



**Useful Data**
**PHYSICS**

Acceleration due to gravity	$g = 10 \text{ m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34} \text{ J-s}$
Charge of electron	$e = 1.6 \times 10^{-19} \text{ C}$
Mass of electron	$m_e = 9.1 \times 10^{-31} \text{ kg}$
Permittivity of free space	$\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N-m}^2$
Density of water	$\rho_{\text{water}} = 10^3 \text{ kg/m}^3$
Atmospheric pressure	$P_a = 10^5 \text{ N/m}^2$
Gas constant	$R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$

**CHEMISTRY**

Gas Constant	R	=	$8.314 \text{ J K}^{-1} \text{ mol}^{-1}$
		=	$0.0821 \text{ Lit atm K}^{-1} \text{ mol}^{-1}$
		=	$1.987 \approx 2 \text{ Cal K}^{-1} \text{ mol}^{-1}$
Avogadro's Number	$N_a$	=	$6.023 \times 10^{23}$
Planck's constant	h	=	$6.625 \times 10^{-34} \text{ J-s}$
		=	$6.625 \times 10^{-27} \text{ erg-s}$
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	$1.66 \times 10^{-27} \text{ kg}$
1 eV		=	$1.6 \times 10^{-19} \text{ J}$

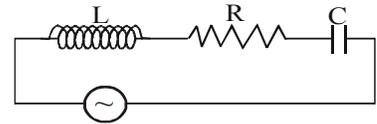
Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

**Physics****PART – I****SECTION – A**  
**Single Correct Choice Type**

This section contains **6 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. An alternating voltage of 220 V and 50 Hz is applied across a circuit containing pure resistance (R), inductance (L) and capacitance (C). As shown in figure. Which statement is true ?

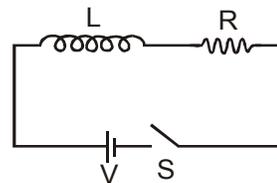


- (A) when power factor is maximum impedance is maximum  
 (B) in inductor and capacitor voltage will be always same  
 (C) if power factor of source is one then current in the circuit is  $220/R$   
 (D) none of these
2. A parallel plate capacitor has a capacitance C and charge Q. Another plate is inserted in between the plates of the capacitor at the center and is connected by a long wire to another far off spherical conductor of radius R. What is the potential difference between the edge of the sphere and one of the outer plates ?

- (A)  $\frac{Q}{C}$  (B)  $\frac{Q}{4C}$   
 (C)  $\frac{Q}{2C}$  (D)  $\frac{2Q}{C}$

**Rough work**

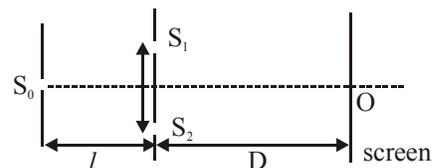
3. An inductor of inductance  $L = \frac{\tau R}{2}$  and a resistor of resistance  $R$  is connected to a battery of emf  $V$  as shown in the figure. The potential difference across the resistance at a time,  $t = \tau \ln 2$  after the switch  $S$  is closed is ( $\tau$  is constant)



- (A)  $\frac{V}{4}$  (B)  $\frac{3V}{4}$   
 (C)  $\frac{V}{2}$  (D)  $\frac{2V}{3}$
4. The reading of a barometer containing some air above the mercury column is 73cm while that of a correct one is 76 cm. If the tube of the faulty barometer is pushed down into mercury until volume of air in it is reduced to half, the reading shown by it will be  
 (A) 70 cm (B) 72 cm  
 (C) 74 cm (D) 76 cm
5. If error in the measurement of mass is 0.8% and in volume it is 0.4%, then error in the measurement of density is  
 (A) 1.2 % (B) 0.4 %  
 (C) 0.8 % (D) 1 %

6. The figure shows a schematic diagram showing the arrangement of Young's double slit experiment

$$d \ll l \text{ and } d \ll D, \frac{\lambda}{d} \ll 1$$



Choose the correct statement related to wavelength of light used.

- (A) larger the wavelength of light larger the fringe width  
 (B) if white light is used in YDSE, then the violet colour forms its first maxima closest to the central maxima  
 (C) the central maxima of all the wavelengths coincide  
 (D) all the above statements are correct

**Rough work**

## Multiple Correct Answer(s) Type

This section contains **4 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE** are correct.

