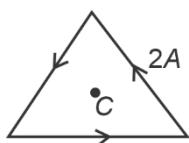




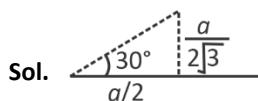


4. In equilateral triangular frame, then is current of  $2A$ . The side of frame is  $4\sqrt{3}$  cm. Magnetic field at center C is



(1)  $30\sqrt{3} \mu T$       (2)  $10\sqrt{3} \mu T$   
 (3)  $3\sqrt{10} \mu T$       (4)  $10\sqrt{10} \mu T$

**Answer (1)**

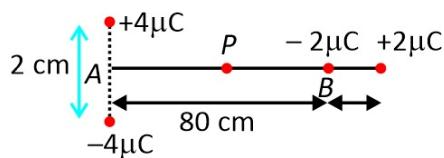


$$B = \frac{\mu_0 I \times 2 \times Cu 30^\circ}{4\pi \left\{ \frac{a}{2\sqrt{3}} \right\}}$$

$$B = \frac{\mu_0 \sqrt{3}}{2\pi \times 2 \times 10^{-2}} = 10^{-5};$$

$$B_{\text{net}} = 3\sqrt{3} \times 10^{-5}$$

5. Four charges are kept as shown in the figure. Find magnitude of electric field at point P. P is midpoint of line AB.



(1)  $180 \text{ kV/m}$       (2)  $\frac{45\sqrt{5}}{8} \text{ kV/m}$   
 (3)  $270 \text{ kV/m}$       (4)  $60\sqrt{3} \text{ kV/m}$

**Answer (2)**

Sol.  $P_1 = 8 \times 10^{-8}$        $P_2 = 2 \times 10^{-8}$

$$E_1 = \frac{kP_1}{r^3} = E_2$$

$$E_1 = \frac{9 \times 10^9 \times 8 \times 10^{-8}}{64 \times 10^3}, E_2 = \frac{9 \times 10^9 \times 2 \times 10^{-8}}{64 \times 10^3}$$

$$= \frac{9}{8} \times 10^4 = \frac{9}{16} \times 10^4$$

$$E = \frac{9}{16} \sqrt{5} \times 10^4 = \frac{45\sqrt{5}}{8} \times 10^3$$

6. One mole of diatomic gas is expanding isothermally from  $V$  to  $2V$  at  $27^\circ\text{C}$ . If the magnitude of work done by the gas in this case is same as the work done in adiabatic process where initial temperature is  $27^\circ\text{C}$  and final temperature is  $T^\circ\text{C}$ . Find the value of  $T$ . [Use  $\ln 2 = 0.7$ ]

(1)  $-37^\circ\text{C}$       (2)  $-57^\circ\text{C}$   
 (3)  $-35^\circ\text{C}$       (4)  $0^\circ\text{C}$

**Answer (2)**

Sol.  $\Delta w_1 = NRT \ln(2) = 300R \ln(2)$

$$\Delta w_2 = N \frac{5}{2} R(T_i - T)$$

$$\Rightarrow \frac{5}{2} R(300 - T) = 300R \ln(2)$$

$$\Rightarrow 300 - T = 120 \ln(2) \quad [\ln 2 = 0.7]$$

$$\Rightarrow 300 - 84 = T = 216 \text{ K}$$

$$\Rightarrow T = -57^\circ\text{C}$$

7. Find the truth table for the given circuit.



		$A$	$B$	$Y$
(1)		0	0	1
		0	1	1
		1	0	0
		1	1	0
$A$	$B$	$Y$		
0	0	1	(2)	$A$
0	1	0		0
1	0	1		1
1	1	1		1

		$A$	$B$	$Y$
(3)		0	0	1
		0	1	0
		1	0	1
		1	1	0
$A$	$B$	$Y$	(4)	$A$
0	0	1		0
0	1	0		1
1	0	0		1
1	1	1		1

**Answer (1)**

Sol.  $\overline{A \cdot (A+B)}$

$$\overline{A} + \overline{(A+B)}$$

$$\overline{A} + \overline{A} \cdot \overline{B} = \overline{A}$$

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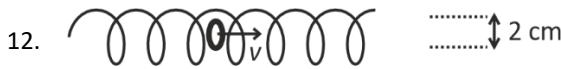


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In a long solenoid of cross-section radius of 2 cm and of 500/cm turns density. A ring moves with constant speed 10 cm/s with axis coinciding with axis of solenoid. The radius and resistance of ring is 1 cm and  $10\Omega$ . Find heat dissipated in ring while it transverses 10 cm of distance. The current in solenoid is  $I = 10 \cos(100\pi t)$

(1) 300  $\mu\text{J}$       (2) 200  $\mu\text{J}$   
 (3) 700  $\mu\text{J}$       (4) 850  $\mu\text{J}$

**Answer (2)**

**Sol.**  $\phi = BA$

$$\phi = \mu_0 n i A$$

$$\begin{aligned} \varepsilon &= -\mu_0 n A \frac{di}{dt} = \mu_0 n A i_0 \omega \sin \omega t \\ \int P dt &= \int \frac{\mu_0^2 n^2 A^2 i_0^2 \omega^2}{R} \sin^2 \omega t dt \\ &= \frac{\mu_0^2 n^2 A^2 i_0^2 \omega^2}{R} \times \frac{1}{2} \\ &= \frac{(4\pi \times 10^{-7})^2 \times (50000)^2 (\pi \times 10^{-4})^2 100 \times 10^4 \times \pi^2}{10 \times 2} \\ &= \frac{16}{2} \times 10 \times 10^{-14} \times 25 \times 10^8 \times 10 \times 10^{-8} \times 10^6 \times \frac{10}{10} \\ &= \frac{400}{2} \times 10^{1-14+8+1-8+6} \\ &= \frac{400}{2} \times 10^{-6} \text{ J} \\ &= 200 \times 10^{-6} \end{aligned}$$

13. A small spherical ball of diameter 2 mm & density 10.5 gm/cc is dropped into a large column of viscous liquid. The density of liquid is 1.5 gm/cc and coefficient of viscosity is 10 poise calculate the terminal velocity ( $g = 10 \text{ m/s}^2$ ).

