

**M. Prakash Institute Entrance Examination  
for IIT JEE Training Batch 2021-23**

February 7, 2021

6.00 pm to 9.00 pm

Total marks: 150

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**Chemistry**

**Useful data:**

Atomic numbers: H:1, C:6, N:7, O:8, F:9, Na:11, Mg:12, Al:13, Si:14, P:15, S:16, Cl:17, K:19, Mn:25, Fe:26, Cu:29, Zn:30, Br:35, Sn:50, I:53, Ba:56, Pb:82, Th:90  
Atomic Masses: H:1, He:4, Li:7, C:12, N:14, O:16, F:19, Na (Sodium): 23, Mg:24, Al:27, P:31, S:32, Cl: 35.5, K (Potassium):39, Ca:40, Fe (Iron): 56, Ti: 48, Mn:55, Cu (Copper): 63.5, Br:80, Sr: 88, Ag: 108, Au (Gold): 197, Pb:207, Bi: 209, Th:231

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**1** A compound ' $A_xB_y$ ' is formed by the combination of the elements belong to following groups and periods in modern periodic table.

(a) Element ' $A$ ' belongs to  $2^{nd}$  group and  $3^{rd}$  period.

(b) Element ' $B$ ' is the most electronegative element.

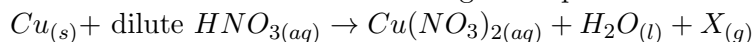
Find the molecular formula of the compound and write its molar mass.

**2** Write the sum of atomic numbers of the following elements:

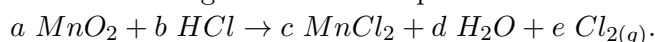
First element: belongs to  $17^{th}$  group and  $4^{th}$  period in modern periodic table and

Second element: the largest element of  $4^{th}$  period of the modern periodic table.

**3** Write the molecular mass of the gas ' $X$ ' produced in the given chemical equation:

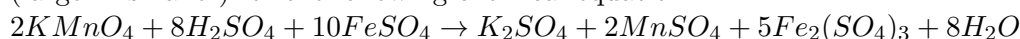


**4** Balance the given chemical equation:

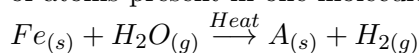


Calculate the number of mole of  $HCl$  required to produced 12 mole of  $MnCl_2$

**5** Write the difference between the molar mass of oxidising agent and reducing agent (larger – smaller) for the following chemical equation:



**6** Identify the unknown compound ' $A$ ' in the given chemical equation and write the total number of atoms present in one molecule of ' $A$ '.



**7** Identify the least reactive metal from the following data and write its Atomic mass.

(1)  $X$ ,  $Y$ ,  $Z$  belong to  $3^{rd}$  period and are silvery white.

(2)  $Z$  reacts rapidly and vigorously with water and liberates hydrogen gas.

(3)  $Y$  cannot displace  $X$  from its aqueous salt solution.

(4)  $Z$  can displace  $Y$  from its aqueous salt solution.

**8** What is the sum of molar mass of first member of Alkane, Alkene and Alkyne series?

**9** A Hydrocarbon  $C_xH_y$  on complete combustion produces a gas ' $B$ ' and water. If the molar mass of gas ' $B$ ' and Hydrocarbon ( $C_xH_y$ ) are same, then the value of  $(x+y)$  is —.

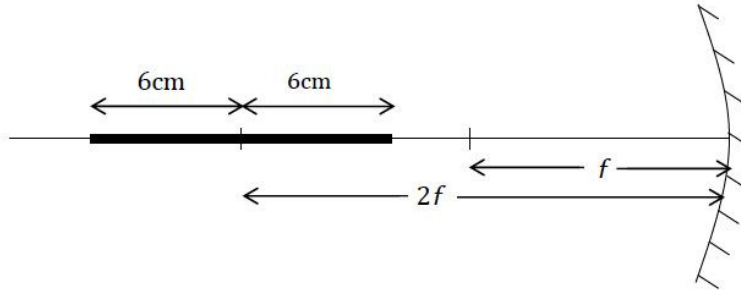
**10** What amount (in gram) of acetic acid is needed to prepare 0.25 mole of methyl ethanoate using methanol and few drops of concentrated sulphuric acid?

