FIITJEE (JEE-Advanced)

BATCHES – NWCM721O1S, NWCM921X1W, NWCM921A1W & PANINI921-XIIG1

PHYSICS, CHEMISTRY & MATHEMATICS

QP Code:

PAPER - 2

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

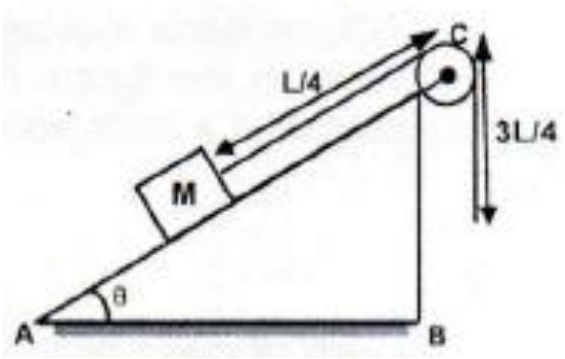
(Numerical based)

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

1. A block of mass *m* is pulled by a constant power *P* placed on a rough horizontal plane. The friction co-efficient between the block and surface varies with its speed *v* as $\mu = \frac{1}{\sqrt{1+v}}$. The acceleration of the block when its speed is 3 m/s will be (Take P=10 watts, m = $\frac{1}{2}$kg , and g = 9.8 m/s^2)

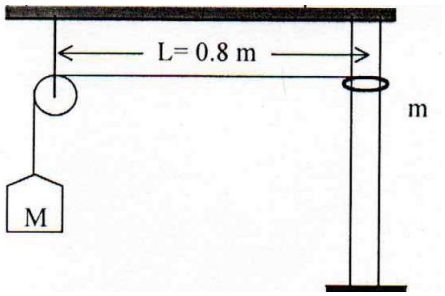
1. **1.77**
Range: 1.75 to 1.80

2. A small block of mass 12 kg is connected with an inextensible string of length L and mass 4 kg. The mass of rope is uniformly distributed over the entire length of string. Now, it is placed on a fixed wedge having slant height L and wedge angle θ (sinθ = 4/5) as shown in the figure. Assume that all the surfaces are frictionless and pulley to be very small. Calculate the Velocity of M when it strikes the ground (in m/s). **(L = 1 m)**



2. **4.35**

3. A ring of mass m = 0.3 kg can slide freely on smooth vertical rod. A light and inextensible string is connected to the ring and passes over a smooth fixed pulley as shown in the figure. The distance of pulley from the rod is 0.8 m the other end of the string is connected to a block of mass M = 0.5 kg. The ring is held in level with pulley and then released from rest. If the distance by which the ring moves down before coming to rest for the first time is X_1 and the distance of the equilibrium position from the initial position is X_2 then find the value of $x_1^2 + x_2^2$ is



3. **2.61**

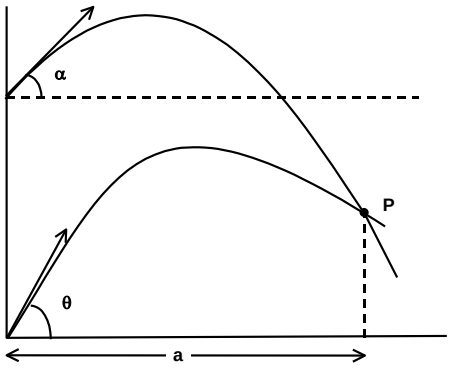
4. An aeroplane flying along the horizontal at a velocity V starts to ascend, describing a circle of radius r in vertical plane. The power delivered by the engine of the plane varies as P α V_h, V_h is the vertical component of the velocity of the plane at height h above the initial level of motion. The velocity of the plane at the upper point of the trajectory is $V_1 = 2V$. If the acceleration of the plane at the moment when its velocity is directed vertically upwards is $\frac{V^2}{R}\sqrt{k}$ then find value of 'k'.

4. **6.81**
Range: 6.80 to 6.82

5. A car of mass m 1 kg accelerates from 10 m/s to 20 m/s. the engine develops the power of 100 W. Calculate the distance moved by the car during the acceleration in meters

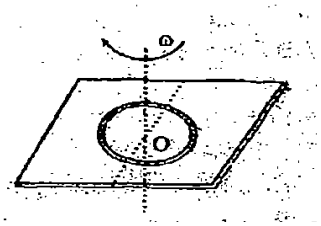
5. **23.33**
Range: 23.30 to 23.35

6. Shots fired simultaneously from the top and the bottom of a tower at an angle α and θ respectively in a vertical plane collide each other. The horizontal distance of the point of collision is 'a' from the tower. Find the height of the tower in meters. (take a = 15 m, α = 30 degree, θ = 60 degree).



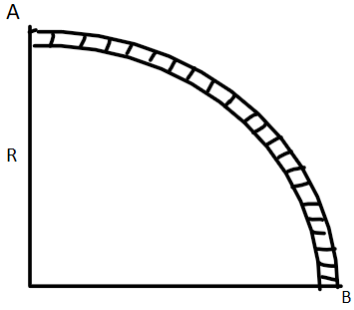
6. **17.32**

7. A uniform ring of mass m is placed on a rough horizontal fixed surface as shown in the figure. The coefficient of friction between the left part of the ring and left part of horizontal surface is 0.6 and between the right half of the ring and the surface is 0.2. At the instant shown, now the ring has been imparted an angular velocity in clockwise sense in the figure shown. At this moment magnitude of acceleration of centre of the ring(in m/s^2) is (take g = 10 m/s^2)



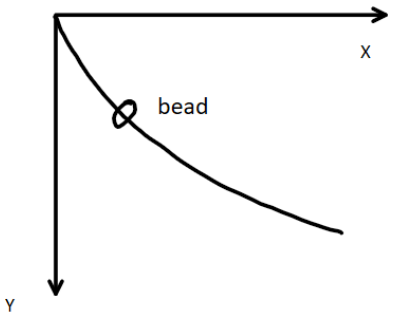
7. **1.27**
Range: 1.25 to 1.30

8. A rope AB of linear mass density λ is placed on a quarter vertical fixed disc of radius R as shown in the figure. The surface between the disc and rope is rough such that the rope is just in equilibrium. Gravitational acceleration is g and λRg = 10 N then find the max tension in the rope in N.



8. **4.14**

9. A bead under the influence of gravity, slides down a frictionless wire whose y coordinate is changing with x co-ordinate as shown in the figure. Assume that at position O the wire is vertical and the bead passes this point with a given speed V downward. If the shape of the wire is such that the vertical component of velocity remains V at all the time. Find a + b in the shape function of wire given by $y = \frac{(agvx)^b}{2g}$ where g is acceleration due to gravity.



9. **3.67**
Range: 3.66 to 3.68

10 A long plank begins to move at t = 0 and accelerates along a straight track with speed given by $v = 2t^2$ and for $0 \le t \le 2$ (where v is in m/s and t is in second). After 2 second the plank continues to move at the constant speed acquired. A small block initially at rest on the plank begins to slip at t = 1 sec and stops sliding at t = 3 sec. If the coefficient of static friction and kinetic friction between the plank and the block is 0.s and 0.k (where s and k are digits after the decimal places) respectively, find $\frac{s^2+k^2}{s+k}$.

10. **3.57**
Range: 3.55 to 3.60

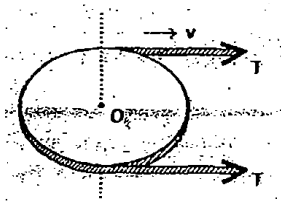
11. A particle whose velocity is given by v = (i + 6t j) m/s is moving in x-y plane. At t = 0, particle is at origin. Find the radius of curvature of path at point $\left(\frac{\sqrt{2}}{3}\text{m}, \frac{2}{3}\text{m}\right)$.

11. **4.50**

12. A power output from a certain experimental car design to be shaped like a cube is proportional to the mass m of the car. The force of air friction on the car is proportional to Av^2, where v is the speed of the car and A is the cross-sectional area. On a level surface the car has a maximum speed v_{max}. Assume that all the versions of this design have the same density. Then v_{max} is proportional to $(m)^C$. Find C

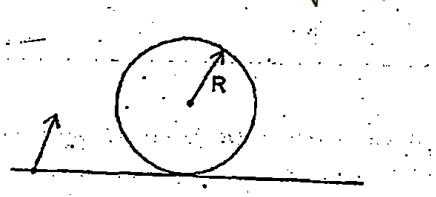
12. **0.11**

13. A flexible drive belt runs over a frictionless pulley as shown in the figure. The pulley is rotating freely about the vertical axis passing through the centre O of the pulley. The vertical axis is fixed on the horizontal smooth surface. The mass per unit length of the drive belt is 1kg/m and the tension in the drive belt is 8 N. The speed of the drive belt is 2 m/s. Find the net Normal force applied by the belt on the pulley in newton.



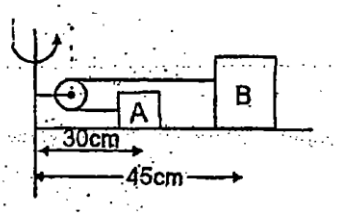
13. **8**

14. A cylinder lies on a horizontal surface. A boy wants to throw a ball over the cylinder with minimum possible speed so that the ball is just able to cross the cylinder. If the minimum speed of projection of ball around the cylinder is $\sqrt{gR\left(k^2-1\right)}$ then find the value of 'k'.



14. **2.41**

15. Two blocks A and B are kept on a rotating table and are connected by a string passing around the frictionless pulley as shown in the figure. Coefficient of friction between the masses and surface is 0.25 and masses of blocks A and B are 15 kg and 45 kg respectively. Find the maximum value of ω for which radial sliding will the occur in radian per second. (g = 10 m/s^2)



15. **3.09**
Range: 3.07 to 3.10

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. 1 g of dry green algae absorbs 4.7×10^{-3} mole of CO_2 per hour by photosynthesis. If the fixed carbon atoms were all stored after photosynthesis as starch,$(C_6H_{10}O_5)_n$, how long (hours) would it take for the algae to double their own weight assuming photosynthesis takes place at a constant rate?

1. 7.88 (Range 7.85 to 8.00)

2. Crude calcium carbide is made in an electric furnace by the following reaction:

   $CaO + 3C \longrightarrow CaC_2 + CO$

   The product contains 85% of CaC_2 and 15% unreacted CaO. How much CaO is to be added to the furnace charge for each 1000 kg of crude product?

2. 893.75 (Range 892.00 to 894.00)

3. A 10 g mixture of Cu_2S and CuS was treated with 200 mL of 0.75 M MnO_4^- in acid solution producing SO_2, Cu^{2+} and Mn^{2+}. The SO_2 was boiled off and the excess MnO_4^- was titrated with 175 mL of 1 M Fe^{2+} solution. Calculate the percentage of CuS in the original mixture.

3. 57.4 (Range 57.00 to 58.00)

4. The degree of dissociation of N_2O_4 according to the equation $N_2O_4 = 2NO_2$ at 70°C and atmospheric pressure is 65.6%. Calculate the apparent molecular weight of N_2O_4 under the above conditions.

4. 55.56 (Range 55.20 to 56.00)

5. 1 mole of a gas is changed from its initial state(15 lit; 2 atm) to final state(4 lit, 10 atm) reversibly. If this change can be represented by a straight line in p-V curve, calculate maximum temperature, the gas attained

5. 698.00 (Range 697.00 to 698.00)

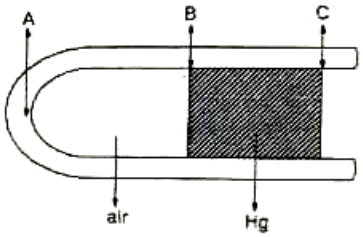
6. Hydrogen like species is in some excited state ‘P’ and on absorbing a photon ‘a’ eV reached to a new state ‘Q’ on de-excitation back to the ground state a total of 10 different wavelengths were emitted in which seven have energy greater than ‘a’ eV. The ionization energy in the ground state will be “xa” eV. Find the value of x.

6. 14.06 (Range 14.00 to 15.00)

7. A sample of $Fe_2(SO_4)_3$ and FeC_2O_4 was dissolved in dil H_2SO_4. The complete oxidation of reaction mixture required 40 L of N/16 $KMnO_4$. After the oxidation, the reaction mixtures was reduced by Zn and dil.H_2SO_4. On again oxidation by same $KMnO_4$, 60 mL were required. Find the value of millimoes of $Fe_2(SO_4)_3$/millimoles of FeC_2O_4.

7. 1.75

8. A 10.0 cm column of air is held by a column of Hg 8.00 cm long in a capillary tube of uniform radius when the tube is held horizontally in room at 0.94 atm.
AB = 10 cm, BC = 8 cm
Calculate length of air column when tube is held vertically with open end down



8. 11.26 (Range 11.20 to 11.30)

9. What is the density(in gm/Lt) of wet air with 75% relative humidity at 1 atm and 300 k? [Given: vapour pressure of H_2O at 300 K is 30 torr and average molar mass of air is 29 g mol^{-1}]

9. 1.16 (Range 1.10 to 1.20)

10. Considering virial equation for real has i.e $PV = RT\left[1+\frac{X}{V}+\frac{Y}{V^2}+\frac{Z}{V^3}+....\right]$. The third virial coefficient of He gas is 4×10^{-2}(Lt/mole)^2 then what will be volume of 2 mole He gas at S.T.P. Volume of one mole of ideal gas at S.T.P is 22.4 lt.

10. 45.20

11. The density of the vapour of a substance at 1 atm pressure and 500 K is 0.36 kg m^{-3}. The vapour effuses through a small hole at a rate 1.33 times faster than oxygen under the same condition. Determine compressibility factor.

11. 1.23

12. One litre of O_2 at STP was passed through an ozonizer when the resulting volume was 888 mL at S.T.P. This quantity of ozonized oxygen was passed through excess of KI solution. Calculate the weight of I_2 liberated in grams. (I = 127)

12. 2.54

13. Igniting MnO_2 in air converts it to Mn_3O_4. A sample of pyrolusite is of the following composition: MnO_2 = 80%, SiO_2 = 15% rest being water. The sample is ignited in air to constant weight. What is the percentage of Mn in the ignited sample(Mn = 55, O = 16)

13. 59.36 (Range 59.00 to 60.00)

14. A H-like atom of atomic number 'Z' is in an excited state of quantum number '2n'. If it can emit a maximum energy of 204 eV and when it makes a transition to quantum state 'n', a photon of energy 40.8 eV is emitted. Find value of (n + Z).

14. 6.00

15. A 100 mL flask contained H_2 at 200 Torr & a 200 mL flask contained Helium at 100 Torr. Two flask were then connected so that each gas filled their combined volume. Assuming no change in temperature, what is the total pressure?

15. 133.33 (Range 133.30 to 133.50)

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. The Range of μ for which the line $y = 2x + \mu$ lies between the circles $(x-1)^2+(y-1)^2=(1)^2$ and $(x-8)^2+(y-1)^7=4$ without intercepting a chord on either circle, is given by $[\alpha,\beta]$. Find $(\alpha-\beta)$

1. (–7.28)
(–7.28) to (–7.31)

2. Let two tangents are drawn from P, (3, 4) point to the circle $x^2+y^2=4$, Find area of triangle ABC, where A, B are points of tangency of tangents from P and 'C' being the centre of the given circle.