(1) 1 cm/s      (2) 2 cm/s  
 (3) 3.5 cm/s      (4) 1.5 cm/s

**Answer (2)**

$$\text{Sol. } V_t = \frac{2 r^2 g}{9 \eta} (\sigma - \rho)$$

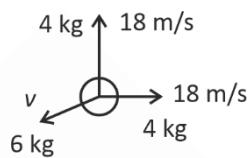
$$= 20 \times 10^{-3} \text{ m/s} = 2 \times 10^{-2} \text{ m/s}$$

14. A mass of 14 kg is exploded into three fragments of 2 : 2 : 3 and both equal fragments fly off with same speed 18 m/s in mutually perpendicular direction. Then find the speed of the third fragment immediately after the explosion.

(1)  $12\sqrt{2}$       (2)  $6\sqrt{2}$   
 (3)  $8\sqrt{2}$       (4)  $10\sqrt{2}$

**Answer (1)**

**Sol.**



$$\vec{P}_1 + \vec{P}_2 + \vec{P}_3 = 0$$

$$\vec{P}_1 + \vec{P}_2 = \vec{P}_3$$

$$\Rightarrow 6 \times v = \sqrt{2} \times 72$$

$$V = 12\sqrt{2} \text{ m/s}$$

15. Speed of sound in air at  $0^\circ\text{C}$  is  $v$ . Then at what temperature ( $^\circ\text{C}$ ) the speed of sound becomes  $2v$ ?

(1) 732 $^\circ\text{C}$       (2) 1092 $^\circ\text{C}$   
 (3) 975 $^\circ\text{C}$       (4) 819 $^\circ\text{C}$

**Answer (4)**

$$\text{Sol. } v = \sqrt{CT}$$

$$\text{So } \frac{v}{v'} = \sqrt{\frac{T}{T'}}$$

$$\Rightarrow \frac{v}{v'} = \sqrt{\frac{273}{T}} = \frac{1}{2}$$

$$\Rightarrow T = 273 \times 4 = 1092 \text{ K}$$

$$\text{So, } T = 819^\circ\text{C}$$

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16. There is electric field in space given as  $\vec{E} = \frac{A}{r^2} \hat{r}$  ( $A$  is constant). There are two point charges of  $-2 \mu\text{C}$  and  $7 \mu\text{C}$  present at  $(9, 0, 0)$  and  $(-9, 0, 0)$  respectively. If electric potential energy of system is zero then  $A$  in SI units is

- $0.63 \times 10^{+3}$
- $-0.325$
- $1.26 \times 10^4$
- $0.325$

**Answer (3)**

**Sol.**  $\frac{Kq}{r^2} = \frac{A}{r^2}$

$$q = \frac{A}{k}$$

$$U = \sum \frac{kq_i q_j}{r_{ij}}$$

$$U = \frac{K(-14) \times 10^{-12}}{18} + K(5) \frac{A}{k \cdot g}$$

$$= \frac{9 \times 10^9 \times 10^{-12}}{18} + K(5) \frac{A}{k \cdot g}$$

$$U = -7 \times 10^{-3} + \frac{5A \times 10^{-6}}{9}$$

$$10^6 \times \frac{63}{5} \times 10^{-3} = A$$

$$12.6 \times 10^{+3} = A$$

17. Fission of single nucleus of U-235 liberates energy of 96 MeV. Energy released by fission of 47 gm of uranium is \_\_\_\_\_.

- $1.84 \times 10^{12} \text{ J}$
- $3.28 \times 10^9 \text{ J}$
- $1.42 \times 10^{15} \text{ J}$
- $3.21 \times 10^{14} \text{ J}$

**Answer (1)**

**Sol.** Moles =  $\frac{47}{235} = \frac{1}{5}$  mole

$$N = \frac{6 \times 10^{23}}{5}$$

$$E = NE = \frac{6 \times 10^{23}}{5} \times 96 \times 10^6 \times 1.6 \times 10^{-19}$$

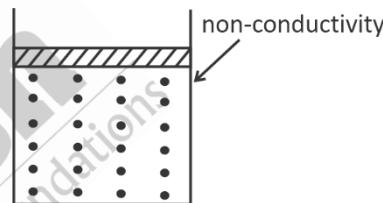
$$= \frac{6 \times 96 \times 1.6}{5} = 10^{10}$$

$$= 1.84 \times 10^{12} \text{ J}$$

18. 1 mole of gas is enclosed in a vertical cylinder and sealed with a massless frictionless piston as shown. On supplying 126 J of heat its temperature raised by  $4^\circ\text{C}$ . Find the height moved by piston due to the heat transfer. Internal energy of the gas is given by  $U = 3nRT$  ( $P = 10^5 \text{ N/m}^2$ )

$$(R = 8.3 \text{ J/K})$$

$$(A_{\text{piston}} = 17 \text{ cm}^2)$$



- 12.50 cm

- 13.50 cm

- 14.50 cm

- 15.50 cm

**Answer (4)**

**Sol.**  $\Delta Q = \Delta U + P\Delta V$

$$126 = 3 \times 8.3 \times 4 + 10^5 \times 16 \times 10^{-4} \times h$$

$$126 = 99.6 + 1.7 h \times 10^2$$

$$h = 15.53 \text{ cm}$$

19.

20.

