



## PHYSICS

### BOOKS - DHANPAT RAI & CO PHYSICS (HINGLISH)

#### CHEMICAL EFFECT OF CURRENT

##### Example

1. A current of 1.6 A is passing through a copper voltameter . Find the number of Cu atoms of deposited on the cathode per minute . Given  $e = 1.6 \times 10^{-19} C$  .



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2. Find the amount of silver liberated at the cathode if 0.5 A of current is passed through  $AgNO_3$  electrolyte for 1 hour . Atomic mass of silver =  $107.9\text{gmol}^{-1}$ .

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3. A steady current of 10.0 A is passed through a water voltameter for 300 s . Estimate the volume of  $H_2$  evolved at standard temperature and pressure . Use the known value of Faraday constant . Relative molecular mass of  $H_2$  is 2.016 and molar volume = 22.4 litres (volume of 1 mol of an ideal gas at STP).

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4. An electric current of 0.4 A is passed through a silver voltameter for half an hour . Find the amount of silver deposited on the cathode. ECE of silver =  $1.2 \times 10^{-3} gC^{-1}$

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5. Calculate the electric current required to deposit 0.972 g of chromium in 3 hours . ECE of chromium is  $0.00018 gC^{-1}$

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6. How long will it take to deposit electrolytically 10.79 g of silver on the cathode of a silver voltameter by a current of 25 A ? (ECE of silver =  $0.001118gC^{-1}$ ).



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7. A brass plate (5 cm × 4 cm) is to be plated on both sides with a coating of thickness 0.25 mm. Calculate the strength of current so that work may be completed in 5 h. Electrochemical equivalent of silver is  $0.00112gC^{-1}$  and density of silver =  $10.5gcm^{-3}$ ,



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8. A silver and copper voltameter are connected in parallel to a 12V battery of negligible resistance . In 30 minutes , 1.0 g of silver and 1.8 of copper are deposited . At what rate is the energy being delivered by the battery . The electrochemical equivalents of Ag and Cu are  $11.2 \times 10^{-4} gC^{-1}$  and  $6.6 \times 10^{-4} gC^{-1}$  , respectively .



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9. An electrolytic cell containing a solution of  $CuSO_4$  has an internal resistance of  $1\Omega$  . It is connected in series with 2V battery of negligible internal resistance and a  $2\Omega$  resistance .

(i) Calculate the mass of Cu that will be deposited on the

copper electrode in 1 hour.

(ii) If the  $2\Omega$  resistance is connected in parallel across the electrolytic cell and the same battery is used, how much copper will be deposited in 1 hour? Electrochemical equivalent of Cu =  $0.00033gC^{-1}$ .

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**10.** It is desired to deposit 0.254 kg of copper on the cathode of a copper voltameter. How long will it take to deposit this amount if a steady current of 100 A is maintained. Use the known value of Faraday constant. Relative atomic mass of copper is 63.5.

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11. A steady current of 10.0 A is maintained in a copper voltameter . Calculate the time required to deposit 2.5 g of copper . Relative atomic mass of copper = 63.5 g .

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12. In a copper plating experiment , the difference between final and initial masses of the cathode is measured carefully and is found to be 16.43 g . The time duration of electrolysis is noted to be 4000 s . The steady reading of current in an ammeter placed in series with the voltameter is 12.6 A . what is the error in the ammeter reading ?

( $F = 96485 \text{ C mol}^{-1}$  , relative atomic mass of Cu = 63.54 )

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**13.** To deposit 0.5 kg of silver per hour on the cathode of a silver voltameter of resistance 0.70 milliohm , how much p.d. must be maintained between the plates ? ( Atomic mass of Ag = 108 , F = 96500 C  $mol^{-1}$ ).

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**14.** A steady potential difference of 1.62 V is maintained across two Pt electrodes placed in a solution of  $CuCl_2$  . At the end of 600s, the mass of copper deposited on the cathode is measured to be 5.92 g. The back emf of the voltameter is given to be 1.34 V. Estimate the resistance of voltameter. Faraday constant =96500 C  $mol^{-1}$ , relative atomic mass of copper =63.5.





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**15.** The potential difference between the terminals of a battery of emf 12 V and internal resistance  $2\Omega$  drops to 10 V when it is connected to a silver voltameter. Calculate the silver deposited at the cathode in half an hour. Atomic weight of silver is  $107.9\text{g mole}^{-1}$



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**16.** A copper voltameter is in series with a heater coil of resistance 0.1 ohm. A steady current flows in the circuit for 20 minutes, and a mass of 0.99 g of copper is deposited at the cathode. If the electrochemical equivalent of copper is

0.00033 g/coulomb, calculate the heat generated in the coil.

