FIITJEE (JEE-Advanced)

BATCHES – Two Year CRP – 2325

PHYSICS, CHEMISTRY & MATHEMATICS

QP Code: 100717 **RIT – 3**

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 Six (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 to **Two decimal places** (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 :_____

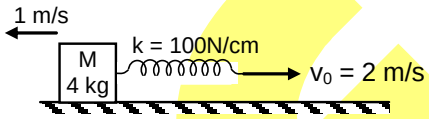
SECTION – 1: PHYSICS

PART – A

(Single Correct Choice Type)

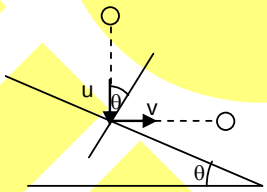
This section contains **6 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

1. 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

2. A ball is dropped on a smooth inclined plane and is observed to move horizontally after the impact. The coefficient of restitution between plane and ball is e. The angle θ is:

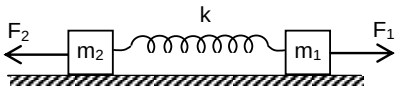


(A) 45°
(B) $\tan^{-1}e$
(C) $\tan^{-1}\sqrt{e}$
(D) $\tan^{-1}\frac{e}{2}$

3. A rod collides elastically with smooth horizontal surface after falling from a height. For maximum angular speed of the rod just after impact, the rod should be released in such a way that it makes an angle α with horizontal, the value of α will be

(A) 0°
(B) $\cos^{-1}\frac{1}{\sqrt{2}}$
(C) $\cos^{-1}\frac{1}{\sqrt{3}}$
(D) $\cos^{-1}\frac{1}{\sqrt{6}}$

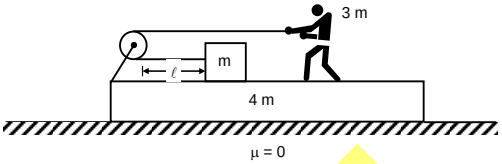
4. Two blocks of masses m_1 and m_2 are connected with a spring of spring constant k. They are kept on a smooth horizontal surface as shown in figure. Initially, the blocks are at rest and the spring is unstretched. If the blocks are pulled by forces F_1 and F_2 as shown in figure, then maximum extension in the spring will be



(A) $\frac{F_1m_1+F_2m_2}{K(m_1+m_2)}$
(B) $\frac{F_1m_2+F_2m_1}{K(m_1+m_2)}$
(C) $2\left(\frac{F_1m_2+F_2m_1}{K(m_1+m_2)}\right)$
(D) $\frac{F_1m_1+F_2m_2}{2K(m_1+m_2)}$

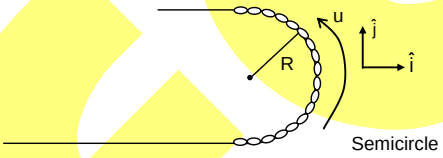
Space For Rough Work

5. A block of mass m is tied to one end of an ideal string other end of the string is pulled by a person of mass 3 m moving towards right as shown in figure. The block and man are resting on a rough wedge of mass 4 m, but the lower surface of the wedge is smooth as shown in figure. Pulley is massless and friction less. The magnitude of displacement of the wedge when the block meets the pulley



(A) $\frac{3}{8}\ell$ (B) $\frac{\ell}{4}$ (C) $\frac{\ell}{5}$ (D) none of these

6. A uniform chain of length 'πR' is moving with speed 'u', on curved line as shown in figure. The velocity of centre of mass of the chain will be



(A) $\frac{2u}{\pi}\hat{i}$ (B) $\frac{2u}{\pi}\hat{j}$

(C) $\frac{u}{\pi}\hat{i}$ (D) $\frac{u}{\pi}\hat{j}$

(Multi Correct Choice Type)

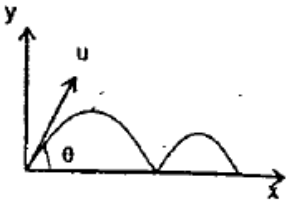
This section contains 6 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

7. A solid body starts rotating about stationary axis with an angular acceleration α, varies as $\frac{d\alpha}{dt} = -\alpha_o\omega \sin\theta$, where ω is angular velocity, θ is an angle of rotation from its initial position and α_o is initial angular acceleration. Then choose the correct option(s).
(A) Average angular acceleration for long time is 0
(B) angular velocity is $\sqrt{2\alpha_o \sin\theta}$
(C) angular velocity is $-\sqrt{2\alpha_o \sin\theta}$
(D) none of these

8. Choose the correct statement or statements regarding elastic collision.
(A) The kinetic energy of the system is conserved during elastic collision.
(B) Momentum of the system is conserved if net external force on system is zero.
(C) Mechanical energy of the system is conserved.
(D) Total energy of the system is conserved.

