FIITJEE (JEE-Advanced)

BATCHES – NWCM721O1S, NWCM921X1W, NWCM921A1W & PANINI921-XIIG1

PHYSICS, CHEMISTRY & MATHEMATICS

Pattern - CPT-1 | **QP Code:** | **TEST - 4**

Time Allotted: 3 Hours **Maximum Marks: 198**

- 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. Each **Section** is further divided into **Two Parts**: **Part-A & B** in the OMR.
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 Two Parts.

(i) **Part-A (01-06) –** Contains six (06) multiple choice questions which have ONLY ONE CORRECT answer Each question carries **+3 marks** for correct answer and **-1 marks** for wrong answer.

(ii) **Part-A (07-12) –** Contains seven (06) multiple choice questions which have **One or More** correct answer.
Full Marks: **+4** If only the bubble(s) corresponding to all the correct options(s) is (are) darkened.
Partial Marks: **+1** For darkening a bubble corresponding **to each correct option,** provided NO incorrect option is darkened.
Zero Marks: **0** If none of the bubbles is darkened.
***Negative Marks*: –2 In all other cases.**
For example, if **(A), (C) and (D)** are all the correct options for a question, darkening all these three will result in **+4 marks**; darkening only **(A) and (D)** will result in **+2 marks**; and darkening **(A) and (B)** will result in **–2** marks, as a wrong option is also darkened.

(ii) **Part-B (01-06)** contains Six (06) 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 :_____

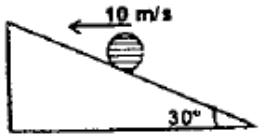
SECTION-1 : PHYSICS

PART – A

(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.**

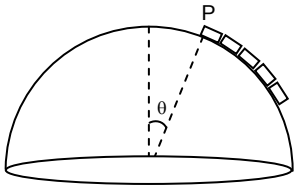
1. A ball of mass 1 kg strikes a wedge of mass 4 kg horizontally with a velocity of 10 m/s. Just after collision, velocity of wedge becomes 4 m/s. Friction is absent everywhere and collision is perfectly elastic. Select the correct alternative(s).



(A) speed of ball just after collision is 6 m/s.
(B) speed of ball just after collision is 8 m/s.
(C) impulse between ball and wedge during collision is 32 N-s.
(D) the given data are incorrect

1. **D**

2. A chain of length 'ℓ' and mass 'm' lies on the surface of a smooth sphere of radius R > ℓ with one end held at the point P as shown in figure. If the chain is released from this position, then the tangential acceleration of the chain just after release



(A) $\frac{Rg}{\ell}\left[1-\cos\left(\frac{\ell}{R}\right)\right]$

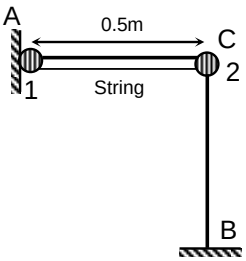
(B) $\frac{Rg}{\ell}\left[\cos\theta\left(\frac{\ell}{R}\right)-\cos\theta\right]$

(C) $\frac{Rg}{\ell}\left[\cos\theta-\cos\left(\theta+\frac{\ell}{R}\right)\right]$

(D) none of these

2. **C**

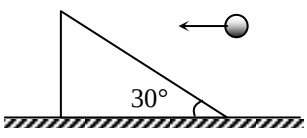
3. Two identical beads of *m* = 100 gram are connected by an inextensible massless string of length 0.5 m can slide along the two arms *AC* and *BC* of a rigid smooth wire frame in a vertical plane. If the system is released from rest as shown in figure, the kinetic energy of the first particle when they have moved such that displacement of bead 1 is 0.1 m is $4x^3 \times 10^{-3}$ J. Find the value of '*x*'. (g = 10 m/s^2)



