FIITJEE (JEE-Advanced)

BATCHES – NWCM721O1S, NWCM921X1W, NWCM921A1W & PANINI921-XIIG1

PHYSICS, CHEMISTRY & MATHEMATICS

QP Code: | **Test - 9**

Time Allotted: 3 Hours | **Maximum Marks: 180**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains **Three Sections**.
3. **Section-I** is Physics, **Section-II** is Chemistry and **Section-III** is Mathematics.
4. In Each Section is **One Part:** Part-A.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with HB pencil for each character of your Enrolment No. and write in ink your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Sections.

(i) **Part-A (01-15)** contains Six (15) Numerical based questions, the answer of which maybe positive or negative numbers or decimals (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30) and each question carries **+4 marks** for correct answer and **there will be no negative marking.**

Name of the Candidate :_____

Batch :_____ **Date of Examination :**_____

Enrolment Number :_____

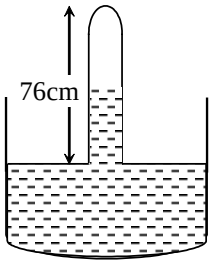
SECTION-1 : PHYSICS

PART – A

(Numerical based)

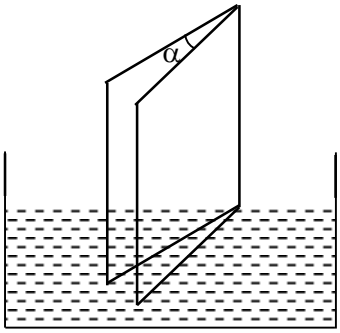
This section contains **15 questions**, numerical based questions, (answer of which maybe positive or negative numbers or decimals).

1. A tube is dipped in mercury as shown. The length of the tube above mercury level is 76 cm. *n* moles of an ideal monatomic gas is trapped in the tube. The amount of heat required to increase the temperature of gas by ΔT *is* $KnR\Delta T$, then Value of K is ?
(Atmospheric pressure= 76 cm of Hg, Neglect the mercury vapour pressure above mercury level and heat capacity of mercury, tube and vessel)



1. **2**

2. Two large square plates of side *l* each are place in a liquid, forming an angle α ($\alpha < 1^0$) with each other as shown in the figure. The surface tension and the density of the liquid are *S* and ρ respectively. The height to which liquid will rise in the space between the two plates as a function of the distance x from the edge is given as "$h = \frac{KS}{x\alpha\rho g}$", Then value of K is ? [Take angle of contact between the plate and the liquid $\approx 0^0$ and acceleration due to gravity = g]

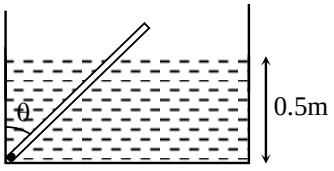


2. **2**

3. Two opposite forces F_1 = 120 N and F_2 = 80 N act on an elastic plank of modulus of elasticity Y = 2×10^{11} N/m^2 and length ℓ = 1 m placed over a smooth horizontal surface. The cross-sectional area of the plank is S = 0.5 m^2. The change in length of the plank is $x \times 10^{-11}$m, then find the value of 'x'.

3. **100**

4. A wooden plank of length 1m and uniform cross-section is hinged at one end to the bottom of a tank as shown in figure. The tank is filled with water up to a height of 0.5 m. The specific gravity of the plank is 0.5. Find the angle θ in degree that the plank makes with the vertical in the equilibrium position.



4. **45**

5. Three particles, each of mass m, are situated at the vertices of an equilateral triangle of side length a. The only forces acting on the particles are their mutual gravitational forces. It is desired that each particle moves in a circle while maintaining the original mutual separation a. Find the initial velocity that should be given to each particle. $\left(\text{take a} = \frac{GM}{16}\right)$

5. **4**

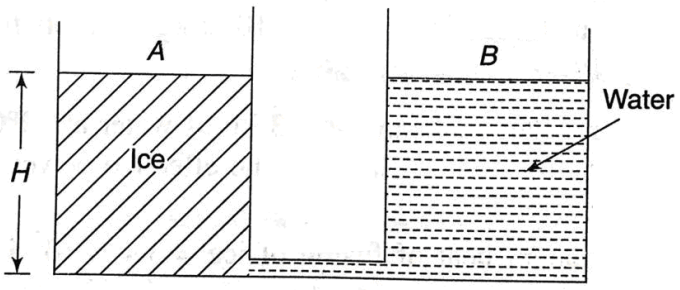
6. The volume of glass vessel is 1000 cc at 20°C. What volume of mercury should be poured into it at this temperature so that the volume of the remaining space does not change with temperature is 10n cc. Coefficient of cubical expansion of mercury and glass are 1.8×10^{-4}/°C and 9.0×10^{-6}/°C respectively. Find the value of 'n'?