Space For Rough Work

9. 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

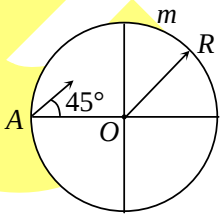


(A) $a = \frac{1}{e}$ (B) $b = \frac{1}{e^2}$

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

10. The magnitude of momentum of a system of particles is constant then the kinetic energy of the system
(A) may increase (B) may decrease
(C) may remains constant (D) none of these

11. A ring of mass *m* and radius *R* is placed on a frictionless horizontal surface. A particle of mass *m* is projected from point *A* with velocity *v* at an angle of 45° with *AO* as shown (particle is projected along the surface). If all collisions are elastic then the correct statement(s) are:



(A) The particle reaches the same point *A* on the ring after time $\frac{4R\sqrt{2}}{v}$.

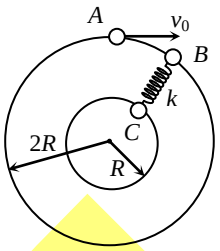
(B) Magnitude of impulse transformed during first collision is $\frac{mv}{\sqrt{2}}$.

(C) Magnitude of impulse transformed during second collision is $\frac{mv}{\sqrt{2}}$.

(D) Particle reaches diametrically opposite point on the ring in time $\frac{2R}{v}$.

Space For Rough Work

12. Three particles each of mass m, can slide on fixed frictionless circular tracks in the same horizontal plane as shown. Particle A moves with velocity v_0 and hits particle B elastically. Assuming that B and C are initially at rest and lie along a radial line and the spring is initially relaxed before impact, then



(A) the velocity of B immediately after impact is v_0

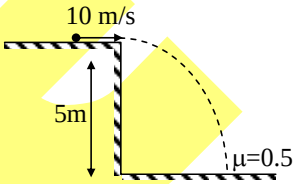
(B) the velocity of C when the stretch in the spring is maximum is $\frac{2v_0}{5}$

(C) the velocity of B when the stretch in the spring is maximum is $\frac{4v_0}{5}$

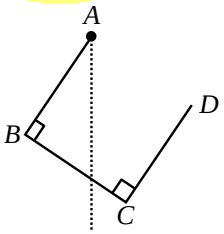
(D) the maximum stretch in the spring in the spring is $\sqrt{\frac{m}{5k}}v_0$

PART – B
(Numerical Type)

1. 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)



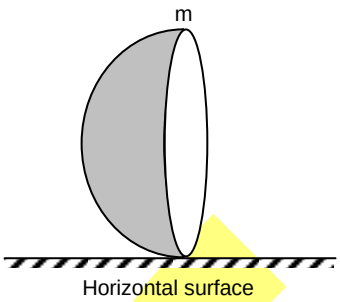
2. Three identical rods are joined and hinged at A as shown. If the angle made by the rod AB with the vertical in equilibrium is θ then the value of 10 sinθ will be



3. A wire of length ℓ and mass m is bent in the form of a rectangle ABCD with $\frac{AB}{BC} = 2$. If the moment of inertia of this wire frame about the side BC is $X\, m\ell^2$, then find the value of '81X'.

Space For Rough Work

4. A solid hemisphere of mass ‘m’ is released from rest from a position shown in figure. If there is no slipping then the magnitude of the friction on the sphere at just after the released will be K mg , then K is



5. A ball of mass m moving with a kinetic energy 3 J undergoes a head on elastic collision with another stationary ball of mass 2 m. During the impact, maximum change in potential energy of the system will be ‘n’ Joule. Find the value of ‘n’.