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## SECTION - B

**Numerical Value Type Questions:** This section contains 5 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. If  $r$  = radius of ball

$\rho$  = density of liquid

$\sigma$  = density of ball

$t$  = time

$A$  = constant

$\eta$  = viscosity

For the expression  $t = A(\rho)^a (\sigma)^b r^c (\eta)^d$

Then the value of  $\frac{c-d}{a+b}$  is

## Answer (3)

$$\text{Sol. } T = \left( \frac{M}{L^3} \right)^{a+b} (L)^c (ML^{-1}T^{-1})^d$$

Let  $a+b = Z$

Then  $Z+d=0 \Rightarrow Z=-d$

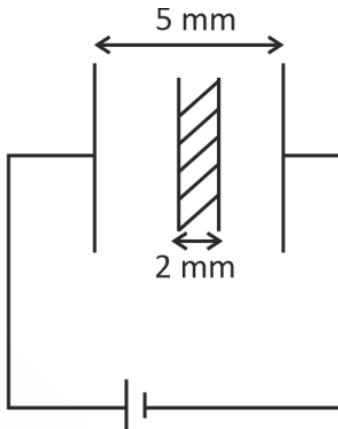
$c-3Z-d=0 \quad c-2Z=0 \Rightarrow c=2Z$

$-d=1; Z=1=(a+b)$

$c=2$

$$\text{So, } \frac{c-d}{(a+b)} = \frac{2+1}{1} = 3$$

22. An empty capacitor is charged with charge  $Q$  when attached with battery as shown. Now a mica sheet of 2 mm thickness is inserted and charge on capacitor  $\frac{5}{4}a$  then the dielectric constant of mica is \_\_\_\_.



## Answer (2)

$$\text{Sol. } \frac{Q_1}{Q_2} = \frac{C_1}{C_2} \quad \frac{Q}{5} = \frac{\frac{\epsilon_0 A}{d}}{\frac{\epsilon_0 A}{d-t+\frac{t}{K}}}$$

$$\Rightarrow \frac{4}{5} = \frac{3+\frac{2}{K}}{5} \Rightarrow K=2$$

23.

24.

25.

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## CHEMISTRY

### SECTION - A

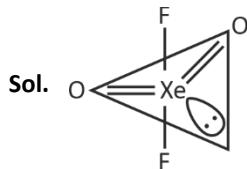
**Multiple Choice Questions:** This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

**Choose the correct answer :**

1. For  $\text{XeO}_2\text{F}_2$ , select the correct statement(s).
  - (A) It shows see-saw shape.
  - (B) Number of lone pair(s) of  $e^-$  on Xe is 1.
  - (C)  $\angle \text{FXeF} = 180^\circ$  (approx.)
  - (D) It has tetrahedral shape.

(1) (A), (C), (D) Only      (2) (A), (B) only  
 (3) (A), (B), (C) only      (4) (B), (C), (D) only

**Answer (3)**



2. Statement I : Size of  $\text{O}^{2-}$  is smaller than  $\text{F}^-$ .

Statement II : Electronegativity of F is more than that of oxygen.

In the light of above statements, choose the correct option.

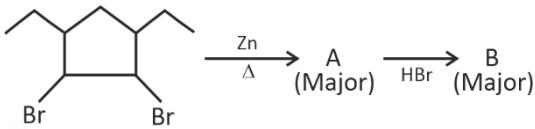
- (1) Both Statement I and Statement II are correct
- (2) Both Statement I and Statement II are incorrect
- (3) Statement I is correct but Statement II is incorrect
- (4) Statement I is incorrect but Statement II is correct

**Answer (4)**

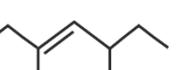
**Sol.** Number of proton in  $\text{O}^{2-}$  is 8 and number of proton in  $\text{F}^-$  is 9 (both have  $10e^-$ ). So,  $\text{O}^{2-}$  is larger than  $\text{F}^-$ . So, Statement I is false.

Statement II is true, F is smaller than O, so F is more electronegative than O.

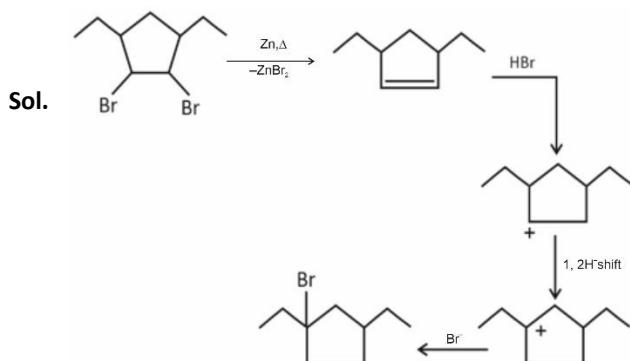
3. Consider the reaction,



Choose the correct option,

- (1) A is 
- (2) B is 
- (3) B is 
- (4) A is 

**Answer (3)**



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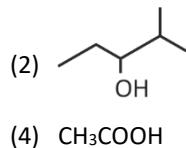
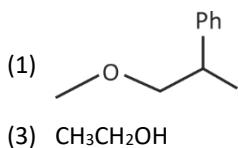
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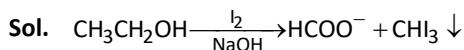
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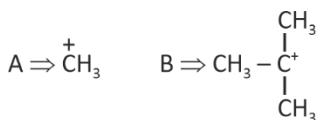
4. Which of the following molecule gives iodoform test.



**Answer (3)**

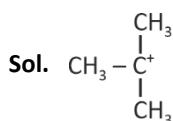


5. Consider the following intermediates.



(1) B is more stable than A as it has 9  $\alpha$  hydrogen  
 (2) A is more stable than B as it has 3  $\alpha$  hydrogen  
 (3) B is more stable than A due to resonance  
 (4) A is more stable due to inductive effect

**Answer (1)**



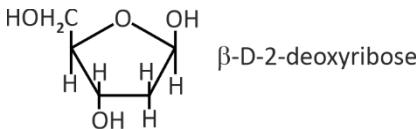
$\Rightarrow$  more stable as it has 9  $\alpha$ -H  
 $\Rightarrow$  +I effect is more than B than A

6. DNA is optically active due to the presence of

(1) Purine nitrogenous base  
 (2) Phosphate molecule  
 (3) D-pentose sugar  
 (4) L-pentose sugar

**Answer (3)**

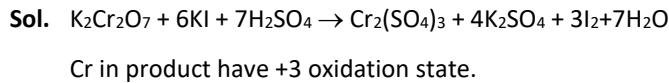
**Sol.** DNA is optically active due to D-pentose sugar.



