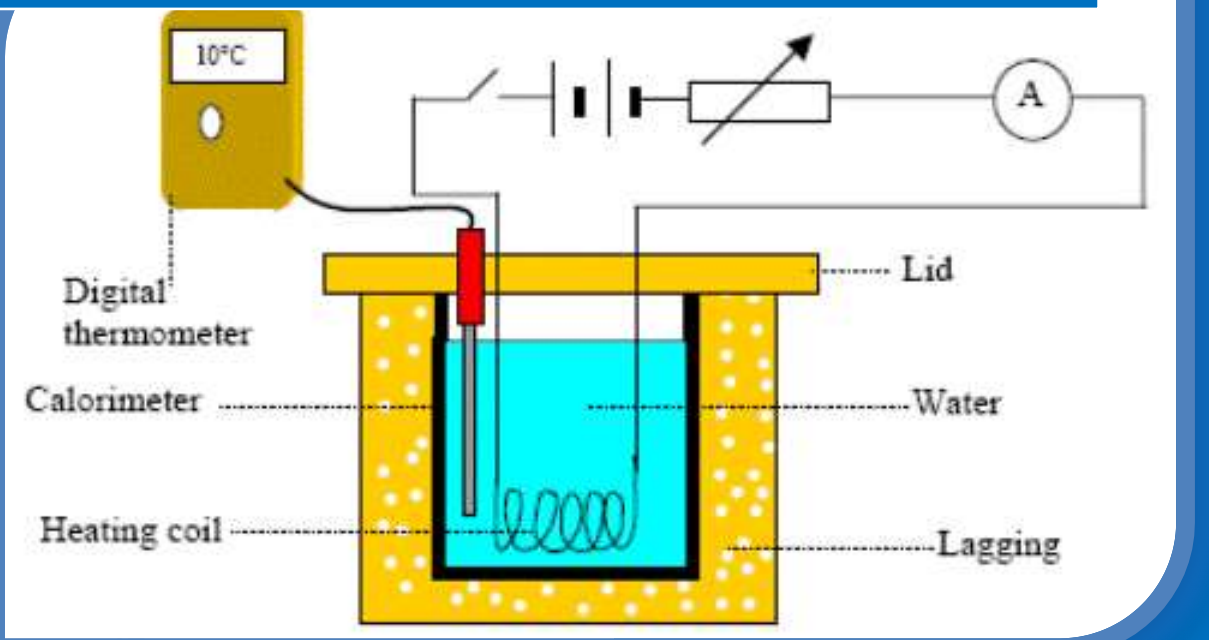
PHYSICS KNOWLEDGEBASE

2020

HEATING EFFECT OF AN ELECTRIC CURRENT



TEACHERS OF PHYSICS
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1. State **three** factors which affect heating by an electric current.

(i) Amount of current, I passing through a conductor.

(ii) Resistance, R of the conductor

(iii) Time, t for which the current flows through the conductor.

2. State the energy changes which occur when one switches on a torch. (2mk)

Chemical energy → Electrical energy → Heat energy → Light energy

3. What is power as it relates to electrical energy?

✓ Is the rate at which electrical energy is converted to useful work per unit time.

4. Name **the** device which changes;

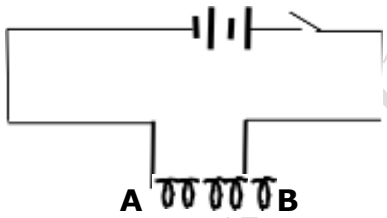
(i) Sound to electrical energy. (1mk)

✓ Microphone

(ii) Electrical energy to kinetic energy. (1mk)

✓ Motor

5. Figures shows a simple water heater.



Give a reason why AB is coiled.
(1mk)

✓ It is coiled to increase resistance thus high amount of electrical energy is converted into heat energy per unit time when the switch is closed.