6. A rod of length $R\sqrt{3}$ is kept vertically inside a fixed smooth spherical shell of radius R such that its both ends are contact with the shell. If the rod is released then the angular speed of the rod, when it becomes horizontal will be “$K\sqrt{\frac{g}{R}}$”, then K is

Space For Rough Work

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. $\log\frac{K_P}{K_C} + \log RT = 0$ is a relationship for the reaction

(A) $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ (B) $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

(C) $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$ (D) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

2. N_2 and H_2 are taken in 1 : 3 molar ratio in a closed vessel to attain the following equilibrium

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

Find K_P for the reaction at total pressure of 2P, if P_{N_2} at equilibrium is $\frac{P}{3}$

(A) $\frac{1}{3P^2}$ (B) $\frac{4}{3P^2}$

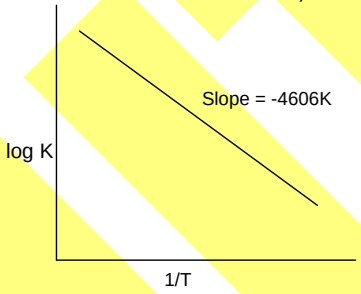
(C) $\frac{4P^2}{3}$ (D) none of these

3. For a first order reaction, the time required for completion of 90% reaction is 'x' times the half life of reaction. The value of 'x' is (ℓn 10 = 2.303, log2 = 0.3010)

(A) 1.12 (B) 2.43

(C) 3.32 (D) 33.31

4. For a reaction consider the plot of ℓnK vs 1/T given in the figure if the rate constant of this reaction at 400 K is $10^{-5}\ s^{-1}$, then rate constant at 500 K is



(A) $2 \times 10^{-4}\ s^{-1}$ (B) $10^{-4}\ s^{-1}$

(C) $10^{-6}\ s^{-1}$ (D) $4 \times 10^{-4}\ s^{-1}$

Space For Rough Work

5. A weak base(BOH with $K_b = 10^{-5}$) is titrated with a strong acid HCl. At 3/4th of the equilvalent point pH of the solution is
(A) 5.823 (B) 5 – log3
(C) 14 – (5 + log3) (D) 8.523

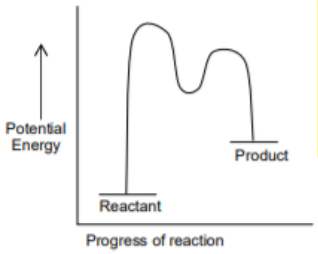
6. The K_{sp} for bismuth sulphide Bi_2S_3 is 1.08×10^{-73}. The solubility of Bi_2S_3 in mol L^{-1} at 298 K is
(A) 1.0×10^{-15} (B) 2.7×10^{-12}
(C) 3.2×10^{-10} (D) 4.2×10^{-8}

(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 among the following statements is/are correct?
(A) pH of 10^{-8} M HCl is equal to 8.
(B) Conjugate base of $H_2PO_4^-$ is HPO_4^{2-}.
(C) pH of 0.1 M NaCl (aqueous solution) $= \frac{1}{2}pK_w$
(D) Ionization of water increases with decrease in temperature.

8. Which of the following solution in water act as buffer?
(A) 0.1 mol of NaOH + 0.15 mol of CH_3COOH.
(B) CH_3COONH_4
(C) 0.5 mol of pyridine + 0.5 mol of Pyridinium chloride.
(D) 0.25 mol of NH_4Cl + 0.5 mol of NaOH.

9. 

Which of the following statement(s) is/are correct for the reaction which energy profile is given above?
(A) It is an endothermic reaction (B) A catalyst may be used for the reaction
(C) It completes in a single step (D) A reaction intermediate is formed

10. Which of the following statement(s) is/are correct?
(A) The relaxation time($t_{average\ life}$) is relevant only to first order kinetics
(B) Time for completion of 90% reaction of first order reaction is 2.303/K
(C) Increase in the concentration of reactant increases the rate of zero order reaction
(D) The half-life of first order reaction is independent of initial concentration

Space For Rough Work

11. For the reaction

$PCl_5(g) \longrightarrow PCl_3(g) + Cl_2(g)$

The forward reaction at constant temperature is favoured by
(A) introduced an inert gas at constant volume
(B) introducing chlorine gas at constant volume
(C) introducing an inert gas at constant pressure
(D) increasing the volume of the container

12. For dissociation of a gas N_2O_5 at $N_2O_5(g) \rightleftharpoons 2NO_2(g) + \frac{1}{2}O_2(g)$. The reaction is performed at constant temperature and volume. If D is the vapour density of equilibrium mixture, P_o is initial pressure of $N_2O_5(g)$ and M is molecular mass of N_2O_5, then the correct information(s) at the equilibrium is/are