(A) 1 (B) 2
(C) 3 (D) 4

3. **C**

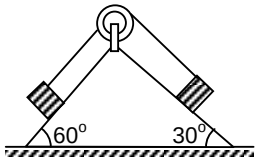
4. A ball of mass 1 kg strikes a wedge of mass 4 kg horizontally with a velocity of 10 m/s. Friction is absent everywhere and collision is elastic. Then



(A) Speed of wedge after collision is (20/17) m/s
(B) Speed of wedge after collision is (10/17) m/s
(C) Speed of wedge after collision is 4 m/s
(D) Speed of wedge after collision is 10 m/s

4. **A**

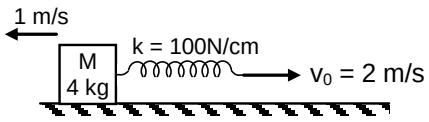
5. Two blocks of equal mass are tied with a light string which passes over a massless pulley as shown in figure. The magnitude of acceleration of centre of mass of both the blocks is (neglect friction everywhere)



(A) $\frac{\left(\sqrt{3}-1\right)^2}{2\sqrt{2}}g$ (B) $\left(\sqrt{3}-1\right)g$ (C) $\frac{g}{2}$ (D) $\left(\frac{\sqrt{3}-1}{2\sqrt{2}}\right)g$

5. **D**

6. The spring block system lies on a smooth horizontal surface. The free end of the spring is being pulled towards right with constant speed v_0 = 2 m/s. At t = 0 sec, the spring of constant k = 100 N/cm is unstretched and the block has a speed 1 m/s to left. The maximum extension of the spring is



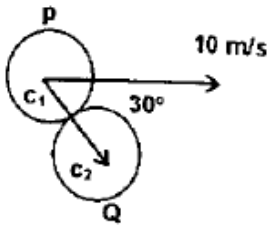
(A) 2 cm (B) 4 cm (C) 6 cm (D) 8 cm

6. **C**

(Multi Correct Choice Type)

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

7. A ball P collides elastically with an another identical ball Q at rest with velocity 10 m/s at an angle of 30° from the line joining their centres c_1 and c_2. Select the correct alternative(s)



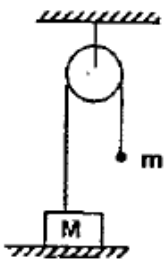
(A) Velocity of ball P after collision is 5 m/s
(B) Velocity of ball Q after collision is $5\sqrt{3}$ m/s
(C) both the ball move at right angle after collision
(D) kinetic energy will not be conserved since collision is not a head-on collision.

7. **ABC**

8. Choose the correct statement or statements regarding elastic collision.
(A) The kinetic energy of the system is conserved.
(B) Momentum of the system is conserved
(C) Mechanical energy of the system is conserved
(D) Total energy of the system is conserved

8. **BCD**

9. A heavy mass M resting on the ground is connected to a lighter mass m through a light inextensible string passing over an ideal pulley. The string connected to mass M is loose. Let lighter mass m be allowed to fall freely through a height h such that the string becomes taut. If t is the time from this instant onward when the heavier mass again makes contact with the ground and ΔE is change in kinetic energy then



(A) $t = \frac{2m}{M+m}\sqrt{\frac{2h}{g}}$ (B) $t = \frac{2m}{M-m}\sqrt{\frac{2h}{g}}$

(C) $\Delta E = -\left(\frac{Mm}{M+m}\right)gh$ (D) $\Delta E = -Mgh$

9. **AC**

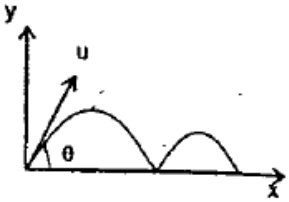
10. Three identical blocks kept in a straight line on a friction less horizontal surface. The coefficient of restitution of them e = $\frac{1}{2}$. If the left mass block has been given a velocity 'u' towards right as shown in figure, then finally

(A) speed of left most block = $\frac{1}{4}u$ (B) speed of left most block = $\frac{13}{64}u$

(C) speed of middle block = $\frac{3}{16}u$ (D) speed of middle block = $\frac{15}{16}u$