7. The figures represent two snaps of a travelling wave on a string of mass per unit length,  $\mu = 0.25$  kg/m. The two snaps are taken at time  $t = 0$  and at  $t = \frac{1}{24}$  s. Then

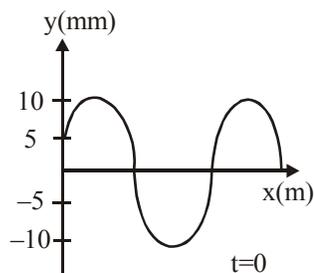


Figure -1

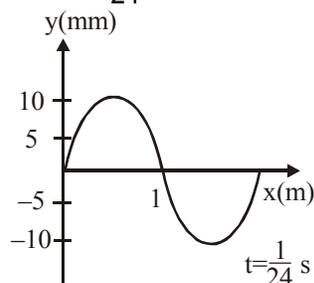
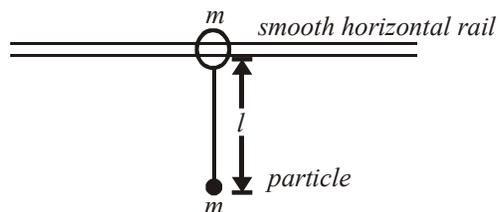


Figure -2

- (A) speed of wave is 4 m/s  
 (B) the tension in the string is 4 N  
 (C) the equation of the wave is  $y = 10 \sin(\pi x - 4\pi t + \frac{\pi}{6})$   
 (D) the maximum velocity of the particle =  $\frac{\pi}{25}$  m/s
8. The ring shown in the figure is given a constant horizontal acceleration ( $a_0 = g/\sqrt{3}$ ). Maximum deflection of the string from the vertical is  $\theta_0$ , then
- (A)  $\theta_0 = 30^\circ$   
 (B)  $\theta_0 = 60^\circ$   
 (C) at maximum deflection, tension in string is equal to  $mg$   
 (D) at maximum deflection, tension in string is equal to  $\frac{2mg}{\sqrt{3}}$



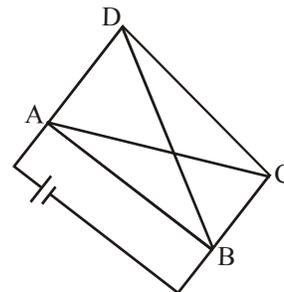
**Rough work**

9. An ideal gas undergoes a process such that  $\rho \propto \frac{1}{T}$ . The molar heat capacity of this process is 33.24 J/mol K.

- (A) The work done by the gas is  $2R\Delta T$ . (B) Degree of freedom of the gas is 4.  
 (C) Degree of freedom of the gas is 3. (D)  $\gamma \left( \frac{C_P}{C_V} \right)$  for the gas is 1.5.

10. A wire frame in the form of a tetrahedron ABCD is connected to a dc source. The resistance of all the edges of the tetrahedron are equal. Choose the correct statement (s)

- (A) the electric current through DC is zero  
 (B) if we remove anyone of the edges AD, AC, DB or BC, the change in current remain same  
 (C) the current through AB is maximum  
 (D) the change in current will be same if AB or DC is removed



**Rough work**

**Assertion - Reasoning Type**

This section contains 4 questions numbered 11 to 14. Each question contains **STATEMENT-1 (Assertion)** and **STATEMENT-2 (Reason)**. Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

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11. STATEMENT-1:  
When a capillary tube is dipped in water, irrespective of the length of the tube water can not come out of the tube.  
**and**
- STATEMENT-2:  
If length of the tube is insufficient radius of meniscus increases to balance the inside and outside pressure.
- (A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.  
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.  
(C) Statement-1 is True, Statement -2 is False.  
(D) Statement-1 is False, Statement-2 is True.
12. STATEMENT-1:  
Electric field does not exist inside the conductor.  
**and**
- STATEMENT-2:  
When electric field is present inside the conductor electrons inside it can not be at rest.
- (A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.  
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.  
(C) Statement-1 is True, Statement -2 is False.  
(D) Statement-1 is False, Statement-2 is True.
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**Rough work**

13. STATEMENT-1:  
 Pair production (sub atomic particles) can not take place in vacuum.  
**and**
- STATEMENT-2:  
 For pair production in vacuum simultaneously momentum and energy are not conserved.
- (A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.  
 (B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.  
 (C) Statement-1 is True, Statement -2 is False.  
 (D) Statement-1 is False, Statement-2 is True.
14. STATEMENT-1:  
 When wave travel from denser medium to rarer medium it bends away from the normal at the point of incidence.  
**and**
- STATEMENT-2:  
 In air speed of sound wave is less than that in the water.
- (A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.  
 (B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.  
 (C) Statement-1 is True, Statement -2 is False.  
 (D) Statement-1 is False, Statement-2 is True.
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***Rough work***

