2C_3}{C_1+C_2+C_3}$

   B. $C_{eq} = \frac{C_1C_2+C_2C_3+C_1C_3}{C_1+C_2+C_3}$

   C. $C_{eq} = \frac{C_1C_2+C_2C_3+C_3C_1}{C_1C_2C_3}$

   D. $C_{eq} = \frac{C_1+C_2+C_3}{C_1C_2C_3}$

   E. $C_{eq} = \frac{C_1C_2C_3}{C_1C_2+C_2C_3+C_3C_1}$

   Model Answer - Use $C_{eq} = \frac{1}{\frac{1}{C_1}+\frac{1}{C_2}} = \frac{C_1C_2}{C_1+C_2}$

4. A parallel plate capacitor is connected to a battery of voltage V. If the plate separation is
decreased, which of the following increase?

I.	Capacitance of capacitor
II.	Voltage across capacitor
III.	Charge on capacitor
IV.	Energy stored on capacitor
V.	Electric field magnitude between plates
VI.	Energy density of E field

A. II, III and IV.
B. I, IV, V and VI.
C. I, II and III.
D. All except II.
E. All increase.

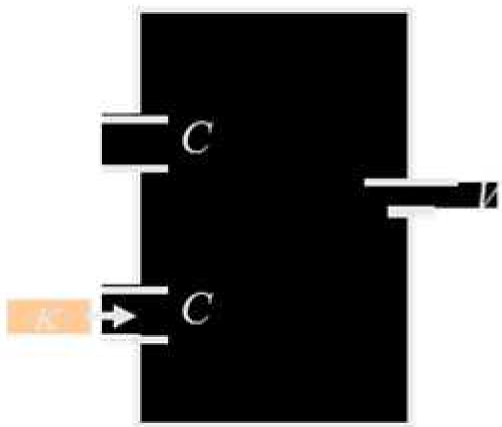
5. Two identical parallel plate capacitors are connected in series to a battery as shown below. If a dielectric is inserted in the lower capacitor, which of the following increase for that capacitor?

I.	Capacitance of capacitor
II.	Voltage across capacitor
III.	Charge on capacitor
IV.	Energy stored on capacitor

A. I and III. D. All except II.
B. I, II and IV. E.
C. I, II and III.

$q = CV$ $C = \frac{\kappa \varepsilon_0 A}{d}$ $U = \frac{q^2}{2C} = \frac{1}{2} CV^2$

Model Answer -



6. When a conductor has a potential difference of 100 volts placed across it, the current through it is 5 ampere. What is the resistance of the conductor?

7. What are the 2 Kirchhoff's Laws?

Answer

Kirchhoff's Laws

A) The Kirchhoff's current law or the junction rule
B) The Kirchhoff's voltage law or the closed loop rule

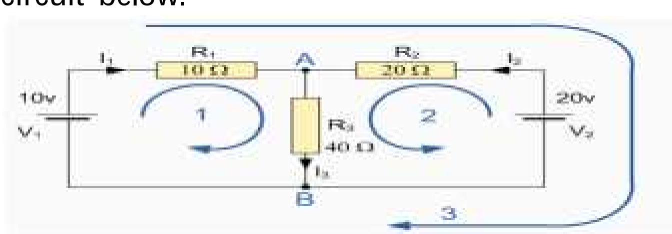
8. State the Kirchhoff's current law and express mathematically?

9. State the Kirchhoff's voltage law and express it mathematically?

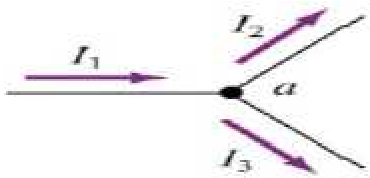
Answer

The algebraic sum of all the voltages in a loop must be equal to zero i.e $\sum V = 0$

10. Determine the values of the current flowing through each of the resistors in the circuit below.



11.



In the circuit above if the current flowing through I_1 is 8 Amps and the current flowing through I_2 and I_3 are the same, Calculate the current in I_2 and I_3?

