VIVEKANAND EDUCATION SOCIETY'S POLYTECHNIC

Study Material

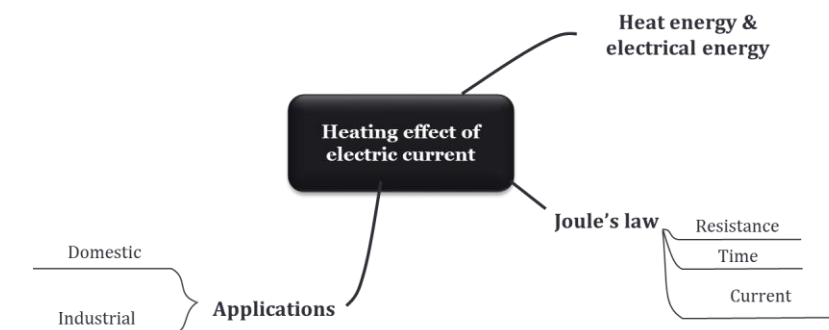|	
Program Code: All Program	
Semester: First	
Course Name: Basic Science (Physics)	
Course Code: 22102	
Topic Name: Electricity, Magnetism & Semiconductors	
UO2c: Explain the heating effect of the given electric current.	
LO4: Student will be able to explain the heating effect of electric current.	
Course Expert: S. K. Rawat	**Date: 26/08/2020**

Concept Map:

Key words: Magnetic field, magnetic field intensity, magnetic flux, magnetic flux density

Key Questions:
1. What are magnetic field and magnetic lines of force?
2. What are properties of magnetic lines of force?
3. What are the applications of coulomb's law of magnetism?

Key Definition:
1. When an electric current is passed through a conductor, the conductor becomes hot after some time and produces heat, this is called heating effect.
2. The amount of heat produced (H) due to passage of electric current (I) depends on Resistance, Time and Current. This is called Joule's law.

Formula:
1. Heat absorbed $H = I^2Rt$

Notes

Heating effect of electric current
When an electric current is passed through a conductor, the conductor becomes hot after some time and produces heat.
This happens due to the conversion of some amount of electric energy into heat energy.
This effect of electric current is called heating effect of electric current.
Heating effect of electric current is also referred as Joule's law.

Joule's Law: The amount of heat produced (H) due to passage of electric current (I) depends on three factors:
1. Resistance: Heat is directly proportional to the resistance, R of the conductor. i.e., **$H \propto R$**
2. Time: Heat is directly proportional to the time, t for which the current flows through conductor. i.e., **$H \propto t$**
3. Current: Heat is directly proportional to the square of current, I flowing through conductor. i.e., **$H \propto I^2$**

Therefore Joule's law equation is given as - **$H = I^2Rt$**.
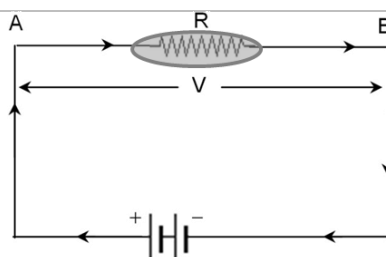
An electric heater having resistance equal to 5Ω is connected to electric source. If it produces 180 J of heat in one second, find the potential difference across the electric heater.

Solution: Given, Resistance (R) = 5 Ω, Heat (H) produced per second by heater = 1800 J, time 't' = 1 s Potential difference (V) =?

To calculate the potential difference, we need to calculate electric current (I) first.

► We know that $H=I^2Rt$
► Or, $180J = I^2 \times 5Ω \times 1s$
► Or, $I^2 = 180 \div 5 = 36$
► Or, $I = 6A$
► Now, potential difference $V=IR$
► Or, $V = 6A \times 5Ω = 30V$

Applications:

Some of the applications of heating effect of electric current are -

1. **Electric heating device:** Electric iron, electric heater, electric toasters are some of the appliances that work on the principle of heating effect of current. In these appliances, Nichrome which is an alloy of nickel and chromium is used as the heating element for the following reasons. (i) It has high specific resistance (ii) It has high melting point (iii) It is not easily oxidized.