7. What is the oxidation state of chromium in the product when  $\text{K}_2\text{Cr}_2\text{O}_7$  reacts with acidified KI

(1) +6      (2) +3  
 (3) +4      (4) +5

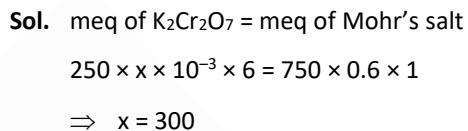
**Answer (2)**



8. 250 cc of  $x \times 10^{-3}$  M acidified  $\text{K}_2\text{Cr}_2\text{O}_7$  solution titrates 750 cc of 0.6 M Mohr's salt completely. Value of x is

(1) 200      (2) 600  
 (3) 400      (4) 300

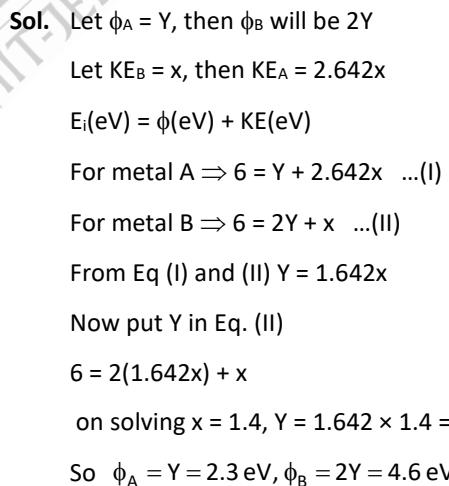
**Answer (4)**



9. Two metals with work function in ratio 1 : 2, are exposed with photons of energy 6 eV. If  $\text{KE}_A : \text{KE}_B$  is 2.642 : 1, then value of  $\phi_A$  and  $\phi_B$  (in eV) are

(1) 2.3, 4.6      (2) 1.4, 2.8  
 (3) 2.3, 3.6      (4) 3.2, 6.4

**Answer (1)**



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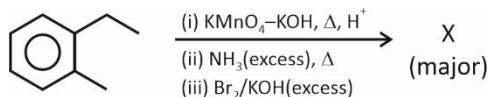
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10. Consider the reaction sequence :



X is,

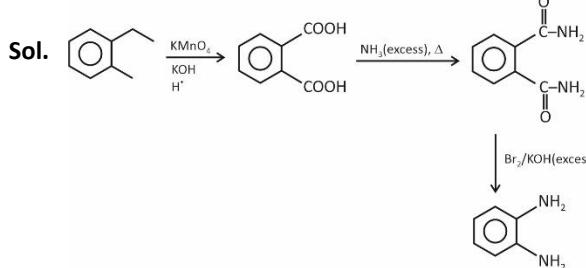
(1)

(2)

(3)

(4)

**Answer (3)**



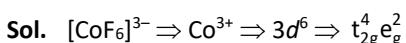
11. Consider the following statement about complexes and its hybridisation.

A.  $[\text{CoF}_6]^{3-}$ ; outer orbital complex,  $sp^3d^2$   
 B.  $[\text{Ni}(\text{CN})_4]^{2-}$ ; inner orbital complex;  $dsp^2$   
 C.  $[\text{Co}(\text{NH}_3)_6]^{3+}$ ; inner orbital complex;  $d^2sp^3$   
 D.  $[\text{FeF}_6]^{3-}$ ; outer orbital complex;  $sp^3d^2$

Choose the correct statement.

(1) A, B, C and D  
 (2) A, B and C only  
 (3) A and B only  
 (4) B and C only

**Answer (1)**



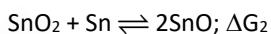
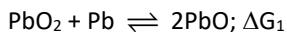
$\text{F}^-$  is WFL  $\Rightarrow sp^3d^2$ , outer orbital complex.

$[\text{Ni}(\text{CN})_4]^{2-} \Rightarrow \text{Ni}^{2+}$  with  $\text{CN}^- \Rightarrow$  SFL  $\Rightarrow dsp^2$ , inner orbital complex

$[\text{Co}(\text{NH}_3)_6]^{3+} \Rightarrow \text{Co}^{3+} \Rightarrow \text{NH}_3$  (SFL)  $\Rightarrow d^2sp^3$ , inner orbital complex

$[\text{FeF}_6]^{3-} \Rightarrow \text{Fe}^{3+} \Rightarrow \text{F}^-$  (WFL)  $sp^3d^2$ , outer orbital complex

12. Consider the following reactions



Select the correct option?

(1)  $\Delta G_1 > 0, \Delta G_2 > 0$   
 (2)  $\Delta G_1 < 0, \Delta G_2 > 0$   
 (3)  $\Delta G_1 < 0, \Delta G_2 < 0$   
 (4)  $\Delta G_1 > 0, \Delta G_2 < 0$

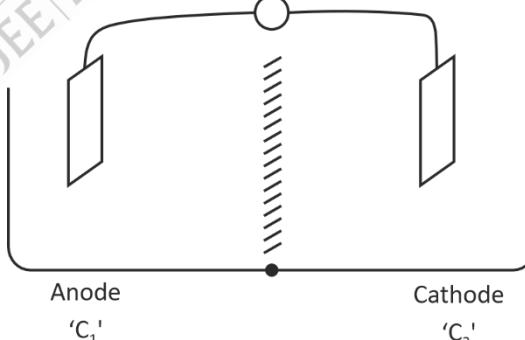
**Answer (2)**

**Sol.** Due to inert pair effect, Pb(II) is more stable than Pb(IV)

$\therefore \text{PbO} > \text{PbO}_2$  (stability)

$\text{SnO}_2 > \text{SnO}$  (stability)

13. Consider a galvanic cell, made up of two  $\text{H}_2$ -electrodes,



Both compartments contain the same metal electrodes. If concentrations of  $\text{H}^+$  in anode and cathode are  $C_1$  and  $C_2$  respectively, then  $E_{\text{cell}} > 0$  when, ( $p_{\text{H}_2} = 1$  atm in both compartments)

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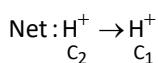
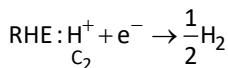
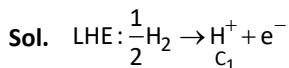


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(1)  $C_2 < C_1$   
 (2)  $C_2 = C_1$   
 (3)  $C_2 > C_1$   
 (4)  $C_2 = 0.5 C_1$