6. **5**

7. A steel wire of diameter 0.5 mm and Young's Modulus 2×10^{11} Nm^{-2} carries a load of mass M. The length of the wire with the load is 1.0 m. A vernier scale with 10 divisions is attached to the end of this wire. Next to the steel wire is a reference wire to which a main scale of least count 1.0mm is attached. The 10 divisions of the vernier scale correspond to 9 divisions of the main scale. Initially, the zero of vernier scale coincides with the zero of main scale. If the load on the steel wire is increased by 1.2 kg, the vernier scale division which coincides with a main scale division is _____. Take g = 10 ms^{-2} and $\pi = 3.2$

7. **3**

8. Two identical cylindrical containers A and B are interconnected by a tube of negligible dimensions. Containers A is filled with an ice block up to height H = 1.8 m and container B is filled up to same height with water. Ice is at 0°C and water is at 40°C. Due to heat exchange between water and ice, the ice block begins to melt. Assume that the ice block melt in horizontal layers starting from the bottom. The thickness of ice block reduces uniformly over the entire cross section of the container. The ice block moves without friction inside the container and no water enters between the vertical wall of the container and the ice block. Heat is exchanged only between the ice block and the water and there is no heat exchange with containers or atmosphere. Calculate the height (in meter) of water in container B when thermal equilibrium is attained. Relative density and specific latent heat of fusion of ice are 0.9 and 80 cal g^{-1} respectively. Specific heat capacity of water is 1 cal g^{-1} °C^{-1}.

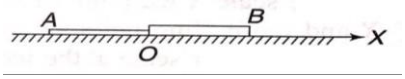


8. **1.71**

9. Two samples of a liquid have volumes 400 cc and 220 cc and their temperature are 10°C and 110°C respectively. Find the final volume (in unit cc) of the mixture if the two samples are mixed. Assume no heat exchange with the surroundings. Coefficient of volume expansion of the liquid is $\gamma = 10^{-3}$ °C^{-1} and its specific heat capacity is a constant for the entire range of temperature.

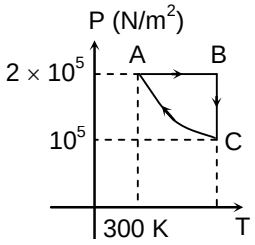
9. **620**

10. A composite bar has two segments of equal length L each. Both segments are made of same material but cross sectional area of segment OB is twice that of OA. The bar is kept on a smooth table with the joint at the origin of the co-ordinate system attached to the table. Temperature of the composite bar is uniformly raised by $\Delta\theta$. The final X co-ordinate of the joint is given by K $L\alpha\Delta\theta$, Then value of |K| is [coefficient of linear thermal expansion for the material is $\alpha^{o}C^{-1}$].



10. **0.167**
Range: 0.166 – 0.168

11. Two moles of a monatomic ideal gas is taken through a cyclic process shown on pressure (P) temperature (T) diagram in figure. Process *CA* is represented as *PT* = Constant. If efficiency of given cyclic process is $1-\frac{x}{12\ln 2+15}$, then find *x*.



11. **21**

12. Water flows at the rate of 0.1500 kg/min through a tube and is heated by a heater dissipating
25.2 W. The inflow and outflow water temperatures are 15.2°C and 17.4°C respectively. When the rate of flow is increased to 0.2318 kg/min and the rate of heating to 37.8 W, the inflow and outflow temperatures are unaltered. Find the specific heat capacity of water (in J/kg –°C).

12. **4200**

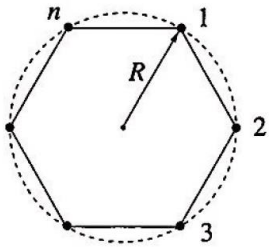
13. In olden times, people used to think that the Earth was flat. Imagine that the Earth is indeed not a sphere of radius R, but an infinite plate of thickness H. What value of H (in Km) is needed to allow the same gravitational acceleration to be experienced as on the surface of the actual Earth? (Assume that the Earth's density is uniform and equal in the two models and radius of earth = 6366 Km)

13. **4244**

14. A rocket is launched from and returns to a spherical planet of radius R in such a way that its velocity vector on returns in parallel to its launch vector. The angular separation at the centre of the planet between the launch and arrival points is θ. If flight of the rocket take time "K T_0 ", where period of a satellite flying around the planet just above its surface is T_0 then value of K will be? Take: θ = 120 degree and Pie = 22/7.

14. **0.6591**
Range: 0.65 – 0.66

15. Point-masses of mass m are at rest at the corners of a regular n-gon, as illustrated in the figure for n = 6.



The system move only because of gravitational force between the bodies. If the time elapses before the bodies collide is $T=\pi\sqrt{\frac{R^3}{K\,Gm}}$. If n = 4, find value of 'K'?