## Physics

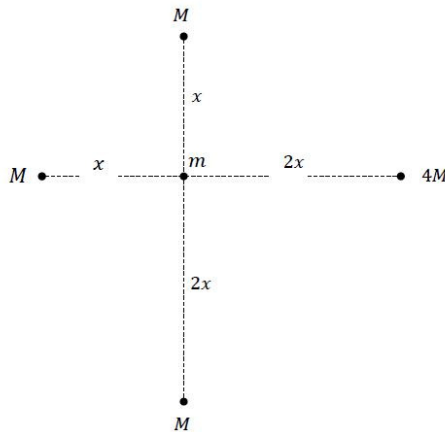
**Important:**

Take  $g = 10 \text{ m/s}^2$ ,  $k = 9 \times 10^9 \text{ N} \cdot (\text{m/C})^2$  and  $G = 6.67 \times 10^{-11} \text{ m}^3/\text{kg} \cdot \text{s}^2$

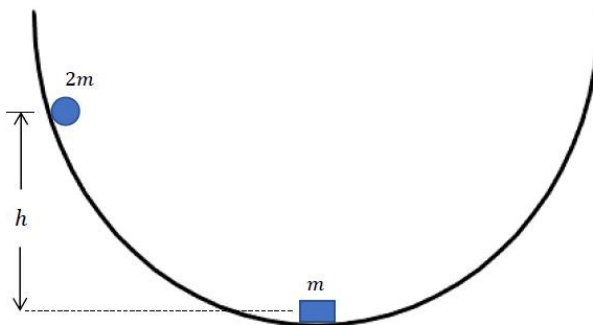
**11** A stick of length 12cm is placed along the principal axis of a concave mirror of focal length 10cm as shown in figure. If the length of its image is ' $l$ ' in cm, calculate the value of ' $4l$ '.



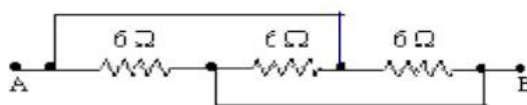
**12** Five point masses are arranged as shown in figure. If the net force on mass ' $m$ ' is  $\frac{k}{l} \times \frac{GMm}{x^2}$ , where common factors in the fraction  $\frac{k}{l}$  have been cancelled off, calculate the value of ' $k + l$ '.



**13** A ball of mass  $2m$  slides in a frictionless semi-circular arc starting from rest at a height  $h$  from the lowest point as shown in figure. At the lowest point, it hits a block of mass  $m$  and sticks to it after collision. The ball and the block together rise to a height  $h_1$  after the collision. If  $\frac{h_1}{h} = \frac{p}{q}$  where common factors in the fraction have been cancelled off, calculate the value of  $p + q$ .



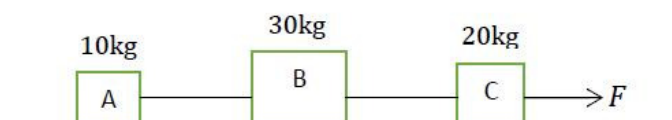
14 Three  $6\Omega$  resistances are arranged as shown in the circuit. Find effective resistance between points A and B in Ohms.



15 When a resistor  $3R$  is connected in series with a resistor  $R$ , and then connected to a battery of emf  $V$ , the power drawn from the battery is  $P_1$ . When resistor  $3R$  is connected in parallel with resistor  $R$ , and then connected to a battery of emf  $V$ , the power drawn from the battery is  $P_2$ . If  $\frac{P_1}{P_2} = \frac{m}{n}$  where common factors in the fraction have been cancelled off, calculate the value of ' $m + n$ '.

16 A ball of mass  $1\text{ kg}$  is at rest on the ground. An upward force of  $15\text{ N}$  is applied on it for  $2\text{ s}$  after which it moves freely under gravity. Find the maximum height (in meters) from the ground to which the ball will rise.

17 Three blocks connected by two identical strings are at rest on a smooth horizontal plane as shown in figure. A force  $F$  is now applied on the  $20\text{ kg}$  block towards right as shown. If the maximum force that each string can withstand is  $480\text{ N}$ , determine the maximum acceleration (in  $\text{m/s}^2$ ) that the three blocks can have.



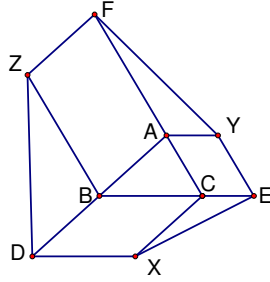
18 A strong man of mass  $80\text{ kg}$  had a sack of  $10\text{ kg}$  strapped to his back. He climbed vertically up, on a straight coconut tree at a uniform pace of  $1$  stride in  $2$  seconds. He took total  $40$  strides, each  $20\text{ cm}$  high. Find the power generated by his legs. Express the answer in unit Watt.

19 A car starts moving on a straight road from rest with uniform acceleration of  $5\text{ m/s}^2$  for some time, it then moves with uniform velocity for some duration and then decelerates uniformly at  $5\text{ m/s}^2$  till it comes to a stop. The total time of motion is  $25$  seconds. If the average velocity for the entire journey is  $72\text{ kmph}$ , determine the time (in seconds) during which the car was moving with constant velocity.