10. **BD**

11. A projectile is fired from a horizontal ground. Coefficient of restitution between projectile and ground is e. Let a, b and c be the ratio of time of flight $\left(\frac{T_1}{T_2}\right)$ maximum height $\left(\frac{H_1}{H_2}\right)$ and horizontal range $\left(\frac{R_1}{R_2}\right)$ in first two collisions with the ground. Then



(A) a = $\frac{1}{e}$ (B) b = $\frac{1}{e^2}$

(C) c = $\frac{1}{e^2}$ (D) all of the above

11. **AB**

12. Choose the correct statement or statements regarding inelastic collision.
(A) The kinetic energy of the system is conserved.
(B) Momentum of the system is conserved
(C) Mechanical energy of the system is conserved
(D) Total energy of the system is conserved

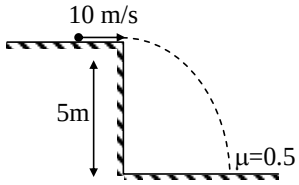
12. **BD**

PART – B
(Numerical based)

1. A ball of mass m moving with a kinetic energy 5 J undergoes a head on elastic collision with another stationary ball of mass 3m. During the impact, maximum change in potential energy of the system will be (in J)

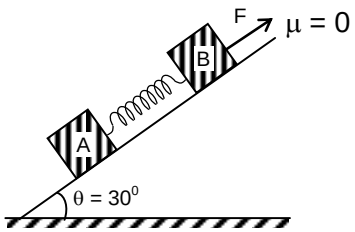
1. **3.75**

2. A small ball moving with a velocity 10 m/s, horizontally (as shown in figure) strikes a rough horizontal surface having $\mu = 0.5$. If the coefficient of restitution is *e* = 0.7. Horizontal component of velocity of ball in m/s after Ist impact will be (g = 10 m/s^2)



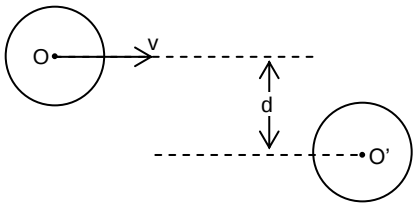
2. **1.5**

3. In the situation shown in the figure, blocks A and B each of mass m are placed on a large, fixed and smooth inclined plane of inclination θ = 30°. The blocks are initially at rest and connected to spring of stiffness k at its natural length when a force F = mg is applied on the block parallel to the plane. What is the difference between maximum and minimum separation between the blocks in cm? (take $\frac{mg}{k} = 8\,cm$)



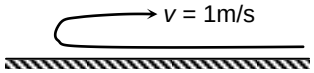
3. **8**

4. A disc of radius r and mass m moving on perfectly smooth surface at a speed v= $\frac{15}{\sqrt{17}}$ m/s undergoes an elastic collision with an identical stationary disc of mass 2 m. The magnitude of velocity (in m/s) of the first disc after the collision will be (given d= $\frac{8r}{5}$)



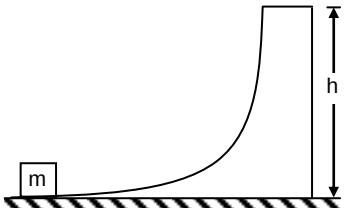
4. **3**

5. A long, thin carpet is laid on a floor. One end of the carpet is bent back and then pulled backwards with constant unit velocity. The speed of centre of mass of the moving part, just above the part of the carpet which is still at rest on the floor, is u m/s, then find the value of 'u' is



5. **0.75**

6. In situation shown in figure a small body of mass 'm' = 1kg placed over a large mass M = 3 kg, whose surface is horizontal near the smaller mass and gradually curves to become vertical. The smaller mass is pushed on the larger one at a speed u = 11 m/s towards right. Assume that all the surfaces are frictionless. The maximum speed of larger mass in m/s will be