6. Fig represents part of electric cooker coil.

(i) Why is the material labeled X is coiled?
(1mk)

✓ It is coiled to increase resistance thus high amount of electrical energy is converted into heat energy per unit time when the switch is closed.

(ii) State the property of material X that makes it suitable for its use.
(1mk)

✓ It has high resistance.

7. An electric heater is found to have a resistance of **950** when operating normally on a **240V** mains. Find the power rating of the heater. (2mk)

$P = V^2/R$. $P = 240^2/950 = 60.63W$

8. An electric bulb rated **40W** is operating on **240V** mains. Determine the resistance of its filament

$R = V^2/P$ $R = 240^2/40 = 1440\Omega$

9. An Electric heater is rated **1000W, 240V.** Calculate the resistance of this element

✓ $R = V^2/P$ $R = 240^2/1000 = 57.6\ \Omega$

10. When a current of **2A** flows in a resistor for **10** minutes, **15kJ** of electrical energy is dissipated. Determine the voltage across the resistor.

✓ $W = VIt$

$15 \times 10^3 = V \times 2 \times 10 \times 60$ $V = \dfrac{15 \times 10^3}{2 \times 10 \times 60} = 12.5V$

11. How many **100W** electric irons could be safely connected to a **240V** moving
circuit fitted with a **13A** fuse? **(2mk)**

✓ (No. of irons) x 100 = IV

✓ No. of irons $= \dfrac{13 \times 240}{100}$

$= 31.2$ = 31 electric irons

12. An electric bulb with a filament of resistance **480** is connected to a **240V** mains supply. Determine the energy dissipated in **2 minutes**. **(3mk)**

Energy, $H = I^2Rt$ But $I = V/R$ $I = 240/480 = 0.5A$ $H = 0.5^2 \times 480 \times 2 \times 60 = 14.4kJ$ or $14400J$

Or Energy, $H = V^2t/R$ $H = \dfrac{240 \times 2 \times 60}{480} = 14.4kJ$

13. An electrical appliance is rated as **240V, 200W**. What does this information mean?

That the appliance operates at a voltage of 240 volts. When it is operating normally, the electrical power outputs is 200 watts i.e. 200J of electrical energy is converted to other useful energy per unit time.

14. An electrical heater is labelled **120W, 240V**. Calculate;

a) The current through the heating element when the heater is on.

Electrical power $P = VI$

$120 = 240I$

$\therefore I = {}^{120}/_{240} = 0.5A$

b) The resistance of the element used in the heater.

From Ohm's law

$V = IR$

$R = V/I$

$= {}^{240}/_{0.5}$

$= 480\Omega$

15. An electric bulb with a filament resistance **300** is connected to a **2V** main supply, determine the energy dissipated in **2** minutes.

$H = {}^{V^2t}/_{R}$ $H = \dfrac{2^2 \times 2 \times 60}{300} = 1.6J$

16. An electric toy is rated **100W, 240V**. Calculate the resistance of the toy when operating normally.

$R = V^2/P$ $R = 240^2/100 = 576\Omega$

17. Find the maximum number of 75W bulbs that can be connected to a 12A fuse on a 240V mains supply. (3mks)

No. of bulbs $\times$ 75 = VI

No. of bulbs $\times$ 75 = 240 $\times$ 12

$\text{No. of bulbs} = \dfrac{240 \times 12}{75}$

= 38 bulbs

18. A bulb is labelled 12V, 36W, when used on a 12V supply. What current will it take? (1 mk)

$I = P/V$ $I = 36/12 = 3A$

19. A car battery is used to light a 12V lamp. A constant current of 3 A passes round the circuit.

(i) **Explain** what happens to the energy of the electron as they flow through the lamp wire. (3mks)

✓ Energy of the electrons reduces since electrical energy is converted into
heat and light energy.

(ii) **How** much energy is transferred by the lamp in 20 seconds?(2mks)

Energy = VIt = 12 × 3 × 20 = 720J

Alternatively;
Power= VI, 12x3= 36W
1W= $1Js^{-1}$
36x20= 720 J

20. An electric kettle is rated 3kW, 250V. Determine the resistance of the coil. (3mks)

1kw=1000w
3kw=3000w
$R = V^2/P \quad R = 250^2/3000 = 20.83\Omega$

21. Two electric heaters A and B rated 1000 W and 2500 W respectively are connected in parallel across a 240 mains supply. Calculate the ratio R_A: R_B of their resistances. (3mks)

Resistance of A = $V^2/P = 240^2/1000 = 57.6\Omega$
Resistance of B = $240^2/2500 = 23.04\Omega$
Ratio $R_A : R_B = 57.6 : 23.04 = 5 : 2$

22. An electric bulb is rated 75W, 240V. Determine the resistance of the bulb. (3mks)

$R = V^2/P \quad R = 240^2/75 = 768\Omega$

23. A wire made from some alloy has a resistance of 2.0 ohms per metre. What length of this wire would be required to make a heating coil of rating '240V, 1kW' (3mk)

Total Resistance R = $V^2/P = 240^2/1000 = 57.6\Omega$

$2\Omega \rightarrow 1$ Metre
$57.6\Omega \rightarrow \frac{57.6\Omega \times 1\text{metre}}{2\Omega} = 28.8$ metres

Length = 28.8m

24. A total charge of 360 coulombs is passed through an 80 ohms resistor in 30 seconds. Determine the amount of heat energy generated. (3mks)

$I = Q/t \quad I = 360/30 = 12A$

$H = I^2Rt$
$= 12^2 \times 80 \times 30$
$= 345600J$ or $345.6kJ$

25. An electric bulb with a filament of resistance 480 is connected to a 240V mains supply. Determine the energy dissipated in 2 minutes.

$E = Pt = V^2t/R = (240^2 \times 2 \times 60)/480 = 14400J$ or $14.4kJ$

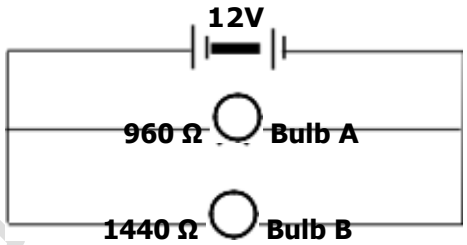
Alternatively;
$I = V/R \quad I = 240//480 = 0.5A$
$E = I^2Rt = 0.5^2 \times 480 \times 2 \times 60 = 14.4kJ$

26. A washing machine for use on 240V mains has a $^1/_3$h.p motor and a heating element rated 3Kw.(1h.p = 0.75kw) . **What** current does it take it take when in use . (3mks)

Total Power = $(^1/_3 \times 0.75) + 3 = 3.25kW$
$I = P/V \quad I = 3250/240 = 13.5A$

27. The circuit shows two bulbs **A** and **B** connected in parallel to each other.

a) Which bulb will light brighter? Give a reason for your answer. (2mk)



A-since it has low resistance.

b) Why are the elements of domestic heating appliances made of nichrome wire instead of tungsten wire.
(1mk)

✓ Nichrome wire is not oxidized easily when current turns it red hot.

✓ It forms oxide layer of chromium oxide when used for the first time that
Prevents the wire from breaking or burning out.

c) What property does a fuse wire have that make it suitable for controlling
excessive currents in circuits?
(1mk)

✓ Low melting point i.e it is made of a material with low melting point e.g thin copper wire.

d) What do you understand by rating **150w, 240v** indicated on an electric
bulb? (2mk

- ✓ This means that the bulb is designed to function at maximum voltage of 240V and its energy consumption is 150w.
- ✓ This knowledge help in designing the type of the switch and the bulb holder to fit the purpose without being damaged.

28. Calculate the heat energy dissipated by a bulb rated **240W** working For **10 min** (3mks)

$E = Pt$

$= 240 \times 10 \times 60$

$= 144kJ$