(A) the total pressure of gases at equilibrium is $\frac{P_o.M}{2D}$

(B) the degree of dissociation of $N_2O_5(g)$ is $\frac{M-2D}{3D}$

(C) the partial pressure of $N_2O_5(g)$ at equilibrium is $\frac{(5D-M).P_o}{3D}$

(D) the partial pressure of $O_2(g)$ at equilibrium is $\frac{(M-2D).P_o}{3D}$

PART – B
(Numerical Type)

1. The molar solubility of $Cd(OH)_2$ is 1.84×10^{-5} M in water. The expected solubility of $Cd(OH)_2$ in a buffer solution of pH = 12 is $x \times 10^{-10}$ M. Then 'x' is

2. 20 mL of 0.1 M NH_4OH is mixed with 40 mL of 0.05 M HCl. The pH of the mixture is

3. pK_a of CH_3COOH and NH_4OH are 4.76 and 4.74 respectively. pH of 0.1 M CH_3COONH_4 solution is

4. Vapour density of N_2O_4 is 45.86 at a certain temperature. The degree of dissociation of N_2O_4 at the same temperature would be $x \times 10^{-3}$. Then x is

5. For a reaction $A \rightleftharpoons B$ the equilibrium constant is 4×10^5 at 500 K. The ΔG^o for the process in Kcal is

6. The rate constant for a reaction is 2.8×10^{-5} $mol^{-1/2}L^{1/2}s^{-1}$. What is the order of the reaction

Space For Rough Work

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. If a, b, c are non – zero real numbers, then the minimum value of the expression $\frac{\left(a^8+4a^4+1\right)\left(b^4+3b^2+1\right)\left(c^2+2c+2\right)}{a^4b^2}$ equals

(A) 12 (B) 24
(C) 30 (D) 60

2. If α,β,γ are such that $\alpha+\beta+\gamma=2,\ \alpha^2+\beta^2+\gamma^2=6,\ \alpha^3+\beta^3+\gamma^3=8,$ then $\alpha^4+\beta^4+\gamma^4$ is

(A) 5 (B) 18
(C) 12 (D) 36

3. For certain real values of a, b, c and d, the equation $x^4+ax^3+bx^2+cx+d=0$ has four non – real roots. The product of two of these roots is 13 + i and the sum of the other two roots is $3+4i$, where $i=\sqrt{-1}$. Then the value of b equals

(A) 69 (B) 54
(C) 51 (D) 46

4. Exact set of values of a for which $x^3(x+1)=2(x+a)(x+2a)$ is having four real solutions is

(A) $[-1, 2]$ (B) $[-3, 7]$
(C) $[-2, 4]$ (D) $\left[-\frac{1}{8}, \frac{1}{2}\right]$

5. Sum of the series $\frac{3}{4}+\frac{5}{36}+\frac{7}{144}+.....$ upto n terms is equal to

(A) $1-\frac{1}{n^2}$ (B) $\frac{n(n+2)}{(n+1)^2}$
(C) $\frac{n^2+2n+2}{(n+1)^2}$ (D) $1+\frac{1}{n^2}$

Space For Rough Work

6. If the equation $ax^2+bx+c=0(a>0)$ has two roots α and β such that $\alpha<-2$ and $\beta>2$, then which is **NOT** correct?

(A) $b^2-4ac<0$ (B) $c<0$

(C) $a+|b|+c<0$ (D) $4a+2|b|+c<0$

(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. The expression $2^{\left(\sqrt{\log_a \sqrt[4]{ab}+\log_b \sqrt[4]{ab}}-\sqrt{\log_a \sqrt[4]{\frac{b}{a}}+\log_b \sqrt[4]{\frac{a}{b}}}\right)\sqrt{\log_b a}}$ is equal to :

(A) $2^{\log_a b}$ if $1<a<b$ (B) 2 if $1<a<b$

(C) $2^{\log_a b}$ if $1<b<a$ (D) 2 if $1<b<a$

8. The value x satisfying the equation $(\log_2 2x)\left(\log_2{}^2 x+\log_2\left(\frac{2}{x}\right)\right)=2$, is

(A) a prime number (B) a composite number

(C) an even number (D) an odd number

9. Let $\alpha(n)=1-\frac{1}{2}+\frac{1}{3}-.....+(-1)^{n-1}\frac{1}{n}$

(A) $\frac{1}{n+1}+\frac{1}{n+2}+.....+\frac{1}{2n}=\alpha(2n)$ (B) $\alpha(2n)<1\forall n$