15. **7.66**
Range: 7.65 – 7.67

SECTION-2 : CHEMISTRY

PART – A

(Numerical based)

This section contains **15 questions**, numerical based questions, (answer of which maybe positive or negative numbers or decimals).

1 A solid cube of edge length = 25.32 mm of an ionic compound which has NaCl type lattice is added to 1kg of water. The boiling point of this solution is found to be 100.52°C (assume 100% ionisation of ionic compound). If radius of anion of ionic solid is 200 pm then calculate radius of cation of solid in pm '(picometer).

(K_b of water = 0.52 K kg mole^1, Avogadro's number, $N_A = 6 \times 10^{23}$, ($\sqrt[3]{75}$) = 4.22)

1. 100

2 5.35 g of a salt ACl (of weak base AOH) is dissolved in 250 ml of solution. The pH of the resultant solution was found to be 4.85. Find the edge length in A^+ . If ACl forms CsCl type crystals having density 2 2g/cc .Given K_b(AOH) = 2×10^{-5} $\frac{r^+}{r^-}$.= 0.731 for this unit cell.

2. 3.43 (Range 3.40 – 3.50)

3 A group 3A metal has a density of 2.7 g/cm^3 and a cubic unit cell with an edge length of 405.5 pm. Reaction of a 1 cm^3 chunk of the metal with an excess of hydrochloric acid gives a colourless gas that occupies 4 L at 27°C and a pressure of 701.1 mm Hg.

(R = 0.082 It-atm / mol-K, $N_A = 6 \times 10^{23}$, $\sqrt[3]{66.67}$ = 405.5 pm),

What is the atomic radius of the metal atom in picometers ?

3. 143.4 (Range 143.0 – 144.0)

4 If a monatomic ideal gas from state (5 atm, 1 It, 300K) is expanded to 5 It volume by reversible adiabatic process and reversible Isothermal process seperately. What is the value of 2($w_{isothermal} - w_{adiabatic}$) in atm^x lt.

(Given : $(1/4)^5 l^3 = 0.1$, In 2 = 0.3).

4. 3

5 A liquid in container is compressed from (2 atm, 1 It) to (10 atm, 0.5 It) isothermally where it absorb 200 J heat and work done on the system is 500 J. Calculate the enthalpy change of process in KJ. (1 atm x 1 It = 100 J).

5. 1

6 Calculate the pH at which the following conversion(reaction) will be at equilibrium in basic medium

$I_2(s) \rightleftharpoons I^- (aq) + IO_3^-(aq)$

when the equilibrium concentrations at 300 K are $[I^-] = 0.10$ M and $[IO_3^-] = 0.10$ M

{Given that $\Delta G_f°(I^-,aq) = -50$ kJ/mole, $\Delta G_f°(I0_3^-,aq) = -123.5$ kJ/mole,

$\Delta G_f°(H_20, \ell) = -233$ kJ/mole,

$G_f°(OH^-,aq) = -150$ kJ/mole, Ideal gas constant = R = $\frac{25}{3}$ J mole^{-1}K^{-1},

log e = 2.3,

6. 8

7 Reaction of gaseous fluorine (F_2) with compound X yields a single product Y, whose mass percent composition is 61.7%`F and 38.3% CI. Calculate $\Delta_r H°$ (in kJ/mol) for the synthesis of Y using following information

$2ClF_3(g) + O_2(g) \longrightarrow Cl_2O(g) + 0F_2(g)$ $\quad \Delta H^o = 205.6$ kJ

$2ClF_3(g) + 2O_2(g) \longrightarrow Cl_2O(g) + 30F_2(g)$ $\quad \Delta H° = 533.0$ kJ

$\Delta_f H°\ (0F_2, g) = 24.7$ kJ/mol

7. 24.7

8 K_a for acetic acid at 25.0°C is 1.754×10^{-5}. As 50.0°C, K_a is 1.633×10^{-5}. What is $\Delta S°$ for the ionization of acetic acid in (J/mole)?

8. -98.7

9 The standard enthalpy and entropy changes for the reaction in equilibrium for the forward direction are given below :

$$CO(g) + H_2O(g) \rightleftharpoons C0_2(g) + H_2O(g)$$

$\Delta H°_{300K} = -41.16$ kJ mo1^{-1} ; $\Delta S°_{300K} = -4.24 \times 10^{-2}$ kJ mol^{-1}

$\Delta H°_{1200K} = -32.93$ kJ mo1^{-1} ; $\Delta S°_{1200K} = -2.96 \times 10^{-2}$ kJ mol^{-1}

Calculate K_P at 1200 K temperature.