6. **2.75**

SECTION-2 : CHEMISTRY

PART – 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. If acetylene gas is passed into Ca in liquid NH_3 at -80°C, followed by decomposition of complex under reduced pressure at 325°C, which of the following compound is formed?
   (A) C_2H_4 (B) CaH_2
   (C) CaC_2 (D) C_2H_6

1. C

2. Which of the following oxide have highest melting point?
   (A) BeO (B) MgO
   (C) CaO (D) SrO

2. B

3. NaH reacts with $SO_2(l)$ to give
   (A) Na_2S (B) $Na_2S_2O_4$
   (C) $Na_2S_2O_3$ (D) Na_2SO_3

3. B

4. $"X" + C + Cl_2 \xrightarrow{\Delta} \text{Chloride salt} + CO\uparrow$
   "X" can be
   (A) Na_2O, CaO (B) SrO, Cs_2O
   (C) BeO, Al_2O_3 (D) MgO, K_2O

4. C

5. BF_3 and NF_3 both are covalent compounds but NF_3 is polar whereas BF_3 is non-polar. This is because
   (A) Nitrogen atom is smaller than boron atom
   (B) N–F bond is more polar than B–F bond
   (C) NF_3 is pyramidal whereas BF_3 is planar triangular
   (D) BF_3 is electron deficient whereas NF_3 is not

5. C

6. Which of the following statements concerning a covalent bond is false?
   (A) The electrons are shared between atoms
   (B) The bond is non–directional
   (C) The strength of the bond depends upon the extent of overlapping
   (D) The bond formed may be polar or non–polar.

6. B

(Multi Correct Choice Type)

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

7. Which of the following compound(s) is/are coloured?
   (A) Li_2O (B) Na_2O
   (C) Rb_2O (D) Cs_2O

7. CD

8. Which of the following statement(s) is/are correct for alkali metal Li?
   (A) Among all alkali metals, the least reactivity of Li towards water have kinetic reason rather thermodynamic reason.
   (B) Among all alkali metals, the least reactivity of Li towards water have thermodynamic reason rather kinetic reason.
   (C) Among all alkali metals, the least reactivity of Li towards water is due to both thermodynamic and kinetic reasons.
   (D) Li reacts with N_2 at 298 K spontaneously to give red-brown moisture sensitive solid.

8. AD

9. Select all the compounds that is/are formed when $NaNO_2$ is heated in the absence of air.
   (A) $NaNO_3$ (B) Na_2O
   (C) N_2 (D) O_2

9. ABC

10. Select all the species that are formed by passing $N_2O(g)$ into a solution of Na in liquid NH_3
   (A) N_2 (B) NaOH
   (C) $NaNH_2$ (D) NH_2NH_2

10. ABC

11. Which of the following statement(s) is/are correct for beryllium hydride?
   (A) It can be made by reaction between dimethylberyllium and diborane followed by decomposition with Ph_3P
   (B) BeH_2 can be made by direct combination
   (C) By thermolysis of $Be(CMe_3)_2$
   (D) By reaction between $BeMe_2$ and $LiAlH_4$

11. ACD

12. Which of the following statement(s) is/are correct?
   (A) Ortho-H_2 and Para-H_2 are nuclear spin isomers.
   (B) At 0K, H_2 contains entirely Para-H_2
   (C) At room temperature, Ortho H_2 : Para H_2 ratio is 3 : 1
   (D) The thermal conductivity of Para H_2 is greater than Ortho H_2

12. ABCD

PART – B
(Numerical based)

1. The two angular nodes take the form of two cones, one inclined at x^o and one at 125.3^o to the z-axis for d_{z^2} orbital. What is the value of x?

1. 54.70^o

2. A diatomic molecule has a dipole moment 1.2 D. If its bond distance is 1.0 $\overset{o}{A}$, what fraction of an electronic charge, e, exists on each atom?

2. 0.25

3. BI_3 is symmetrical planar molecule. The distance between iodine atoms is 3.54 $\overset{o}{A}$. The covalent radius of iodine is 1.33 $\overset{o}{A}$, then what is covalent radius of boron in the same unit?