2. 1.45
(1.45 to 1.47) sq units

3. The Real values of 'r' if circles
$S_1:(x-1)^2+(y-3)^2=r^2$ and
$S_2:(x-4)^2+(y+1)^2=9$ intersect at two points, is given by the range (a, b); then find (b - a)

3. 6

4. Let, $x,y,z\in R$ with $x\ge y\ge z\ge\frac{\pi}{12}$ such that x + y + z = $\frac{\pi}{2}$. Find the different between minimum and maximum value of the product $\cos x.\sin y.\cos z$

4. 0.34

5. If $\tan(\alpha-\beta)=\sin 2\beta$, then find the value of $\frac{\tan\alpha+\tan\beta}{\tan 2\beta}$

5. 2

6. If $\sin(\alpha+\beta)=1,\sin(\alpha-\beta)=1/2$ where $\alpha,\beta,\in\left[0,\frac{\pi}{2}\right]$; find $\tan(\alpha+2\beta).\ \tan(2\alpha+\beta)$.

6. 1

7. Let $x,y\in R$ such that $\frac{\sin x}{\sin y}=3$ and $\frac{\cos x}{\cos y}=\frac{1}{2}$, Find $\frac{\sin 2x}{\sin 2y}\times\frac{\cos 2x}{\cos 2y}$

7. 0.84

8. 'P' is a variable point on the line y = 4. Tangents are drawn to the circle $x^2+y^2=4$ from P to touch it at A and B. The perallelgram PAQB is completed. The equation of the locus of Q is $(x^2+y^2)(y+\eta)=\mu.y^2.\ (\mu,\eta\in R)$. Find $\eta\times\mu$

8. 8

9. A circle with centre in the 1st quadrant is tangent to $y = x + 4, y = x - 6$ and y-axis. Let (p, q) be the centre of the circle. If (p + q) = $a + b\sqrt{a}$, when $a,b, \in Q$, Find $|a - b|$

9. 6

10. A straight line is drawn through the centre of the circle $x^2 + y^2 - 2ax = 0$, parallel to the straight line $x + 2y = 0$ and intersecting the circle at A and B. The area of ΔAOB is $\frac{a^2}{\sqrt{k}}$. Find 'k'.

10. 5

11. Let two points A and B lie on the lines y = x and y = 2x such that AB = 2ℓ. The locus of mid – point of AB is $\ell^2 = (\lambda x - \mu y)^2 + (4x - 3y)^2$. Find $\lambda + \mu$

11. 5

12. The value of $\sin^4\frac{\pi}{8} + \sin^4\frac{3\pi}{8} + \sin^4\frac{5\pi}{8} + \sin^4\frac{7\pi}{8}$ is

12. 1.50

13. The minimum value of $\left[(x_1 - x_2)^2 + \left(12 - \sqrt{1 - x_1^2} - \sqrt{4x_2}\right)^2\right]^{\frac{1}{2}}$ for all permissible value of x_1 and x_2 is $\left(a\sqrt{b} - c\right)$ where $a,b,c \in N$, Find (a + b – c)

13. 8

14. Assume that α, β, υ satisfy $O < \alpha < \beta < \upsilon < 2\pi$ if $\cos(x + \alpha) + \cos(x + \beta) + \cos(x + \upsilon) = 0$, for arbitrary $x \in R$, then $\upsilon - \alpha = ?$

14. 4.18
(range 4.18 to 4.19)

15. Let A = (–2, 0) and B = (2, 0), then the number of integral values of a, $a \in [-10, 10]$ for which line segment AB subtends an acute angle at point C = (a, a +1) is

15. 19

ANSWERS

SECTION-1 : PHYSICS

PART – A

SECTION – 2 : CHEMISTRY

PART – A

SECTION – 3 : MATHEMATICS

PART – A