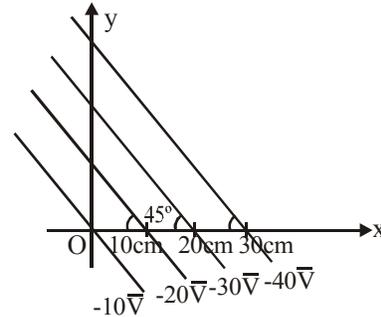
### Comprehension Type

This section contains 3 groups of questions. Each group has 3 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

#### Paragraph for Question Nos. 15 to 17

The gravitational field strength  $\vec{E}$  and gravitational potential  $V$  are related as  $\vec{E} = -\left(\frac{\partial V}{\partial x}\hat{i} + \frac{\partial V}{\partial y}\hat{j} + \frac{\partial V}{\partial z}\hat{k}\right)$

In the figure, transversal lines represent equipotential surfaces. A particle of mass  $m$  is released from rest at the origin. The gravitational unit of potential,  $1\bar{V} = 1\text{cm}^2 / \text{s}^2$

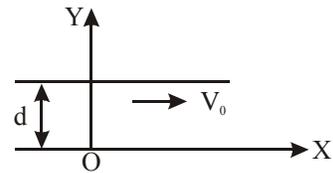


15. y-component of  $E$  at the point whose co-ordinates are (4cm, 4cm) is  
 (A)  $1 \text{ cm/s}^2$  (B)  $8 \text{ cm/s}^2$   
 (C)  $4 \text{ cm/s}^2$  (D) none of these
16. x-component of the velocity of the particle at the point (4cm, 4cm) is  
 (A) 4 cm/s (B) 2 cm/s  
 (C)  $2\sqrt{2} \frac{\text{cm}}{\text{s}}$  (D) 1 cm/s
17. Speed of the particle ( $v$ ) ( $y$  is in cm and  $v$  is in cm/s) as function of its  $y$ -co-ordinate is  
 (A)  $v = 2\sqrt{y}$  (B)  $v = \sqrt{2} \cdot y$   
 (C)  $v = 2y$  (D)  $v = 2y + 4y^2 + 2y^2$

**Rough work**

**Paragraph for Question Nos. 18 to 20**

Using the concept of relative motion, answer the following question. Velocity of the river with respect to ground is given by ' $V_0$ '. Width of the river is ' $d$ '. A swimmer swims (with respect to water) perpendicular to the current with acceleration  $a = 2t$  (where  $t$  is time) starting from rest from the origin  $O$  at  $t = 0$ .

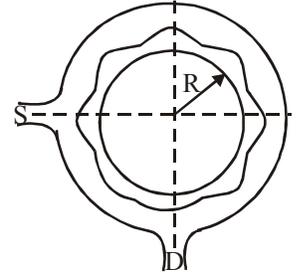


18. The time of crossing the river is  
 (A)  $(d)^{1/3}$  (B)  $(2d)^{1/3}$   
 (C)  $(3d)^{1/3}$  (D) Information is insufficient
19. The drift of the swimmer is  
 (A)  $V_0(d)^{1/3}$  (B)  $V_0(2d)^{1/3}$   
 (C)  $V_0(3d)^{1/3}$  (D) None of these
20. The equation of trajectory of the path followed by the swimmer  
 (A)  $y = \frac{x^3}{3V_0^3}$  (B)  $y = \frac{x^2}{2V_0^2}$   
 (C)  $y = \frac{x}{V_0}$  (D)  $y = \sqrt{\frac{x}{V_0}}$

**Rough work**

**Paragraph for Question Nos. 21 to 23**

A narrow tube is bent in the form of a circle of radius  $R$ , as shown in the figure. Two small holes  $S$  and  $D$  are made in the tube at the positions right angle to each other. A source placed at  $S$  generates a wave of intensity  $I_0$  which is equally divided into two parts: one part travels along the longer path, while the other travels along the shorter path. Both the part waves meet at the point  $D$  where a detector is placed.



21. If a maxima is formed at a detector then, the magnitude of wavelength  $\lambda$  of the wave produced is given by
- (A)  $\pi R$  (B)  $\frac{\pi R}{2}$   
 (C)  $\frac{\pi R}{4}$  (D) all of these
22. If a minima is formed at the detector then, the magnitude of wavelength  $\lambda$  of the wave produced is given by
- (A)  $2\pi R$  (B)  $\frac{3}{2}\pi R$   
 (C)  $\frac{2}{5}\pi R$  (D) None of these
23. The maximum intensity produced at  $D$  is given by
- (A)  $4I_0$  (B)  $2I_0$   
 (C)  $I_0$  (D)  $3I_0$