**Answer (3)**



$$E = E^\circ - \frac{0.0591}{1} \ln \frac{C_1}{C_2}$$

$$E_{\text{cell}} = 0.0591 \ln \frac{C_2}{C_1}$$

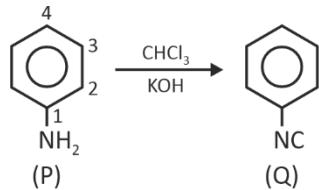
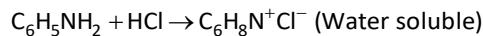
$C_2 > C_1$  for  $E_{\text{cell}} = +\text{ve.}$

14. A compound P with molecular formula  $C_6H_7N$  is sparingly soluble in water. However on reaction with HCl, it becomes soluble. On reaction with KOH +  $CHCl_3$ , it gives foul smelling compound Q. The number of different type(s) of H atoms present in P is

(1) 4  
 (2) 5  
 (3) 7  
 (4) 8

**Answer (1)**

**Sol.**  $C_6H_7N$  D.U. = 4



Foul smell

Number of different type of H = 4

15. X & Y are elements from group 15. The difference in electronegativity values of X and phosphorus is more than difference in electronegativity of phosphorus and Y. Element X and Y respectively are

(1) N and As  
 (2) As and Sb  
 (3) As and N  
 (4) As and Bi

**Answer (1)**

**Sol.** EN of N = 3.0

P = 2.1

As = 2.0

Sb = 1.9

Bi = 1.9

$\Delta EN(N \text{ and } P) = 0.9$

$\Delta EN(As \text{ and } P) = 0.1$

$\Delta EN(Sb \text{ and } P) = 0.2$

$\Delta EN(Bi \text{ and } P) = 0.2$

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16. Given below are two statements.

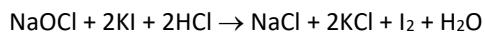
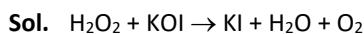
**Statement I:** Potassium hypoiodite (KOI) can act as a reducing agent in reaction with  $\text{H}_2\text{O}_2$ .

**Statement II:** When  $\text{NaOCl}$  reacts with  $\text{KI}$  in acidic medium,  $\text{NaOCl}$  acts as oxidising agent.

In the light of above statements, choose the correct option.

- Both statement I and statement II are correct
- Both statement I and statement II are incorrect
- Statement I is correct but statement II is incorrect
- Statement I is incorrect but statement II is correct

**Answer (1)**



17.

18.

19.

20.

### SECTION - B

**Numerical Value Type Questions:** This section contains 5 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

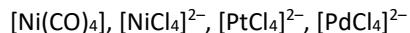
21. In estimation of chlorine by Carius method, 0.245 g organic compound gave 0.5453 g  $\text{AgCl}$ . Find percentage of chlorine in the organic compound

**Answer (55)**

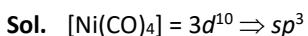
**Sol.** 
$$\% \text{ of Cl} = \frac{\frac{0.5453}{0.245} \times 35.5}{143.5} \times 100$$

$$= 55.06\%$$

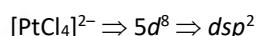
22. How many of the following complex(es) have unpaired electrons



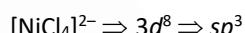
**Answer (1)**



$$n = 0$$



$$n = 0$$



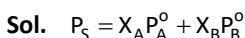
$$n = 2$$



$$n = 0$$

23. An ideal solution is formed by mixing 3 mole of A and 1 mole of B and the vapour pressure of solution is found to be 500 mm Hg. After further addition of 1 mole A, vapour pressure of solution becomes 520 mm Hg. Find  $P_A^0$ .

**Answer (600)**



$$500 = \frac{3}{4} \times P_A^0 + \frac{1}{4} \times P_B^0$$

$$2000 = 3P_A^0 + P_B^0 \quad \dots(i)$$

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After adding 1 mole of A,

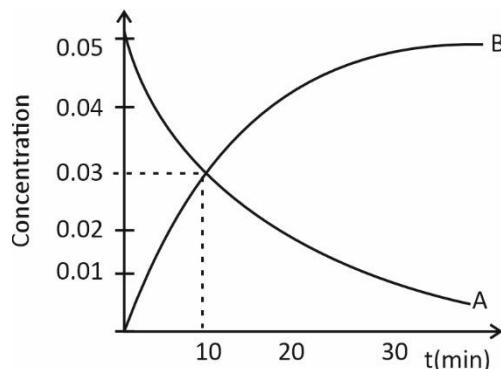
$$520 = \frac{4}{5}P_A^0 + \frac{P_B^0}{5}$$

$$2600 = 4P_A^0 + P_B^0 \quad \dots \text{(ii)}$$

$$\text{(ii)} - \text{(i)} \Rightarrow 600 \text{ mm} = P_A^0$$

24. For a reaction  $A \xrightarrow{\text{(g)}} nB \xrightarrow{\text{(g)}}$ , a concentration vs. time

curve is,



Find 10 n

**Answer (15)**

**Sol.** For the reaction,

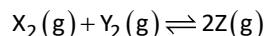
$$-\frac{dA}{dt} = +\frac{1}{n} \frac{dB}{dt}$$

$$\frac{0.05 - 0.03}{10} = \frac{1}{n} \left( \frac{0.03 - 0}{10} \right)$$

$$\frac{0.02}{0.03} = \frac{1}{n}$$

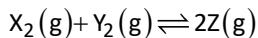
$$n = 1.5$$

25. Consider the following reaction



3 mol of  $X_2$ , 3 mol of  $Y_2$  and 9 mol of  $Z$  are present at equilibrium and the volume of container is 1L. If 10 mol of  $Z$  is added at equilibrium, calculate the number of moles of  $Z$  at new equilibrium