3. 0.71

4. The algebraic sum of the bond order in O_2^+, O_2, O_2^- and O_2^{--} is Z. What is the value of $\frac{Z}{3}$

4. 2.33

5. The bond length in an HI molecule is 1.61 $\overset{o}{A}$ and the measured dipole moment is 0.44 D. What is the magnitude (in units of *e*) of the negative charge on I in HI?
(1 debye = 3.34×10^{-30} coulomb-meters; e = 1.6×10^{-19} coulombs)

5. 0.057

6. The dihedral angle in solid H_2O_2 crystal is Y^o, What is the value of Y?

6. 90.20

SECTION-3 : MATHEMATICS

PART – 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. A circle is described whose centre is the vertex and whose diameter is three-quarters of the latus rectum of the parabola $y^2 = 4ax$. If PQ is the common chord of the circle and the parabola and L_1L_2 is the latus rectum, then the area of the trapezium PL_1L_2Q is

   (A) $3\sqrt{2}a^2$ (B) $2\sqrt{2}a^2$

   (C) $4a^2$ (D) $\left(\frac{2+\sqrt{2}}{2}\right)a^2$

1. D

2. Through the vertex O of the parabola $y^2 = 4ax$ two chords OP & OQ are drawn and the circles on OP & OQ as diameter intersect in R. If θ_1, θ_2 & ϕ are the angles made with the axis by the tangents at P & Q on the parabola and by OR, then $\cot\theta_1 + \cot\theta_2$ is equal to

   (A) $-2\tan\phi$ (B) $-2\tan(\pi - \phi)$

   (C) 0 (D) $2\cot\phi$

2. A

3. Let P & Q be points (4, -4) and (9, 6) of the parabola $y^2 = 4a(x - b)$. Let R be a point on the arc of the parabola between P & Q. then the area of ΔPRQ is largest when

   (A) $\angle PRQ = 90^0$ (B) the point R is (4, 4)

   (C) the point R is $\left(\frac{1}{4},1\right)$ (D) none of these

3. C

4. If $x + y + z = 5$ and $xy + yz + zx = 3$, then least and largest value of x are

   (A) $\frac{10}{3},5$ (B) $-1, \frac{13}{3}$

   (C) $\frac{17}{3}, 7$ (D) none of these

4. B

5. If x_1 and x_2 are the arithmetic and harmonic mean of the roots of the equations $ax^2+bx+c=0$, then quadratic equation whose roots are x_1 and x_2 is

   (A) $abx^2 + (b^2 + ac)x + bc = 0$ (B) $2ab\,x^2 + (b^2 + 4ac)x + 2bc = 0$

   (C) $2abx^2 + (b^2 + ac)x + bc = 0$ (D) none of these

5. B

6. S_1: If $P(x) = ax^2 + bx + c$ and $Q(x) = -ax^2 + bx + c$, where $ac \neq 0$, P(x) Q(x) has at least two real roots.

   S_2: Let S be the set of real values of 'a' for which the roots of $x^2 - 6ax + 2 - 2a + 9a^2 = 0$ exceed 3. Then $S \in (11/9, \infty)$.

   S_3: If $x^2 + ax + b$ is an integer for every odd integer x, then a and b must be integers.

   S_4: There is no real x such that $e^{\sin x} - e^{-\sin x} - 4 = 0$

   (A) FTTT (B) TFTF

   (C) TTFT (D) TTTF

6. C

(Multi Correct Choice Type)

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

7. If equation of tangent at P, Q and vertex A of parabola are $3x + 4y - 7 = 0$, $2x + 3y - 10=0$ and $x - y = 0$ respectively, then
   (A) focus is (4, 5)
   (B) length of latusrectum is $2\sqrt{2}$
   (C) axis is $x + y - 9 = 0$
   (D) vertex is $\left(\frac{9}{2}, \frac{9}{2}\right)$