Solution

I_1 = 8 amps

Applying the junction rule, we have that $I_1 = I_2 + I_3$

i.e 8 = $I_2 + I_3$

Since $I_2 = I_3$ this implies that $2I_2 = 8$

Therefore, I_2 =4. Thus, $I_2 = I_3$ =4 amp

12. In Wheatstone bridge P = 9 ohm, Q = 11 ohm, R = 4 ohm and S = 6 ohm. How much resistance must be put in parallel to the resistance S to balance the bridge

(A) 24 ohm (B) 44/9 ohm (C) 26.4 ohm (D) 18.7 ohm

13. A voltmeter having a resistance of 998 ohms is connected to a cell of emf 2 volt and internal resistance 2 ohm. The error in the measurement of emf will be

(A) 4 ×10–1 volt (B) 2 ×10–3 volt

(C) 4 ×10–3 volt (D) 2 ×10–1 volt

Solution: (C) Error in measurement = Actual value – Measured value

Actual value = 2A

i = 2/998+2 = 1/500 A

Since E = V + ir = ⇒ V = E – ir = 2 – 1/500 × 2 = 998/500 V

Measured value = 998/500 V ⇒ Error = 2 – 998/500 = 4 × 10–3 volt.

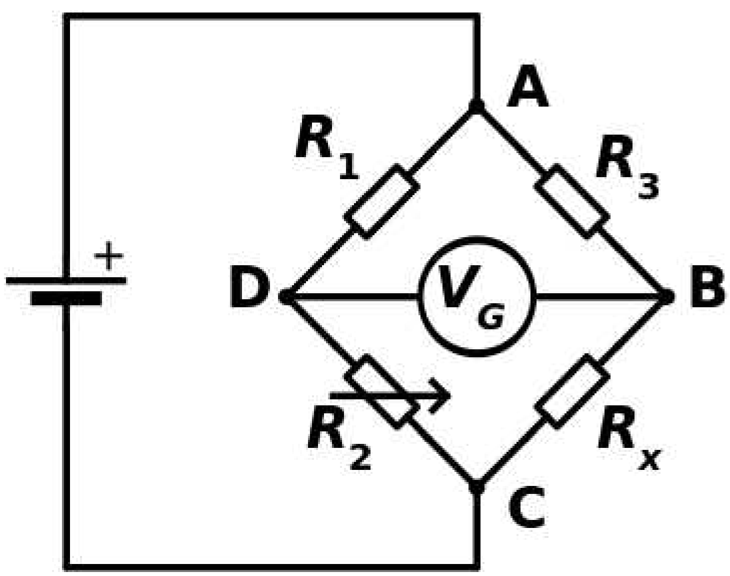
14. The unknown resistance to be measured, R_x, is placed in a circuit with accurately determined resistances R_1, R_2 and R_3. One of these R_2, is a variable resistor which is adjusted so that when the switch is closed momentarily, the ammeter shoes no current flow. Determine R_x in terms of R_1, R_2 and R_3.

(A) $R_x =$ [illegible]

(B) $R_x =$ [illegible]

(C) $R_x =$ [illegible]

(D) $R_x =$ [illegible]



15. If the Wheatstone bridge above is ‘balanced’ when $R_1 = 630\Omega$, $R_2 = 972\ \Omega$, and $R_3 = 42.6\ \Omega$, what is the value of the unknown resistance?

(A) 1000 Ω (B) 676 Ω (C) 100 Ω (D) 65.7 Ω

Solution:

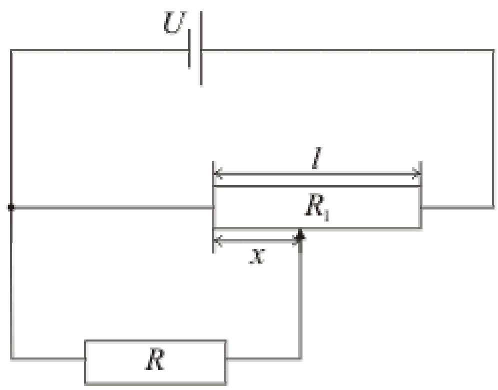
$R_x =$ [illegible]

= [illegible]

= 65.7 Ω

16. A potentiometer made from homogenous resistance wire of length l and resistance $R_l = al$ is used to changed voltage at an appliance of resistance R.

Find the voltage across and current through a resistor R as a function of the distance x of the sliding contact from the end of the potentiometer.