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**17.** A copper voltameter and water voltameter are connected in series. How much oxygen will be liberated in water voltameter when 0.5 g of copper is deposited in copper voltameter. Chemical equivalent of copper and oxygen are 32 and 8 respectively.

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**18.** If a current of 3 A be passed through a voltameter for 100 minutes, the amount of copper deposited is found to

be 5.94 g. Calculate the electrochemical equivalent of nickel, when relative atomic masses of copper and nickel are 63.57 and 58.68 respectively.

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**19.** In a silver plating system, an electrolysis current of 5.0 A is used for a certain time and 0.5 mol of silver is deposited. How many moles of copper and iron will be deposited in their respective plating system if an electrolysis current of 10.0 A is passed for twice the time for silver plating. ( Relative atomic mass of silver=107.3, of copper -63.54, of iron=55.85).

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20. A silver and a copper voltameter are connected in series with a 12.0 V battery of negligible internal resistance. 0.806 g of silver is deposited in half an hour in the silver voltameter. Calculate (i) magnitude of current flowing in the circuit (ii) mass of copper deposited in the copper voltameter during the same period. Given that ECE of silver  $1.12 \times 10^{-8} \text{ kgC}^{-1}$



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21. A current of 1 A is passed through a dilute solution of sulphuric acid for some time to liberate 1 g of oxygen. How much hydrogen is liberated during this period? How long the current was passed? Faraday constant  $= 96500 \text{ mol}^{-1}$



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**22.** In producing chlorine through electrolysis, 100 kW power at 125 V is being consumed. How much chlorine per minute is liberated ? Electrochemical equivalent for chlorine =  $0.367 \times 10^{-6} \text{ kgC}^{-1}$



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**23.** A plate of area  $10 \text{ cm}^2$  is to be electroplated with copper ( density  $9 \text{ g cm}^{-3}$ ) to a thickness of 0.001 cm on both sides using a battery of 12 V. Calculate the energy spent by the cell in the process of deposition. If the energy

is used to heat 100 g of water, calculate the rise in temperature of water. ECE of copper =  $0.0003gC^{-1}$ .

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**24.** A piece of metal weighing 200 g is to be electroplated with 5% of its weight with gold. If the strength of the available current is 2 ampere, how long would it take to deposit the required amount of gold. ECE of H =  $0.1044 \times 10^{-4}$ , atomic mass of gold = 197.1, atomic weight of hydrogen = 1.008.

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25. A charged capacitor of  $5 \times 10^{-2}$  F capacity is discharged through a resistor R of  $20\Omega$  and a copper voltameter of internal resistance  $30\Omega$  connected in series. If  $4.62 \times 10^{-6}$  kg copper is deposited, calculate the heat generated in the resistor R.

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## Problems From Competitive Examinations

1. One ampere current flows for one minute through a silver voltameter. It deposits 0.067 g of silver on the cathode. Calculate

(i) the electrochemical equivalent of copper.

(ii) how much charge will flow to deposited 108 g of silver ?

(iii) how much charge is carried by a silver ion ?

( Avagadro's number,  $N = 6.024 \times 10^{23}$ ).

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## Type A

1. Electrochemical equivalent for copper is  $3.2 \times 10^{-7} kgC^{-1}$  An electric current of 3.0 A is passed through a copper voltameter for one minute .How much will be deposited during electrolysis?

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2. A current of 1.5 A is passed through a silver voltameter for 35 minutes. The mass of silver deposited during electrolysis is 3.528 g. Calculate the electrochemical equivalent of silver.

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3. How long will it take to deposit electrolytically 127 g of copper on the cathode of a copper voltameter by a current of 50 A?

(ECE of copper =  $0.0003294 \text{ g/C}$ )

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4. For what time must a current of 2.5 A pass through zinc sulphate solution to deposit 2 g of zinc. ECE of Zn =  $0.0003387 \text{ gC}^{-1}$

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5. How many grams of chlorine can be produced by the electrolysis of molten NaCl with a current of 1 A for 15 minutes. ECE of chlorine =  $0.367 \times 10^{-7} \text{ kgC}^{-1}$

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6. How long would it take a current of 1.2 A to deposit a layer of copper 0.10 mm thick on both sides of a

brass rectangular plate  $10\text{cm} \times 15\text{cm}$ ? Electrochemical  
equivalent of copper =  $0.00033\text{gc}^{-1}$  density of copper  
=  $8.9\text{gcm}^{-3}$