7. ABCD

8. If A & B are points on the parabola $y^2 = 4ax$ with vertex O such that OA perpendicular to OB and having r1 & r2 respectively, then the value of $\frac{r_1^{4/3} r_2^{4/3}}{r_1^{2/3} + r_2^{2/3}}$ is
   (A) $16a^2$
   (B) a^2
   (C) 4a
   (D) none of these

8. A

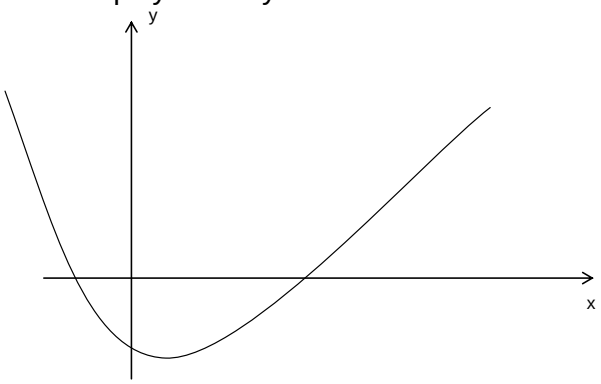
9. The locus of mid point of the focal radii of a variable point moving on the parabola, $y^2 = 4ax$ is a parabola whose
   (A) Latus rectum is half the latus rectum of the original parabola
   (B) Vertex is (a/2, 0)
   (C) Directrix is y-axis
   (D) Focus has the co-ordinates (a,0)

9. ABCD

10. The real value of t satisfying the equation $(3^t - 9)^3 + (9^t - 3)^3 = (9^t + 3^t - 12)^3$ are
    (A) – 1
    (B) 1
    (C) 1/2
    (D) 2

10. BCD

11. The graph of the quadratic polynomial $y = ax^2 + bx + c$ is as shown in the figure. Then



    (A) $b^2 - 4ac > 0$
    (B) $b < 0$
    (C) $a > 0$
    (D) $c < 0$

11. ABCD

12. $\frac{\pi^e}{x - e} + \frac{e^\pi}{x - \pi} + \frac{\pi^\pi + e^e}{x - \pi - e} = 0$ has
    (A) one real root in (e, π) and other in $(\pi - e, e)$
    (B) one real root in (e, π) and other in $(\pi, \pi + e)$
    (C) two real toots in $(\pi - e, \pi + e)$
    (D) no real roots

12. BC

PART – B
(Numerical based)

13. The chord of the parabola $y^2 = 4ax$, whose equation is $y - x\sqrt{2} + 4a\sqrt{2} = 0$ is a normal to the curve and its length is $\lambda\sqrt{3}a$, then find λ.

13. 6

14. The two parabolas $y^2 = 4ax$ and $y^2 = 4(a - 1)(x - b)$ can not have common normal other than axis unless $b > \lambda$, then find λ.

14. 2

15. From a point A common tangents are drawn to the circle $x^2 + y^2 = \frac{a^2}{2}$ and the parabola $y^2 = 4ax$. Find the area of the quadrilateral formed by the common tangents, the chords of contact of the point A, w.r.t the circle and the parabola is $\frac{\lambda a^2}{4}$, then find λ.

15. 15

16. If $f(x) = \frac{ax^2 + 2(a+1)x + 9a + 4}{(-a)x^2 + 3(-3+2a)x - a}$ is always negative and the range of values of a is a $\in \left(\frac{\lambda}{4}, \infty\right)$, then find value of λ.

16. 3

17. Find the integral value of a, for which the quadratic expression $ax^2 + (a - 2)x - 2$ is negative for exactly two integral value of x.

17. 1

18. Find the absolute value of the difference of the real roots of the equation $x^2 - 2^{2010}x + |x - 2^{2009}| + 2(2^{4017} - 1) = 0$

18. 2

ANSWERS

SECTION-1 : PHYSICS

PART – A

PART – B

SECTION – 2 : CHEMISTRY

PART – A

PART – B

SECTION – 3 : MATHEMATICS

PART – A

PART – B