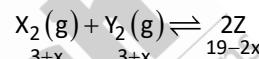
**Answer (15)**



**Sol.** at eq<sup>n</sup> 3 mol 3 mol 9 mol

$$K_{\text{eq}} = \frac{(9)^2}{3 \times 3} = \frac{9 \times 9}{3 \times 3} = 9$$

when 10 mol of  $Z$  is added reaction moves in backward direction



$$9 = \frac{(19 - 2x)^2}{(3+x)^2}$$

$$3 = \frac{19 - 2x}{3+x}$$

$$9 + 3x = 19 - 2x$$

$$5x = 10$$

$$x = \frac{10}{5} = 2$$

moles of  $Z$  at new equilibrium

$$= 19 - 2 \times 2$$

$$= 15$$

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## MATHEMATICS

### SECTION - A

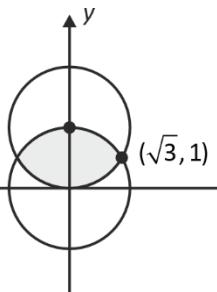
**Multiple Choice Questions:** This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

**Choose the correct answer :**

1. The area (in square units) between the curves  $x^2 + y^2 = 4$  and  $x^2 + (y - 2)^2 = 4$  is

(1)  $\frac{8\pi}{3} - 2\sqrt{3}$       (2)  $\frac{8\pi}{3} + \sqrt{3}$   
 (3)  $\frac{4\pi}{3} - 2\sqrt{3}$       (4)  $\frac{4\pi}{3} + 2\sqrt{3}$

**Answer (1)**



**Sol.**

$$\begin{aligned}
 A &= 2 \int_0^{\sqrt{3}} \left( \sqrt{4-x^2} - (2 - \sqrt{4-x^2}) \right) dx \\
 &= 2 \left[ \left| x\sqrt{4-x^2} + 4 \sin^{-1} \left( \frac{x}{2} \right) \right|_0^{\sqrt{3}} - 2(\sqrt{3}) \right] \\
 &= 4 \left( \frac{2\pi}{3} - \frac{\sqrt{3}}{2} \right) \text{ sq. units} = \frac{8\pi}{3}
 \end{aligned}$$

2. Number of ways to distribute 6 identical oranges among 4 persons such that each gets at least one orange is

(1) 8  
 (2) 10  
 (3) 12  
 (4) 13

**Answer (2)**

$$\text{Sol. } x_1 + x_2 + x_3 + x_4 = 6, \quad x_i \geq 1$$

$$\Rightarrow x'_1 + x'_2 + x'_3 + x'_4 = 2 \quad x'_i \geq 0$$

$$\Rightarrow \text{Number of ways} = {}^{2+4-1}C_{4-1}$$

$$= {}^5C_3 = 10 \text{ ways}$$

3. The minimum value of  $\cos^2 \theta + 6\sin\theta\cos\theta + 3\sin^2 \theta + 3$

(1) -1      (2) 1  
 (3)  $5 + \sqrt{10}$       (4)  $5 - \sqrt{10}$

**Answer (4)**

$$\text{Sol. } \cos^2 \theta + 6\sin\theta\cos\theta + 3\sin^2 \theta + 3$$

$$4 + 3\sin 2\theta + 2\sin^2 \theta$$

$$4 + 3\sin 2\theta + 1 - \cos 2\theta$$

$$E = 5 + 3\sin 2\theta - \cos 2\theta$$

$$E_{\min} = 5 - \sqrt{10}$$

4. Let  $A = \{1, 2, 3, \dots, 9\}$ ;  $xRy$  iff  $x - y$  is multiple of 3.

$S_1$  : Number of elements in  $R$  is 36

$S_2$  :  $R$  is equivalence relation

(1)  $S_1$  &  $S_2$  both are correct  
 (2)  $S_1$  is correct but  $S_2$  is not correct  
 (3)  $S_2$  is correct but  $S_1$  is not correct  
 (4)  $S_1$  &  $S_2$  both are incorrect

**Answer (3)**

**Sol.**  $S_1 : (x, y) \equiv (3k_1, k_2) \text{ OR } (3k_1 + 1, 3k_2 + 1) \text{ OR } (3k_1 + 2, 3k_2 + 2)$

$$\equiv 3 \times 3 + 3 \times 3 + 3 \times 3$$

$$= 27 \text{ elements}$$

$S_1$  is incorrect.

$R$  is reflexive, symmetric as well as transitive relation.

$$\text{as } (x, x) \in R \quad \forall x \in A$$

$$(x, y) \in R \rightarrow (y, x) \in R$$

$$(x, y) \in R \text{ and } (y, z) \in R \Rightarrow (x, z) \in R.$$

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### JEE (MAIN)

5. Let there are 2 bags A and B. Bag A has 9 white, 8 black balls and bag B has 6 white balls, 4 black balls. From a bag B, a ball is randomly selected and put into the bag A. Now, a ball is randomly selected from bag A. If the

probability that selected ball is white is  $\frac{p}{q}$ ,  $\gcd(p, q)$

= 1, then  $p + q$  is equal to

(1) 21

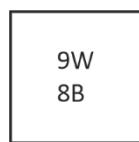
(2) 23

(3) 22

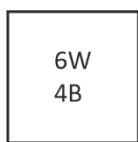
(4) 24

**Answer (2)**

**Sol.**



Bag A



Bag B

A : probability of getting white from bag A

$B_w$  : probability of getting white from bag B

$B_b$  : probability of getting black from bag B

$$P\left(\frac{A}{B_w \cup B_b}\right) = P(B_w)P\left(\frac{A}{B_w}\right) + P(B_b)P\left(\frac{A}{B_b}\right)$$

$$= \frac{6}{10} \times \frac{10}{18} + \frac{4}{10} \times \frac{9}{18}$$

$$= \frac{60+36}{180} = \frac{96}{180} = \frac{8}{15}$$

6. The value of  $\int \frac{dx}{(4x+6)\sqrt{4x^2+12x+7}}$  is equal to

$$(1) \frac{\sqrt{2}}{8} \tan^{-1}\left(\frac{4x^2+12x+7}{\sqrt{2}}\right) + c$$

$$(2) \frac{\sqrt{2}}{8} \tan^{-1}(4x^2+12x+7) + c$$

$$(3) \frac{1}{2} \tan^{-1}\left(\frac{4x^2+12x+7}{2}\right) + c$$

$$(4) \frac{\sqrt{2}}{4} \tan^{-1}\left(\frac{4x^2+12x+7}{\sqrt{2}}\right) + c$$

**Answer (1)**

**Sol.**  $I = \int \frac{(2x+3)}{2 \cdot (2x+3)^2 \sqrt{4x^2+12x+7}} dx$

$$\text{Let } 4x^2+12x+7 = t^2$$

$$\therefore (2x+3)dx = \frac{2tdt}{4}$$

$$\therefore I = \int \frac{2t dt}{8 \cdot (4x^2+12x+9)t} = \int \frac{dt}{4(t^2+2)}$$