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**Rough work**

# Chemistry

## PART - II

### SECTION - A

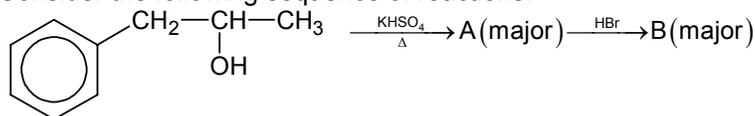
#### Straight Objective Type

This section contains 6 multiple choice questions numbered 1 to 6. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. How many isomeric hexenes, on hydrogenation gives hexane?  
 (A) 2 (B) 3  
 (C) 4 (D) 5

2. What is the criterion for a compound to exhibit enantiomerism?  
 (A) the molecule must contain chiral carbon (s)  
 (B) the molecule must be a chiral molecule  
 (C) the molecule must be chiral molecule  
 (D) the mirror images must be superimposable

3. Consider the following sequence of reactions:



(A) and (B) respectively are:

- (A)  $\text{PhCH}=\text{CHCH}_3$  &  $\text{Ph}-\underset{\text{Br}}{\text{CH}}-\text{CH}_2\text{CH}_3$  (B)  $\text{PhCH}=\text{CHCH}_3$  &  $\text{Ph}-\text{CH}_2-\underset{\text{Br}}{\text{CH}}-\text{CH}_2$   
 (C)  $\text{PhCH}_2\text{CH}=\text{CH}_2$  &  $\text{Ph}-\underset{\text{Br}}{\text{CH}}-\text{CH}_2-\text{CH}_2$  (D)  $\text{Ph}\underset{\text{Br}}{\text{CH}}-\text{CH}_2\text{CH}_3$  &  $\text{Ph}-\underset{\text{Br}}{\text{CH}}=\text{CHCH}_3$

*Rough Work*

4. In which of the following, the given property varies in the same order as given for different compounds mentioned.
- (A) Lattice energy –  $\text{BaO} < \text{CaO} < \text{SrO} < \text{MgO}$   
(B) Thermal stability –  $\text{CaCO}_3 < \text{BeCO}_3 < \text{Na}_2\text{CO}_3 < \text{MgCO}_3$   
(C) Solubility –  $\text{K}_2\text{SO}_4 > \text{BeSO}_4 > \text{CaSO}_4 > \text{BaSO}_4$   
(D) Hydration energy –  $\text{Fe}^{3+} < \text{Al}^{3+} < \text{CO}^{2+} < \text{Fe}^{2+}$
5. Three samples of  $\text{H}_2\text{O}_2$  which are labeled as 10 vol., 20 vol. and 30 vol. are mixed by taking 100 ml of each and the mixture is diluted to 1000 ml. The molar concentration of the resultant solution is:
- (A) 0.893 M (B) 0.536 M  
(C) 11.2 M (D) 1.0 M
6. Consider two solutions:  
I: 0.5 M NaCl solution at  $25^\circ\text{C}$ ; NaCl is completely ionized.  
II: 2.0 M  $\text{C}_6\text{H}_5\text{COOH}$  in benzene at  $25^\circ\text{C}$ , the acid dimerizes to the full extent.  
Which of the following statement is correct:
- (A) Both solution display equal osmotic pressure  
(B) Both have equal vapour pressure  
(C) Solution II is hypertonic  
(D) Solution II has lower depression in freezing point than solution I

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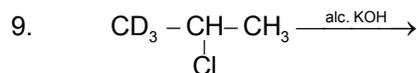
**Rough Work**

**Multiple Correct Choice Type**

This section contains 4 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

7. Which of the following is correct for a non-ideal solution of liquids A and B, showing negative deviation?
- (A)  $\Delta H_{\text{mix}} = -ve$  (B)  $\Delta V_{\text{mix}} = -ve$   
 (C)  $\Delta S_{\text{mix}} = +ve$  (D)  $\Delta G_{\text{mix}} = -ve$

8.  $A_2O_n$  is oxidized to  $AO_3^-$  by  $MnO_4^-$  in acid medium. If  $1.5 \times 10^{-3}$  mol of  $A_2O_n$  requires 60 ml of 0.03 M  $KMnO_4$  solution for complete oxidation, which of the following statement(s) is/are correct?
- (A) The value of  $n = 2$   
 (B) Empirical formula of oxide is AO  
 (C) 0.15 mole of  $A_2O_n$  would require 0.15 mole of  $K_2Cr_2O_7$  solution  
 (D) "A" may be a metal from second group of periodic table



True about above reaction is/are:

- (A) It is E2 elimination  
 (B) Saytzeff's alkene is major product in above reaction  
 (C)  $CD_3 - CH = CH_2$  is major product  
 (D) It is anti elimination
10. If uncertainty in position of an electron is same as uncertainty in its momentum, than the uncertainty of each can be:
- (A)  $\frac{1}{2} \sqrt{\frac{h}{\pi}}$  (B)  $\sqrt{\frac{h}{\pi}}$   
 (C)  $\frac{1}{4} \sqrt{\frac{h}{\pi}}$  (D)  $2\sqrt{\frac{h}{\pi}}$

**Rough Work**

**Reasoning Type**

This section contains 4 questions numbered 11 to 14. Each question contains STATEMENT-1 (Assertion) and STATEMENT-2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

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11. STATEMENT-1: 2-chlorobutane on dehydro chlorination gives 2-butene (cis + trans) as a major product rather than 1-butene.  
**and**  
STATEMENT-2: 2-butene is thermo dynamically more stable than 1-butene.  
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.  
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.  
(C) Statement-1 is True, Statement -2 is False.  
(D) Statement-1 is False, Statement-2 is True.
12. STATEMENT-1: Neopentyl chloride on nucleophilic substitution with aq.  $\text{OH}^-$  gives 2-methyl-2-butanol as major product.  
**and**  
STATEMENT-2: It involves  $\text{S}_{\text{N}}2$  mechanism  
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.  
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.  
(C) Statement-1 is True, Statement -2 is False.  
(D) Statement-1 is False, Statement-2 is True.
- 

*Rough Work*

13. STATEMENT-1: A radio active nucleide undergoes 63.0% decay in its average life period.  
[antilog 0.43 = 0.27]  
**and**  
STATEMENT-2: Average life period of a radio active nuceide is 1.44 times to its half-life period.  
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.  
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.  
(C) Statement-1 is True, Statement -2 is False.  
(D) Statement-1 is False, Statement-2 is True.
14. STATEMENT-1: Activation energy ( $E_a$ ) of a reaction can not be zero.  
**and**  
STATEMENT-2: All collisions between the reactant molecules can not lead to the formation of product.  
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.  
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.  
(C) Statement-1 is True, Statement -2 is False.  
(D) Statement-1 is False, Statement-2 is True.
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***Rough Work***

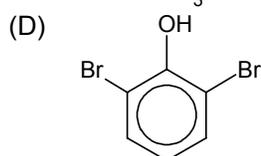
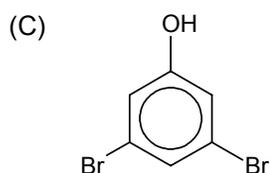
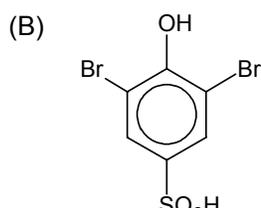
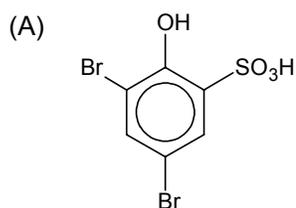
## Comprehension Type

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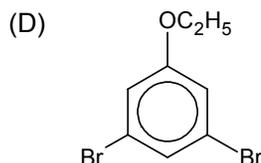
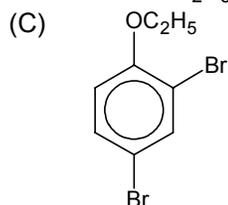
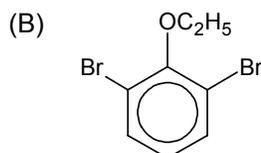
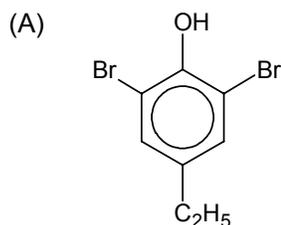
## Paragraph for Question Nos. 15 to 17

An organic compound "A" has the molecular formula  $C_6H_6O$ . It can be manufactured through cumene hydro peroxide process. "A" on sulphonation with conc.  $H_2SO_4$  at  $100^\circ C$  gives a thermodynamically controlled product "B". Which in turn react with 2 equivalents of  $Br_2$  to give "C". "C" on heating with dilute  $H_2SO_4$  gives "D".

15. Structure of "D" is:



16. When "D" is treated with aq. NaOH followed by  $C_2H_5-I$  (ethyl iodide) gives "E". E is:



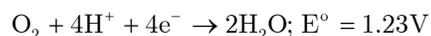
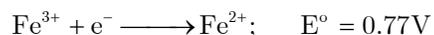
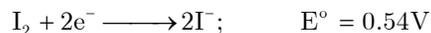
17. The by product in the cumene-hydroperoxide process is:

- (A) Acetone (B) Acetophenone  
(C) Acetaldehyde (D) Butanone

*Rough Work*

**Paragraph for Question Nos. 18 to 20**

Redox reactions play a vital role in chemistry and biology. The values of  $E^\circ_{\text{red}}$  of two half cell reactions decide which way the reaction is expected to proceed. A simple example is Daniel cell in which zinc goes into solution and copper gets deposited. Given below are a set of half-cell reactions (acidic medium) along with their  $E^\circ$  values.