2. **Fuse wire:** Fuse wire is an alloy of lead 37% and tin 63%. It is connected in series in an electric circuit. It has high resistance and low melting point. When large current flows through a circuit due to short circuiting, the fuse wire melts due to heating and hence the circuit becomes open. Therefore, the electric appliances are saved from damage.

3. **Electric bulb:** Since the resistance of the filament in the bulb is high, the quantity of heat produced is also high. Therefore, the filament is heated to incandescence and emits light. Tungsten with a high melting point (3380^oC) is used as the filament. The filament is usually enclosed in a glass bulb containing some inert gas at low pressure.

4. **Electric arc** and **electric welding** also work on the principle of heating effect of current.

Link to YouTube/ OER/ video/e-book:

1. https://www.excellup.com/classten/scienceten/electricityten5.aspx
2. https://www.topperlearning.com/doubts-solutions/cbse-class-1-physics/electricity/heating-effect-of-electric-current
3. https://upscgk.com/mcq.aspx?ArticleID=47dd0205-6ace-4c7a-a49a-d433f13060ee

Key Take away:

1. Concept of heating effect of electric current.
2. Joule's law
3. Application of heating effect of electric current.

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Formative Assessments

<22102> : <All Program> : < All Program >: <Electricity, Magnetism & Semiconductors>: <UO2c> : <LO4> : <Assessments> : <Formative>

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Assessment Type: Formative Assessments: Embedded questions in video/ PPT

Set 1		
Question No 1	Question No 2	Question No 3
The capacity to do work is called as _____	According to Joule's law, electrical energy is converted to _____	Heating effect of electric current is used in _____.
Remembering	Understanding	Applications
a) Heat	a) mechanical energy	a) electric kettle
a) Energy	b) chemical energy	b) fan
b) Work	c) light energy	c) Freezer
c) Power	d) heat energy	d) TV
Ans: <Energy >	Ans: < heat energy >	Ans: < electric kettle>

Set 2		
Question No 1	Question No 2	Question No 3
Find the odd one out-	When current is passed through a coil, it gets heated up. This is due to _____ effect of electric current.	Heat produced by current in wire during 't' time is determined by _____
Understanding	Understanding	Understanding
a) electric toaster	a) mechanical	a) $H = I^2R$
b) electric fan	b) chemical	b) $H = Irt$
c) electric iron	c) heating	c) $H = I^2Rt$
d) room heater	d) magnetic	d) $H = I^2t$
Ans: <electric fan>	Ans: <heating>	Ans: < $H = I^2Rt$ >

Practice Worksheets

<22102> : <All Program> : < All Program >: <Electricity, Magnetism & Semiconductors>: <UO2c> : <LO4> : <Assessments> : <Formative>

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A. An electric fuse is based on a) the heating effect of the current b) the chemical effect of the current c) the magnetic effect of the current d) none of the above	B. Heating effect produced by current is due to the _____. a) collision of electrons b) movement of electrons c) resistance in electrons d) loss of energy
Ans A:	Ans B:
C. Which one of the following is based on the heating effect of current? a) Geyser b) Hair dryer c) Both (A) and (B) d) None of the above	D. An electric fuse works on the principle of – a) magnetic effect of electric current b) chemical effect of heating current c) heating effect of electric current d) none of the above
Ans C:	Ans D:
E. According to Joule's law, heat generated in the conductor is directly proportional to _____ a) current flowing through conductor b) resistance of the conductor c) time for which the current flows d) all of the above	F. When current is passed through a coil, it gets heated up. This is due to _____. a) mechanical effect of electric current b) chemical effect of electric current c) heating effect of electric current d) none of the above
Ans E:	Ans F:
G. Which of the following is a safety device? a) Electric bulb b) Electric Fuse c) Electric iron d) Electric heater	H. An electric heater having resistance equal to 5Ω is connected to an electric source. If it produces 180 J of heat in one second, then the potential difference across the electric heater is a) 15V b) 30V c) 45V d) 60V
Ans G:	Ans H: