PHYSICS

BOOKS - NN GHOSH PHYSICS (HINGLISH)

HEATING AND CHEMICAL EFFECT OF CURRENT

Example

1. In a hostel there are one hundered 40-W lamps, ten 60-W fans and a 1000-W electricity over. If all the appliances are used for 5hours daily, Find the electric

bill in an month of 30 days If the cost of 1 B.O.T unit is 30paise.

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2. A 220V-500W aluminium electric kettle weighing 1.2kg is used to boil water from a 180V supply. How long will it take 1kg of water from $30^{\circ}C \text{to} 100^{\circ}C$? (Relative heat heat capacity of aluminimum =0.3)

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3. Compare the amounts of heat developed in three wires having length in the ratio 1:5:8 and radii 1:2:3

when joined in parallel

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4. A 9000Ω voltmeter is connected across a resistor R and an ammeter of ressistance 0.015Ω in series. The voltmeter reads 117V and a ammeter reads 0.13A. Calculate the value of R and power input to R.

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5. A metal plate weighting 750g is to be electroplated wiwth 0.05% of its weight of silver. If a current of 0.8A is used. Find the time needed for depositing the

required weight of silver.

E.C.E. of silver is $11.18 \times 10^{-7} kgC^{-1}$.

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6. The electromechanical equivalent of silver is $11.18 \times 10^{-7} kgC^{-1}$. If the atomic weight of silver is 108 and Avogardo number 6.6×10^{23}, calculate the charge on a silver ion in silver nitrate solution.

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7. If 96500C of electricity liberates 1g equivalent of any substance, what time will it take for a current of 0.15A

to liberate 20g of copper from a sluition of copper sulphate? $(\text{Atomic weight of copper} = 64.)$

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8. An electric iron rated for V=220V has a power P=1000W. When it is switched on, the voltage across the socket drops from $V_1 = 240V \text{to} V_2 = 210V$. Find the resistance of the leads.

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9. In a house there are ten 60-watt lamps. Three 40-watt flourorescent tubes and three 40-watt fans.

When all these are switched on what is the current drawn from the mains if the supply voltage is 220V? Calculate the power drawn and the cost for using them for 6hours daily in a month of 30 days.(1 B.O.T. unit costs 30 pasise).

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10. A 500-W-200V electric kettle is used to prepare 4cups of tea How long will it take? Assume that a cup contains 250cc of water. Specific heat capacity of water $4200 Jkf^{-1}K^{-1}$ and the initial temeprature of water $250^{\circ}C$. Also calcuate the cost of prepare tea if 1 B.O.T. costs 35 paise.

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11. Show that heat develped inn wires each of resistance r joined in paralledl between two ponts at a contant potential difference is n^2 times the heat developed in the same wieres when they are joined in series beetween the same two points.

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12. Show that the power supplied by a battery to an external reistance is maximum when it is equal to the internal resistance of the batter. Further show that

this maximum power is $\frac{e^2}{4r}$ where is the emf of the battery and r is internal reisistance.

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13. The average temeprature coefficient of tungsten is $5.1 \times 10^{-3}/.^{\circ} C$. The filament of an electric at lamp has a cold resistance of $9.7\Omega at 20^{\circ} C$. When glowing fully it has a resistance of 121Ω. Calculate its temperature. If is a 100-watt lamp, what current does it consume?

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14. Compare the heat developed in the four arms of a balanced. Wheatstone bridge. The resistance of the arms are 10Omega ,100Omega,40Omega and 400Omega`. Also indicate in which arm the heat produced will be the minimum and in which the maximum.

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15. A wire of resistance 5Ω is connected to a battery of emf 2V and internal resistance 1Ω (a) How much energy is transferred from the chemical to the electrical form, (b) How much apear in the wire as

double heat in 2min? (c) Account for the difference between (a) and (b)

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16. An electric kettle taking 3.5A at 210V brings 1200cc of water from $25^\circ \text{to} 95^\circ C$ in 12minutes. Find the percentage of the supplied energy which goes towards heating water.

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17. In a hostel, 160bulb, of resistance 1200Ω eachar lighhted on a 220V supply every day from 6.P.M to

11.P.M. If the electrical energy costs 25paise per kilowatt hour, find the cost of lighting the hostel for a mont of 30days.

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18. A 220V electric kettle takes 990W. Calculate (i) the resistance of the heating element, (ii) the time required to melt and boil away 1kg of ice assuming a heat loss of 40% by conduction and radition.

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19. A lit of mass M=0.8 ton is raised to a height h=40m in t=0.5min. The voltage across the motar terminals is V=220V and the motar efficiency $\eta = 90\,\%$. Find the power an current consumed by the motar and the price of one hoisting if B.O.T. costs 60 paise.

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20. A 660-W electric lheater is hdesigned to operate from 129V lines. What is the resistance? What current does it draw? What is the rate of production of heat in calories per second? If the line voltage drops to 110V.

What is power does the heater takes in waits? (J=4.2 joules per calorie).

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Example B

1. A 2 m long wire of resistance 4Ω and diameter 0.64 mm is coated with plastic insulation of thickness 0.66 mm. A current of 5A flows through the wire. Find the temperature difference across the insulation in the steady state. Thermal conductivity of plastic is $0.16 \times \left(10^{-2}\right) cal / scm.^{\circ} C.$

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2. A fuse made of lead wire has an area for cross-section $0.2mm^2$. On short circuiting will the fuse wire reaches 32 A. How long after the short circuiting will the fuse begin to melt? For lead, specific heat capacity $134Jkg^{-1}K^{-1}$, melting point $=327^\circ C$, relative density =11.34, initial temperature $=20^\circ C$ electricaL resistivity $= 11 \times 10^{-8}\Omega m$.

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3. An electric kettle has two windings. When one of the n is switched on the kettle begins to boil in t_1 minutes

and when the other is switched on it begins to boil in t_2 minutes. In what time will the kettle begin to boil if both windings are switched on simultaneously in series and a parallel?

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4. A shortage battey with an emf of 10V and an internal resistance 1Ω is connected across an extenal resistance R and liberates of 9W power. Find the potential difference across the teminals of the battery and the value or values of R.

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5. A copper voltameter is connecterd in series with a battey and a 1Ω coil. The current is passed for an hour and the increasae in weight of the cathode is 2.952g. The reading of the voltmeter connected across $1 - ohm$ coil is 2.5V. Calculate E.C.E. of copper.

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6. A metal plate with a total surface are of $300cm^2$ is to be benickel plate. If a current of 1.5A is used for 3 hours, find the thickness of nickel deposited. (Density of nickel $= 8800kgm^{-3}$, E.C.E. of a nickel$30.4 \times 10^{-8}kgC^{-1}$

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7. A copper voltameter is connected in series with a tangent galvanometer of 10 turns and 5cm in radius. Calculate the weight of copper is deposited in 30 minutes if the deflection of the galvanometer is 60°. (Horizontal component of earth's field $= 28Am^{-1}$ and $\mathrm{E.C.E\ of\ copper} = 32.8 \times 10^{-8} kgC^{-1}$.

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8. In copper voltameter 20mg of copper is deposited on the cathode of the voltameter by $0.15 - \wedge$ current in 6minutes 42sec. Calculate (i) amount of electricity required to liberate one gram equivalent of any substance, (ii) charge carried by an electron. (Atomic mass of copper =64l Avogardo constant= $= 6.02 \times 10^{23} \mathrm{mol}^{-1}$ and copper is divalent.)

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9. A steady current is passed for 25minutes through a silver voltameter and ammeter in series and 0.059g of silver of deposited. The ammeter reads 0.3A. Find the

errror, if any, in the ammeter reading, given that the E.C.E. of silver $= 11.18 \times 10^{-7} kgC^{-1}$.

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10. A current of 5A is passed fir 5hours through three voltameters arranged in series, containing solution of copper sulphate. Silver nitrate and sulphuric acid. Calculate the masses of silver, copper and hydrogen liberated (E.C.E of silver $= 11.18 \times 10^{-7} kgC^{-1}$m=, atomic weight of silver =107.88, atomic weight of copper =63.57 and atomic weight weight of hyrdrogen=1.008.)

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11. A current passes throgugh a copper voltameter and water voltameter I series. How much hydrogen at $27^{\circ}C$ and pressure of 100cm of mercury wil be liberated during the time it takes for 17.5g of copper to be deposited? (Atomic weight of copper=63 and density of hydrogen at S.T.P.=$0.09kgm^{-3}$.

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12. When a detonating gas explodes, 34.5kcal ar liberted per gram of hydrogen. Use this observation to ding the minimum emf of a battery at which the electrolysis of water is possible. (A faraday=96,500C.)

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13. A cell develops the same power across two resistances R_1 and R_2 separately. The internal resistance of the cell is

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14. A series battery by 6 lead accumulators each of emf 2.0V and intenal resistance 0.5Ω is charged by a 20V d.c. supply, What series resistance should be used in the charging, circuit in order to limit the current to 1A.

Calculate the power sullpied by the source and the fraction of energy stored in the battery.

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15. A dynamo of emf $\varepsilon_1 = 120V$ and internal resistance $r = 0.5\Omega$, and a storage battery of $\varepsilon_2 = 110V$ are connected to an extenal resistance R. At what maximum value of R will there be no current through the storage battery? How will be the battery operate when the resistance R is large or smaller than the calculated value?

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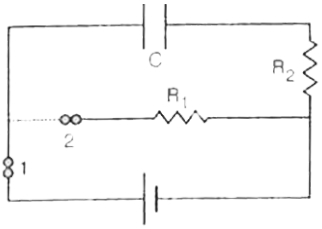
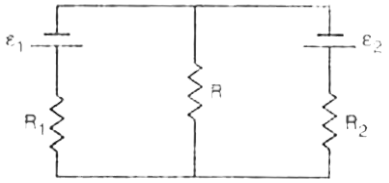
16. A Capacitor of capacitance $C = 5\mu F$ is connected to source of emf $\varepsilon_2 = 200V$ with the switch S in the position 1 (Figure 6.2). Subsequently the switch is pushed to the position2. Find the amount of heat generated in $R_1 = 500\Omega$ if $R_2 = 300\Omega$.





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17. In the cirucit (figure6.3) resistance R_1 and R_2 are known and cells ar of emf e_1 and e_2 and negligible internal resistance. At what value of R will the thermal

power generated in it be the highest? What is it equal to?

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18. A capacitor of capacitance C is charged to a voltage V_0 and subsequently discharged through a combination of a resistor R and another identical capacitor C in series. Find the current at time t and heat generated in the same time.

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19. Show the Joule's law can be expressed as $Q = \rho l^2$ or σE^2 where Q is the heat generated per unit volume of the conductor, j=current density, ρ =respectively of the material of the conductor, σ =conductivity and E= electric field step up in the conductor.

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20. A coil of radius r=25cm is made of a thin copper wire of length l=500m and resistance R rotates with an angular velocity $\omega = 500m$ and resistance R rotates with an angular velocity $\omega = 300rad/\sec$ about its

axis. Calculate the quantities of charges in the coil that will flow duie to the sudden stoppage of the coil

"["Hint: Loss in KE= Heat produced"]"

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21. What amount of heat will be generated in a coil of resistance R due to a charge q passing through it if the current in the coil

a. decreases down to zero uniformly during a time interval t_0?

b. decrases down to zero having its value every t_0 seconds?

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22. A Perfect gas is enclosed in a vertical cylinder filled with a piston of mass m. The gas is heated by passing constant current I through a heating coil of resistance R placed inside the cylinder. At what speed v must the piston move upward in order that temperature of the gas may remain unchanges? Assume ideal insulating walls and piston and there is no fusion.

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23. A straight conductor of area of cross-section S and resistivity ρ is connected to a ballistic galvometer. The conductor is moved with speed v and stoped suddenly.

The ballistic gal=vom=nometer registors flow of q couloumbs of electricity Show that this observation can be used to measure $\frac{e}{m}$ of electrons.

"["Hint: Orderly motion of elcctrons is throuwn into randon motion within relaxation time τ"]"

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