Solution:

The expression for the resistance of the potentiometer reads

$Rx+Ry=Rl=al$

where l stands for the length of the whole potentiometer and a is a constant of proportionality.

The resistance of a wire is a linear function of its length thus we can express the resistances of the resistors R_x and R_y express as:

$Rx = ax$
$Ry = a(l-x)$

Our goal is to find the current I_2 through the resistor R thus we express all currents as functions of I_2.

The algebraic sum of the currents into any junction is zero.

$I=I_1+I_2$

The resistor with the resistance R and the part of the potentiometer with resistance R_x are in parallel connection thus:

$RI_2 = R_x I_1 = axI_1$

We express the current I_1 as

$I_1 =$ [illegible] ….. (*)

Since the total voltage across the circuit is known we can express the emf (electromotive force) as a sum of drops of voltage across resistors. Hence:

[illegible]

Inserting the expression (*) into this equation we obtain:

[illegible]

We determine the constant of proportionality from the expression:

[illegible]

and insert it into the equation for the total voltage:

[illegible]

Now we can express the current I_2 through the resistor R:

[illegible]

and simplifying we obtain:

[illegible]

The final expression for the current through the resistor as a function of the distance *x* of the sliding contact from the end of the potentiometer reads:

[illegible]

The voltage across the resistor is given as a product of the current through this resistor and the resistance of the resistor:

[illegible]

17. Lenz's law is ………

a.) The change in direction of an induced current or emf in a given circuit
b.) The direction of any magnetically induced current or emf is such as to oppose the direction of the phenomena causing it (ANS)
c.) The direction of any magnetic field to the flow of induced current or emf
d.) None of the Above

18. To have induction there must be a change in the magnetic field, therefore a change in magnetic flux.

a) False
b) True
c) Not applicable
d) Sometimes

19. Suppose the rod is moving with a speed of 5.0m/s perpendicular to a 0.80-T magnetic field. The rod has a length of 1.6 m and a negligible electrical resistance. The rails also have a negligible electrical resistance. The light bulb has a resistance of 96 ohms. Find (i.) the emf produced by the rod and (ii.) the current induced in the circuit.

a.) 6.4V and 0.057A
b.) 6.2V and 0.067A
c.) 6.4V and 0.067A (ANS)
d.) 6.2V and 0.066A

20. The S.I unit of an induced current is ………………………………

a.) Ampere (A)
b.) Siemens (S)
c.) Volt (V)
d.) Ohms (Ω)

21. A coil of wire consists of 20 turns each of which has an area of 0.0015 m^2. A magnetic field is perpendicular to the surface. Initially, the magnitude of the magnetic field is 0.050 T and 0.10s later, it has increased to 0.060 T. Find the average emf induced in the coil during this time.

a.) – 4.0×10^{-3}
b.) -3.0×10^{-3} (ans)
c.) 3×10^{-3}
d.) 4.5×10^{-2}

22. Certain heavy industrial equipment uses AC power that has a peak voltage of 679v. What is the rms voltage?

23. What is the peak power consumption of a 120-V AC microwave oven that draws 10.0A?

Solution:

Using the equation: [illegible] we can calculate the average power given the rms values for the current and voltage:

[illegible]

Next, since the peak power is the peak current times the peak voltage:

[illegible] = 2([illegible]) = 2 [illegible]

24. An AC generator consists of 8 turns of wire of area 0.09 m^2 and total resistance 12 Ω. The loop rotates in a magnetic field of 0.5 T at a constant frequency of 60 Hz. What is the maximum induced EMF?

25. Assume that a motor having coils with a resistance of 10 Ω is supplied by a voltage of 120 V. When the motor is running at its maximum speed, the back EMF is 70 V. Find the current in the coils when the motor is first turned on.

solution

When the motor is first turned on, the back EMF is 0 V. The current in the coils is maximum and equal to:

$$I = \frac{EMF}{R} = \frac{120V}{10\,\Omega} = 12A$$

b. Find the current in the coils when the motor has reached maximum speed.

Solution

At the maximum speed, the back EMF has its maximum value. The effective supply voltage is now the external source minus the back EMF.

The current is reduced to: $I = \frac{EMF - EMF_{back}}{R} = \frac{120V - 70V}{10\Omega} = 5A$