$$= \frac{1}{4} \frac{1}{\sqrt{2}} \tan^{-1}\left(\frac{t}{\sqrt{2}}\right)$$

$$\therefore I = \frac{\sqrt{2}}{8} \tan^{-1}\left(\frac{4x^2+12x+7}{\sqrt{2}}\right) + c$$

7. Let A and B are points on parabola  $y^2 = 4x$  such that OAB is an equilateral triangle such that O is the vertex of parabola and AB is perpendicular to axis of parabola, then the minimum distance of circle as A and B as diametric points from the point O is

$$(1) 4(3+\sqrt{3})$$

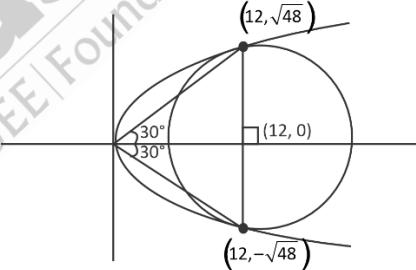
$$(2) 4(3-\sqrt{3})$$

$$(3) 4(2-\sqrt{3})$$

$$(4) 4(2+\sqrt{3})$$

**Answer (2)**

**Sol.**



$\Rightarrow$  circle is

$$(x-12)^2 + (y-\sqrt{48})(y+\sqrt{48}) = 0$$

$$\Rightarrow (x-12)^2 + y^2 = 48 \quad \Rightarrow \text{radius} = 4\sqrt{3}$$

Minimum distance is  $12 - \sqrt{48}$

$$= 4(3-\sqrt{3})$$

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8. The mean and variance of following data is  $\mu$  and 19, respectively.

Class interval	4 – 8	8 – 12	12 – 16	16 – 20
$f$ (frequency)	3	$\lambda$	4	7

The value of  $\lambda + \mu$  is

(1) 19 (2) 20  
(3) 13 (4) 17

**Answer (1)**

$$\text{Sol. } \mu = \frac{3 \times 6 + \lambda \times 10 + 4 \times 14 + 7 \times 18}{14 + \lambda} = \frac{10\lambda + 200}{14 + \lambda}$$

$$19 = \sigma^2 = \frac{3 \times 6^2 + \lambda(10)^2 + 4(14)^2 + 7(18)^2}{14 + \lambda} - \left( \frac{10\lambda + 200}{14 + \lambda} \right)^2$$

$$\Rightarrow \lambda = 6$$

$$\mu = 13$$

$$\lambda + \mu = 19$$

9. If  $\vec{a}, \vec{b}$  and  $\vec{c}$  are such that  $\vec{a} \times \vec{b} = 2(\vec{a} \times \vec{c})$  and angle between  $\vec{b}$  and  $\vec{c}$  is  $60^\circ$ , if  $|\vec{a}| = 1, |\vec{b}| = 4, |\vec{c}| = 3$ , then  $|\vec{a} \cdot \vec{c}|$  is

(1)  $\frac{3}{\sqrt{7}}$  (2)  $\frac{5}{\sqrt{7}}$   
(3)  $\frac{6}{\sqrt{7}}$  (4)  $\frac{9}{\sqrt{7}}$

**Answer (3)**

$$\text{Sol. } \because \vec{a} \times \vec{b} = 2\vec{a} \times \vec{c}$$

$$\therefore \vec{a} \times (\vec{b} - 2\vec{c}) = 0$$

$$\therefore \vec{b} - 2\vec{c} = \lambda \vec{a} \quad \dots(1) \text{ (where } \lambda \in \mathbb{R} \text{ )}$$

$$\text{and } \vec{b} \cdot \vec{c} = |\vec{b}| |\vec{c}| \cos 60^\circ = 6 \dots (2)$$

Squaring both sides of equation (1) we get :

$$|\vec{b}|^2 + 4|\vec{c}|^2 - 4\vec{b} \cdot \vec{c} = \lambda^2 |\vec{a}|^2$$

$$\therefore \lambda^2 = 16 + 36 - 24 = 28$$

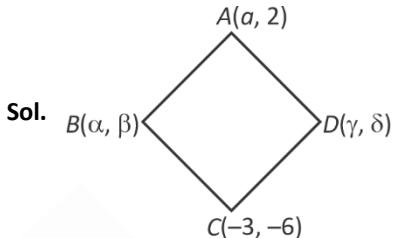
from (1) :  $\vec{b} \cdot \vec{c} - 2\vec{c} \cdot \vec{c} = \lambda \vec{a} \cdot \vec{c}$

$$\therefore |\vec{a} \cdot \vec{c}| = \frac{1}{\pm \sqrt{28}} (6 - 18) = \frac{12}{\sqrt{28}} = \frac{6}{\sqrt{7}}$$

10. Let  $A, B, C, D$  be rhombus with  $A(a, 2), B(\alpha, \beta), C(-3, -6)$  and  $D(\gamma, \delta)$ , then the value of  $|\alpha + \beta + \gamma + \delta|$  is if  $AC$  is parallel to  $y = 2x + 14$  is

(1) 0 (2) 1  
(3) 6 (4) 9

**Answer (3)**



$\therefore AC$  is parallel to  $y = 2x + 14$

$$\Rightarrow \frac{8}{a+3} = 2 \Rightarrow a = 1$$

$$\text{Now } \frac{1-3}{2} = \frac{\alpha+\gamma}{2} \Rightarrow \alpha + \gamma = -2$$

$$\frac{2-6}{2} = \frac{\beta+\delta}{2} \Rightarrow \beta + \delta = -4$$

$$|\alpha + \beta + \gamma + \delta| = 6$$

11.