18.  $\text{Fe}^{3+}$  is stable but  $\text{Mn}^{3+}$  is not stable in acidic solution because:  
 (A)  $\text{O}_2$  oxidises  $\text{Mn}^{2+}$  to  $\text{Mn}^{3+}$   
 (B)  $\text{O}_2$  oxidises both  $\text{Mn}^{2+}$  and  $\text{Fe}^{2+}$  into  $\text{Mn}^{3+}$  and  $\text{Fe}^{3+}$  respectively.  
 (C)  $\text{Fe}^{3+}$  oxidises  $\text{H}_2\text{O}$  to  $\text{O}_2$   
 (D)  $\text{Mn}^{3+}$  oxidises  $\text{H}_2\text{O}$  to  $\text{O}_2$ .
19. Among the following identify the correct statement:  
 (A) Chloride ion is oxidized by  $\text{O}_2$  (B)  $\text{Fe}^{2+}$  ion is oxidized by iodine  
 (C) Iodide ion is oxidized by chlorine (D)  $\text{Mn}^{2+}$  is oxidized by chlorine.
20. Which of the following reaction is not spontaneous?  
 (A)  $\text{Cl}_2 + 2\text{I}^- \longrightarrow 2\text{Cl}^- + \text{I}_2$  (B)  $\text{Mn}^{2+} + \text{Fe}^{3+} \longrightarrow \text{Mn}^{3+} + \text{Fe}^{2+}$   
 (C)  $\text{Cl}_2 + 2\text{H}_2\text{O} \longrightarrow 2\text{HCl} + \text{O}_2$  (D)  $\text{O}_2 + 2\text{HI} \longrightarrow \text{H}_2\text{O} + \text{I}_2$

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**Rough Work**

**Paragraph for Question Nos. 21 to 23**

When 20.02 g of a white solid (X) is heated, 4.4 g of an acid gas (A) and 1.8 g of a neutral gas (B) are evolved leaving behind a solid residue (Y) of weight 13.8 g (A) turns lime water milky and (B) condenses into a liquid which changes anhydrous copper sulphate blue. The aqueous solution of Y is alkaline to litmus and gives 19.7 g of white precipitate (Z) with barium chloride solution. (Z) gives carbon-dioxide with an acid.

21. The white solid 'X' is:  
(A) metal sulphate (B) metal chloride  
(C) metal carbonate (D) metal bicarbonate
22. Atomic weight of the metal is:  
(A) 23 g/mole (B) 39.0 g/mole  
(C) 6 g/mole (D) 24 g/mole
23. Gas 'B' is:  
(A) H<sub>2</sub> gas (B) O<sub>2</sub> gas  
(C) CO<sub>2</sub> gas (D) H<sub>2</sub>O vapour
- 

***Rough Work***

# Mathematics

## PART – III

### SECTION – A

#### Straight Objective Type

This section contains **6 multiple choice questions** numbered 1 to 6. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

- Let ABC be a triangle with AB = 3, BC = 4 and AC = 5. Let I be the centre of the circle inscribed in triangle ABC. The product of the distances of incentre from the vertices A, B and C of the triangle ABC, is  
 (A) 10 (B) 9  
 (C)  $5\sqrt{2}$  (D)  $\sqrt{10}$
- The value of definite integral  $\int_0^1 \frac{dx}{R(x)+x+4}$  is if  $R\left(\sqrt{3+\sqrt{3+\sqrt{3+\dots\infty}}}\right) = 0$ , where R is a polynomial function.  
 (A)  $\frac{\pi}{8}$  (B)  $\frac{\pi}{4}$   
 (C)  $\frac{\pi}{2}$  (D)  $\pi$
- Number of natural numbers less than and coprime with 11664 is  
 (A) 7776 (B) 5558  
 (C) 3888 (D) none of these
- If  $f(x) = \begin{vmatrix} \cos(x+\alpha) & \cos(x+\beta) & \cos(x+\gamma) \\ \sin(x+\alpha) & \sin(x+\beta) & \sin(x+\gamma) \\ \sin 2\alpha & \sin 2\beta & \sin 2\gamma \end{vmatrix}$   
 where  $\alpha$  and  $\beta$  are constant, then the value of  $2f\left(\frac{\pi}{4}\right) - 3f\left(\frac{\pi}{6}\right) + f\left(\frac{\pi}{3}\right)$  is  
 (A) 0 (B) 1  
 (C) -1 (D) none of these