9. 0.77

10 The given reaction

$2C0 + O_2 \longrightarrow 2C0_2$ $\quad \Delta H = -560$ kJ

2 moles 1 mole

is carried and in one litre container, if the pressure in the container gets changes from 70 atm to 40 atm as reaction gets completed. Calculate ΔU of the reaction. [1L atm = 0.1 kJ]

10. -557

11. In the icosahedron of B_{12} unit each boron atom is bonded to how many boron atoms.

11. 5

12. The total number of molecules having three-centre two-electron bonds among the following is B_2H_6, Al_2Cl_6, $BeCl_2(s)$, Al_2H_6, $[Be_2(CH_3)_2]_nC_2H_6$, $Al_2(SH_3)_3$, $C_2(CH_3)_6$

12. 5

13. How many 3c - 2e bonds are present in B_4H_{10}?

13. 4

14. The compound $(CH_3)_n\ Si(Cl)_{4-n}$ on hydrolysis gives a branched chain silicone. What is the value of n?

14. 1

15. The number of oxygen atoms in the largest possible heterocyclic ring in P_4O_{10} is

15. 4

SECTION-3 : MATHEMATICS

PART – A

(Numerical based)

This section contains **15 questions**, numerical based questions, (answer of which maybe positive or negative numbers or decimals).

1. Let $x = 111.....11$ (20 digits)
   $y = 333.....33$ (10 digits)
   and $z = 222.....22$ (10 digits) then find the value of $\frac{x - y^2}{z}$

1. 1

2. There are five different boxes and seven different balls. The number of ways in which these balls can be distributed so that box 2 and box 4 contain only 1 ball each and at least 1 box is empty is N. (Order of putting the balls in the boxes is NOT considered). Then value of N is

2. 3906

3. Let 'p' be an integer for which both roots of the quadratic equation $x^2 + 2(p-3)x + 9 = 0$ lies in (–6, 1). If $2, g_1, g_2, ...g_{19}, g_{20}, p$ are in G.P., then find the value of $g_4 g_{17}$.

3. 12

4. Sum of the series $\sum_{r=1}^{68} (-1)^{r+1} \frac{1}{\sin^2(r+1)^o - \sin^2 1^o}$ is equal to $\frac{\cot A^o}{\sin B^o}$ then value of $A^3 + B^3$

4. 16

5. Find the number of non – empty subsets S of $\{1,2,3,4,5,6,7,8,9,10,11,12\}$ such that, no two consecutive integers belong to S and if, S contains k elements, then S contains no number less than k.

5. 128

6. The number of ways in which 12 identical balls can be grouped in four marked non empty sets A, B, C, D such that $n(A) < n(B)$ is

6. 70

7. Let $f(n) = \frac{4n + \sqrt{4n^2 - 1}}{\sqrt{2n+1} + \sqrt{2n-1}}$, $n \in N$ the remainder when $f(1) + f(2) + f(3) + ... + f(60)$ is divided by 9 is

7. 8

8. For each positive integer k, let S_k denote the increasing arithmetic sequence of integers whose first term is 1 and whose common difference is k. For example, S_3 is the sequence 1, 4, 7, 10,…..Find the number of values of k for which S_k contain the term 361.

8. 24

9. The value of $\sum_{p=1}^{20}\sum_{q=1}^{20} 2\tan^{-1}\left(\frac{p}{q}\right)$ is equal to

9. 628 (range 628 - 628.89)

10. Let $a_1, a_2, a_3, ...a_n$ be real numbers in arithmetic progression such that $a_1 = 15$ and a_2 is an integer. Given $\sum_{r=1}^{10}(a_r)^2 = 1185$. If $S_n = \sum_{r=1}^{n} a_r$ and maximum value of n is N for which $S_n \geq S_{(n-1)^r}$ then find N – 10.

10. 6

11. The sum of all seven digit integers with sum of the digits equal to 10 and formed by using the digits 1, 2 and 3 only is λ then value of $\frac{\lambda}{1111111}$ is

11. 110

12. Let a and b be positive integers. The value of xyz is 55 and $\frac{343}{55}$ when a, x, y, z, b are in arithmetic and harmonic progression respectively. Find the value of (a + b)

12. 8

13. The greatest integer less than the value of $1+\frac{1}{2}+\frac{1}{3}+.....+\frac{1}{20}$, is (If required, use the fact that $20 < e^3 < 21$

13. 3

Instruction for Question no. 14 and 15

Let $f(n) = \sum_{k=0}^{n} {}^{n}C_k \cos\left(\frac{2k\pi}{n}\right)$ and $g(n) = \sum_{k=0}^{n-1} {}^{n-1}C_k \cos\left(\frac{2k\pi}{n}\right)$, then

14. The value of f(6) is

14. 27

15. If value of $\frac{f(9)}{g(9)}$ is equal to λ then value of λ is

15. 2

ANSWERS

SECTION-1 : PHYSICS

PART – A

SECTION – 2 : CHEMISTRY

PART – A

SECTION – 3 : MATHEMATICS

PART – A