12.

13.

14.

15.

16.

17.

18.

19.

20.

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**SECTION - B**

**Numerical Value Type Questions:** This section contains 5 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. If  $A = \begin{bmatrix} 0 & 2 & -3 \\ -2 & 0 & -1 \\ 3 & 1 & 0 \end{bmatrix}$  and if  $B(I - A) = (I + A)$ , where  $I$  is identity matrix of order 3, then trace of  $(BB^T)$  is

**Answer (03.00)**

**Sol.**  $B(I - A) = (I + A)$

Since  $A$  is skew symmetric matrix

$$\Rightarrow A^T = -A \text{ since, } B^T(I - A^T) = (I + A^T)$$

$$\Rightarrow B^T(I + A) = (I - A)$$

$$\Rightarrow BB^T(I + A) = B(I - A) = (I + A)$$

$$\Rightarrow BB^T(I + A)(I + A)^{-1} = (I + A)(I + A)^{-1}$$

$$= I_{3 \times 3}$$

$$\Rightarrow \text{Trace}(BB^T) = 3$$

22.  $S = \text{No. of 4-digit numbers } abcd \text{ where product of digits is 20}$

$P = \text{No. of 5-digit number } abcde \text{ where product of digits is 20, then}$

$S + P$  is equal to

**Answer (74)**

**Sol.**  $\{a, b, c, d\}$

$$\text{Digits : } 5, 4, 1, 1 \Rightarrow \text{No. of arrangement} \Rightarrow \frac{4!}{2!} = 12$$

$$5, 2, 2, 1 \Rightarrow \text{No. of arrangement} \Rightarrow \frac{4!}{2!} = 12$$

$$\Rightarrow S = 12 + 12 = 24$$

$$\{a, b, c, d, e\}$$

$$\text{Digits : } 5, 4, 1, 1, 1 \Rightarrow \text{No. of arrangement} \Rightarrow \frac{5!}{3!} = 20$$

$$5, 2, 2, 1, 1 \Rightarrow \text{No. of arrangement} \Rightarrow \frac{5!}{2!2!} = 30$$

$$\Rightarrow P = 20 + 30 = 50$$

$$S + P = 74$$

23. Let  $S$  be the set defined as

$$S = \left\{ x : \int_0^x t^2 \sin(t-x) dt = x^2 \text{ and } x \in [0, 1000] \right\}, \text{ then}$$

number of elements in  $S$  is

**Answer (1)**

**Sol.** Let  $I = \int_0^x t^2 \sin(t-x) dt$

$$= \int_0^x (x-t)^2 \sin((x-t)-x) dt$$

$$= -x^2 \int_0^x (\sin t) dt + 2x \int_0^x t \sin t dt - \int_0^x t^2 \sin t dt$$

$$= -x^2(-\cos t) \Big|_0^x + 2x(\sin t - t \cos t) \Big|_0^x$$

$$- (2t \sin t + (2-t^2) \cos t) \Big|_0^x$$

$$= x^2 \cos x - x^2 + 2x(\sin x - x \cos x)$$

$$- 2x \sin x + (x^2 - 2) \cos x + 2$$

$$= x^2 \cos x - x^2 + 2x \sin x - 2x^2 \cos x - 2x \sin x$$

$$+ x^2 \cos x - 2 \cos x + 2$$

$$= -x^2 - 2 \cos x + 2$$

$$\Rightarrow -x^2 - 2 \cos x + 2 = x^2 \Rightarrow 2(1 - \cos x) = 2x^2$$

$$\Rightarrow 2 \sin^2 \frac{x}{2} = x^2 \Rightarrow x = 0 \text{ only solution}$$

24. The number of solutions of the equation

$$\log_{(x-3)}(2x^2 - 7x + 3) = 2 \log_{(2x-1)}(x-3)$$

**Answer (1)**

**Sol.**  $\log_{(x-3)}(2x^2 - 7x + 3) = 2 \log_{(2x-1)}(x-3)$

or,

$$\log_{(x-3)}(x-3)(2x-1) = 2 \log_{(2x-1)}(x-3)$$

or,

$$1 + \log_{(x-3)}(2x-1) = 2 \log_{(2x-1)}(x-3)$$

Let  $\log_{(x-3)}(2x-1) = y$

$$\therefore 1 + y = \frac{2}{y}$$

$$\text{Or, } y^2 + y - 2 = 0$$

$$\therefore \log_{(x-3)}(2x-1) = 1, -2$$

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$$\therefore 2x - 1 = x - 3$$

$\therefore x = -2$  not acceptable.

$$\text{and } 2x - 1 = (x - 3)^2$$

$$\therefore (2x - 1)(x - 3)^2 = 1$$

By solving we get :

$$(2x - 5)(x^2 - 4x + 2) = 0$$

$$\therefore x = \frac{5}{2}, 2 + \sqrt{2}, 2 - \sqrt{2}$$

Only  $x = 2 + \sqrt{2}$  satisfy the equations

$\therefore$  Number of solutions = 1.

25. If a sequence  $\{a_n\}$  satisfy the relation  $\sum_{k=1}^n a_k = \alpha n^2 + \beta n$ , and  $a_{10} = 56$  and  $a_6 = 2a$ , then  $(\alpha + \beta)$  is equal to

**Answer (20)**

$$\text{Sol. } \sum_{k=1}^n a_k = \alpha n^2 + \beta n$$

$$a_{10} = 56 = a + 9d$$

$$a_6 = 2a_1 \Rightarrow a + 5d = 2a$$

$$= a + 5d$$

$$\Rightarrow 14d = 56 \Rightarrow d = 4 \text{ and } a = 20$$

$$\sum_{k=1}^n a_k = \frac{n}{2} (2 \times 20 + (n-1)4)$$

$$= 20n + 2(n)(n-1)$$

$$= 2n^2 + 18n$$

$$\Rightarrow \alpha = 2, \beta = 18 \Rightarrow \alpha + \beta = 20$$



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