**Rough work**

5. The number of terms in the expansion of  $(1 + ax + bx^2 + abx^3)^{26}$  after the like terms are added is, where  $a, b \in \mathbb{Z}$
- (A) 75 (B) 78  
(C) 79 (D) 52

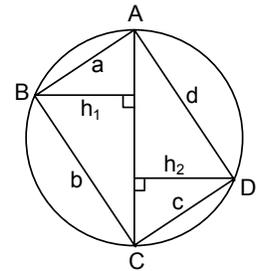
6.  $\frac{626 \int_0^{\infty} e^{-x} \sin^{25} x dx}{\int_0^{\infty} e^{-x} \sin^{23} x dx}$  is equal to
- (A) 625 (B) 624  
(C) 600 (D) none of these

**Multiple Correct Answer(s) Type**

This section contains **4 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE are correct**.

7. ABCD is a cyclic quadrilateral as shown which of the following must be true?

- (A)  $\cos B = \frac{a^2 + b^2 - c^2 - d^2}{2(ab + cd)}$   
 (B)  $ab + cd = 2(h_1 + h_2)R$ , where R is the circumradius of the quadrilateral  
 (C) area of the quadrilateral =  $\frac{1}{2}(ab + cd) \sin B$   
 (D) if  $d_1$  and  $d_2$  are the length of the diagonals of the quadrilateral then  $ac + bd = d_1 d_2$



8. Which of the following is/are true?
- (A) A is a non-singular square matrix of order  $n \times n$  and k is a scalar, then  $|\text{adj}(kA)|$  is equal to  $k^{n^2-n} |A|^{n-1}$   
 (B) if  $|A| = 0$  and  $\text{adj}A \cdot B = O$ , then system of equation  $AX = B$  has infinitely many solutions. Here A is matrix of order  $3 \times 3$ ,  $X = \begin{bmatrix} x \\ y \\ z \end{bmatrix}$  and B is matrix of order  $3 \times 1$   
 (C) A and B are two square matrices of order  $n \times n$  such that  $AB = O$  and A is non singular, then B must be null matrix  
 (D) if AB is non singular, then A and B both must be non singular

**Rough work**

9. Let  $f : \mathbb{R} \rightarrow (0, \infty)$  be a real valued function satisfying  $\int_0^x t f(x-t) dt = e^{2x} - 1$ , then which of the following is/are correct ?
- (A) the value of  $(f^{-1})'(4) = \frac{1}{8}$  (B) derivative of  $f(x)$  w.r.t.  $e^x$  at  $x = 0$  is 8
- (C)  $\lim_{x \rightarrow 0} \frac{f(x) - 4}{x} = 4$  (D)  $f(0) = 4$
10. Internal bisector of  $\angle A$  of a triangle ABC meets side BC at D. A line drawn through D perpendicular to AD intersects the AC at E and the side AB at F. If a, b, c represent sides of  $\triangle ABC$ , then
- (A) AE is H.M. of b and c (B)  $(b + c) AD = 2bc \cos(A/2)$
- (C)  $(b + c) EF = 4bc \sin(A/2)$  (D) the triangle AEF is isosceles

### Reasoning Type

This section contains 4 questions numbered 11 to 14. Each question contains STATEMENT-1 (Assertion) and STATEMENT-2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

11. STATEMENT 1: If  $a > 0, b > 0$ , then  $\frac{a+b}{2} \geq \sqrt{ab}$ . The equality holds when  $a = b$ .
- STATEMENT 2: If  $\frac{a^2 + b^2}{2} \geq ab$ . The equality holds when  $a^2 = b^2$ .
- (A) Both the statements are true and Statement 2 is correct explanation of Statement 1  
 (B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1  
 (C) Statement 1 is true and Statement 2 is false  
 (D) Statement 1 is false and Statement 2 is true
12. STATEMENT 1:  $\cos^{-1}\left(\frac{3}{4}\right) > \sin^{-1}\left(\frac{3}{4}\right)$ .
- STATEMENT 2:  $\cos^{-1}x > \sin^{-1}x$  is true if  $-1 \leq x < \frac{1}{\sqrt{2}}$ .
- (A) Both the statements are true and Statement 2 is correct explanation of Statement 1  
 (B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1  
 (C) Statement 1 is true and Statement 2 is false  
 (D) Statement 1 is false and Statement 2 is true