20 Car P and Car Q start together and move towards East. When they start, car P is ahead of car Q by some distance. Car P keeps a uniform velocity of  $36\text{ kmph}$  for the first  $20\text{ s}$  of the motion and then accelerates uniformly at  $1.5\text{ m/s}^2$ , for rest of the motion. Car Q has initial velocity zero and has a uniform acceleration of  $2\text{ m/s}^2$  for its entire travel. Car Q overtakes P when velocity of P is  $25\text{ m/s}$ . Find the initial distance between the two cars in meter.

## Mathematics

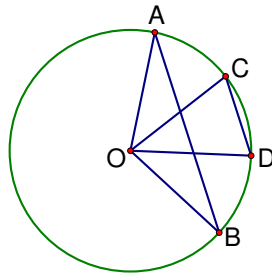
**21** Refer to the diagram. Given  $\triangle ABC$ , extend  $AB$  to  $D$  such that  $AB = BD$ , extend  $BC$  to  $E$  such that  $BC = 2CE$  and extend  $CA$  to  $F$  such that  $AF = 2AC$ . Draw parallelograms  $BCXD$ ,  $ACEY$  and  $ABZF$ . Join  $DZ$ ,  $XE$  and  $FY$ . Total area of hexagon  $DXEYFZ$  is 322 square units. Find area of  $\triangle ABC$ .



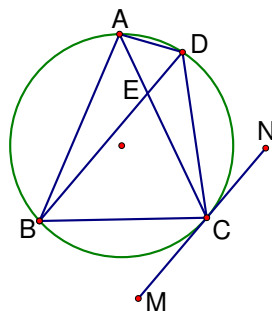
**22** In right angled triangle  $ABC$ ,  $m\angle A = 90$ .  $D, E$  are on  $BC$  such that  $BD = DE = CE$ . If  $BC = 6$  find  $AD^2 + AE^2$ .

**23** In acute angled  $\triangle ABC$ ,  $H$  is orthocenter and  $O$  is circumcenter. If  $AO = AH$ , find measure of angle  $A$ .

**24** In given figure  $\overline{AB}$  and  $\overline{CD}$  are parallel chords of circle with center at  $O$  and radius  $R$ . If  $AB = 46, CD = 18$  and  $m\angle AOB = 3m\angle COD$ , find  $R$ .



**25**  $\triangle ABC$  is inscribed in circle  $AB = AC$ . Line  $MN$  is tangent to circle at  $C$ .  $BD \parallel MN$  and  $AC$  intersects  $BD$  at  $E$ . If  $AB = 18$  and  $BC = 12$ . Find  $AE$ .



**26** Given  $x = \frac{\sqrt{7} + \sqrt{3}}{\sqrt{7} - \sqrt{3}}$  and  $y = \frac{\sqrt{7} - \sqrt{3}}{\sqrt{7} + \sqrt{3}}$ .

Find the value of  $\sqrt{2(x^4 + y^4 + (x + y)^4)}$

**27** Given  $\frac{1}{x} + \frac{1}{y + z} = \frac{1}{2}$ ,  $\frac{1}{y} + \frac{1}{z + x} = \frac{1}{3}$ ,  $\frac{1}{z} + \frac{1}{x + y} = \frac{1}{4}$

Find  $23 \left( \frac{1}{x} + \frac{1}{y} + \frac{1}{z} \right)$ .

**28** In  $\triangle ABC$ ,  $D$  is midpoint of  $\overline{BC}$ ,  $E$  is midpoint of  $\overline{CA}$  and  $F$  is midpoint of  $\overline{AB}$ . Given  $D(3, 3)$  and  $B(-1, 7)$ , slope of line  $DE = -\frac{5}{2}$  and slope of  $DF = \frac{1}{2}$ . If centroid  $G \equiv (h, k)$ , then  $h^2 + k^2$  equals

**29** Sum of first 9 terms in an arithmetic progression is 28 and sum of first 28 terms in the same arithmetic progression is 9. If  $S$  is sum of first 37 terms in the same AP then  $|S|$  equals.

**30**  $P(x) = x^4 + 4x^3 + 12x^2 + 16x + k$ .  $P(x)$  is a perfect square, that is, it gets factorized into two same factors. Find the sum of all possible values of  $k$ .

**Answers:**

<b>Q.No.</b>	1	2	3	4	5	6	7	8	9	10
<b>Ans.</b>	62	54	30	48	6	7	27	70	11	15
<b>Q.No.</b>	11	12	13	14	15	16	17	18	19	20
<b>Ans.</b>	75	7	13	2	19	15	12	90	15	525
<b>Q.No.</b>	21	22	23	24	25	26	27	28	29	30
<b>Ans.</b>	28	20	60	27	10	48	18	10	37	16