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7. A spoon having  $10\text{cm}^2$  area is to be electroplated with  
silver. Calculate the thickness of silver coating when a  
current of 0.12 A is passed for 48 h through the electrolyte.  
Electrochemical equivalent of silver is  $0.001118\text{gC}^{-1}$  and  
density is  $10.5\text{gcm}^{-3}$



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8. A metal surface of surface area  $250\text{cm}^2$  is to be coated on both sides with copper by electrolysis. How long will it take to deposit a copper layer 0.01 cm thick if a current of 1.5 A is used. ECE of copper =  $0.0003\text{gC}^{-1}$  and density of copper =  $9\text{gcm}^{-3}$

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9. To deposit 0.5 kg of silver per hour on the cathode of a silver voltameter of resistance 0.70 milliohm. How much p.d. must be maintained between the plates?

(Atomic mass of Ag = 108,  $F = 965000\text{Cmole}^{-1}$ )

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10. A steady e.m.f of 1.72 is maintained across two platinum electrodes placed in a solution of  $CuCl_2$ . At the end of 510 s, the mass of copper deposit is 5.1 g. The back e.m.f of voltmeter is given to be 1.527 V. Calculate the resistance of the voltmeter [Faradays constant =  $96500 C \text{ mole}^{-1}$ , Atomic mass of copper = 63.5]

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11. A copper voltmeter and an ammeter are connected in series with a battery through a resistance. In 50 minutes 0.99 g Copper is deposited on the plates. The ammeter reads 0.95 A. Calculate the error in its reading. ECE of copper is  $0.0003 g C^{-1}$

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12. In copper plating experiment 6.35 g of copper is deposited in one and a half hours. An ammeter connected in series records a current of 3.5 A. Calculate the error in ammeter reading.

$$[F = 96500 \text{ C mol}^{-1}, \text{ gram atomic mass of copper} = 63.5 \text{ g}]$$

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13. In a copper voltameter, 0.593 g copper is deposited by a current of 2 A in 15 minutes. Calculate the atomic weight of copper. Faraday's constant = 96500 C.

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**14.** A silver and a copper voltameter are connected in parallel across a 6 V battery of negligible internal resistance. In half an hour, 1 g of copper and 2 g of silver are deposited. Calculate the rate at which the energy is supplied and the electrochemical equivalent (ECE) of silver. The ECE of copper is  $3294 \times 10^{-7} \text{ gC}^{-1}$  and that of silver is  $1118 \times 10^{-6} \text{ gC}^{-1}$ .



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**15.** It is desired to deposit 0.54 kg of silver per hour on the cathode of a silver voltameter whose resistance is  $0.72 \text{ m}\Omega$ . How much potential difference must be maintained between the plates of the voltameter during electrolysis? Use the known

value of Faraday's constant .Relative atomic mass of silver is 108.

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16. A current passes through an a coil of wire  $200\Omega$  immersed in a vessel containing 2 kg of water and then sent through a copper voltameter .It is found that temperature .It is found that temperature of water rises  $5^\circ$  C per minute .How much copper is deposited per minute ?  
ECE of copper =  $3.3 \times 10^{-4} gC^{-1}$

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17. Fig .7.2 Shown an eletrolyte AgCl through which current is passes it is observed that 2.68 g of silver is deposited in 10 minutes on the cathode Find the heat devel- oped in the  $20\Omega$  resistor during this period .Atomic mass of silver is 107 .9.



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Type B

1. A copper and a silver voltameter are connected are connected in series .How much sliver will be deposed in the sliver volameter when 0.5 g of copper is deposed in

the copper voltameter .Chemical equivalents of copper and silver are 32 and 108 respectively .

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2. A current of 0.2 A is passed through a silver voltameter for 3 hours and 20 minutes. Find the mass of silver liberated ECE of hydrogen =  $0.0000105gC^{-1}$  ,chemical equivalent of hydrogen =1 and ECE and that for silver =108

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3. Find the strength of current that deposited 0.777 g of metallic copper in half an hour in a copper voltameter .The

atomic mass of copper is 63 and ECE of hydrogen is  $0.00001036gC^{-1}$

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4. A silver and copper voltameter are connected in series with 12 V battery of negligible resistance .It is found that 0.806 g of silver is deposited in half an hour ,. Find silver  $= 1.12 \times 10^{-6}kgC^{-1}$  and that of copper  $= 6.6 \times 10^{-7}kgC^{-1}$

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5. Calculate the current required to deposit 1 g copper in 30 minutes in a voltameter containing cupric sulphate .

Atomic mass of silver = 107.9 , atomic mass of copper = 63.6 and ECE of silver =  $0.00118 \text{gC}^{-1}$



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