### Rough work

13. STATEMENT 1: The line  $x - 2y + 1 = 0$  is a member of the family of lines  $x - y + \lambda(x - 2y + 1) = 0$ , where  $\lambda \in \mathbb{R}$ .  
STATEMENT 2:  $x - y + \lambda(x - 2y + 1) = 0$ , where  $\lambda \in \mathbb{R}$ , is a family of straight lines each member of which passes through the point of intersection of the lines  $x - y = 0$  and  $x - 2y + 1 = 0$ .  
(A) Both the statements are true and Statement 2 is correct explanation of Statement 1  
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1  
(C) Statement 1 is true and Statement 2 is false  
(D) Statement 1 is false and Statement 2 is true
14. STATEMENT 1: The number of values of  $x$  satisfying the equation  $(1 + \sec^2 \pi x) (1 + \sec^2 y) [|\sin x| + |\cos x|] = -x^2 + 4x$  is one (where  $[\cdot]$  represents greatest integer function).  
STATEMENT 2:  $\sec^2 \theta \geq 1$  (wherever defined) and  $1 \leq |\sin \theta| + |\cos \theta| \leq \sqrt{2}$ .  
(A) Both the statements are true and Statement 2 is correct explanation of Statement 1  
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1  
(C) Statement 1 is true and Statement 2 is false  
(D) Statement 1 is false and Statement 2 is true

### Comprehension Type

This section contains **3 paragraphs**. Based upon paragraphs **3 multiple choice questions** have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of **which ONLY ONE** is correct.

#### Paragraph for Question Nos. 15 to 17

Read the following write up carefully and answer the following questions:

Given the curves  $y = \int_{-\infty}^x f(t) dt$  passing through  $\left(0, \frac{1}{2}\right)$  and  $y = f(x)$ , ( $f(x) > 0$  differentiable  $\forall x \in \mathbb{R}$ ) passing through  $(0, 1)$ . If tangents drawn to both the curves at the points with equal abscissa intersect at same point on x-axis, then

15. Number of solution of  $f(x) = 2ex$  is  
(A) 0  
(B) 1  
(C) 2  
(D) none of these

#### Rough work

16.  $\lim_{x \rightarrow \infty} (f(x))^{f(-x)}$  is equal to  
 (A) 3 (B) 6  
 (C) 1 (D) none of these
17. Number of points of discontinuity of  $y = \{f(x)\}$ , in  $[-1, \ln 2]$ , where  $\{.\}$  denotes fractional part, is  
 (A) 3 (B) 4  
 (C) 5 (D) 6

**Paragraph for Question Nos. 18 to 20**

**Read the following write up carefully and answer the following questions:**

Let  $x \in \mathbb{R}^+$  such that  $3[x]$ ,  $6\{x\}$ ,  $2x$  form a G.P., where  $[.]$  denotes the greatest integer function and  $\{.\}$  denotes the fractional part function.

18. Common ratio of the G.P. is  
 (A)  $\frac{1}{2}$  (B) 1  
 (C)  $\frac{4}{3}$  (D) 2
19. The value of  $x$  is  
 (A)  $\frac{3}{2}$  (B)  $\frac{9}{2}$   
 (C) 2 (D) 2
20. Sum of the terms of the G.P. is  
 (A)  $\frac{13}{2}$  (B)  $\frac{17}{2}$   
 (C) 9 (D) 5

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**Rough work**

**Paragraph for Question Nos. 21 to 23**

Read the following write up carefully and answer the following questions:

For  $x \in \left(0, \frac{\pi}{2}\right)$ , let  $f_n(x) = \int n \sin 2x (\sin^{2n-2} x - \cos^{2n-2} x) dx - \frac{1}{2^{n-1}}$ ,  $n \in \mathbb{N}$  and  $f_n\left(\frac{\pi}{4}\right) = \frac{1}{(2^{n-1})}$

21. The derivative of  $f_n(x)$  where  $n = 2$  and  $x = \frac{\pi}{3}$  is
- (A) 1 (B)  $\frac{\sqrt{3}}{2}$   
 (C) 0 (D)  $\frac{1}{2}$
22. If  $g(x) = \lim_{n \rightarrow \infty} \sum_{n=1}^n f_n(x)$ , then minimum value of  $g(x)$  is
- (A) 1 (B) 2  
 (C) 3 (D) 4
23. If  $n = \lim_{t \rightarrow -\infty} [\cot^{-1} t]$ , then  $\int \frac{f_n(x)}{\sin^2 x \cos^2 x} dx$  equals, where  $[\cdot]$  denotes the greater integer function
- (A)  $\tan x - \cot x + 3x + c$  (B)  $\tan x - \cot x - 3x + c$   
 (C)  $\tan x + \cot x - 3x + c$  (D)  $\tan x + \cot x + 3x + c$

**Rough work**