(C) $\alpha(2n)\geq 0.5\forall n$ (D) $0.5<\alpha(n)<1\forall n$

10. a, b, c are in 3 distinct numbers in H.P., a, b, c >0, then

(A) $\frac{b+c-a}{a},\frac{c+a-b}{b},\frac{a+b-c}{c}$ are in A.P. (B) $\frac{b+c}{a},\frac{c+a}{b},\frac{a+b}{c}$ are in A.P.

(C) $a^5+c^5\geq 2b^5$ (D) $\frac{a-b}{b-c}=\frac{a}{c}$

11. If the sum of squares of 3 real numbers a, b, c is equal to 1, then the value of expression $(4a-3b)^2+(5b-4c)^2+(3c-5a)^2$ is always less than

(A) 50 (B) 51

(C) 52 (D) 53

Space For Rough Work

12. Let α and β be the roots of $x^2 - x - 1 = 0$, with $\alpha > \beta$. For all positive integers n, define

$a_n = \frac{\alpha^n - \beta^n}{\alpha - \beta}, n \geq 1$

$b_1 = 1$ and $b_n = a_{n-1} + a_{n+1}, n \geq 2$

Then which of the following options is/are correct?

(A) $\sum_{n=1}^{\infty} \frac{a_n}{10^n} = \frac{10}{89}$

(B) $b_n = \alpha^n + \beta^n$ for all $n \geq 1$

(C) $a_1 + a_2 + a_3 + ...a_n = a_{n+2} - 1$ for all $n \geq 1$

(D) $\sum_{n=1}^{\infty} \frac{b_n}{10^n} = \frac{8}{89}$

PART – B
(Numerical Type)

1. The expression $\frac{\left(\log_{\frac{a}{b}} p\right)^2 + \left(\log_{\frac{b}{c}} p\right)^2 + \left(\log_{\frac{c}{a}} p\right)^2}{\left(\log_{\frac{a}{b}} p + \log_{\frac{b}{c}} p + \log_{\frac{c}{a}} p\right)^2}$, wherever defined, simplifies to the number ____

2. In a geometric progression with common ratio q, the sum of the first 109 terms exceeds the sum of the first 100 terms by 12. If sum of the first nine terms of the progression is $\frac{\lambda}{q^{100}}$ then find the value of λ.

3. Sum of three numbers in G.P. is 21 and the sum of their squares is 189. If the common ratio of the G.P. is 'a' or 'b' then a + b equals to

4. Let α, β be the roots of the equation $x^2 + x - 3 = 0$. The value of $\frac{\alpha^3 - 4\beta^2 + 29}{4}$ is equal to

5. Given that a, b are integers and the two real roots α, β of the equation $3x^2 + 3(a+b)x + 4ab = 0$ satisfy the relation $\alpha(\alpha+1) + \beta(\beta+1) = (\alpha+1)(\beta+1)$. The number of ordered pairs (a, b) is equal to

6. Suppose that a, b and c are positive real numbers such that $a^{\log_3 7} = 27$, $b^{\log_7 11} = 49$, and $c^{\log_{11} 25} = \sqrt{11}$. Then $a^{(\log_3 7)^2} + b^{(\log_7 11)^2} + c^{(\log_{11} 25)^2}$ =

Space For Rough Work

QP Code: 100717

ANSWERS

SECTION-1 : PHYSICS

PART – A

1.	C	2.	C	3.	C	4.	C
5.	B	6.	B	7.	ABC	8.	BCD
9.	AB	10.	ABC	11.	ABC	12.	ABCD

PART – B

1.	1.5	2.	6	3.	3.5
4.	0.26 (range: 0.26 to 0.27)			5.	2
6.	1.41 (range: 1.41 to 1.42)				

SECTION – 2 : CHEMISTRY

PART – A

1.	B	2.	B	3.	C	4.	B
5.	C (bonus)	6.	A	7.	BC	8.	ABC
9.	ABD	10.	ABD	11.	CD	12.	ABC

PART – B

1.	2.49 (range 2.4 to 2.6)			2.	5.2 (range 5.1 to 5.3)
3.	7.01	4.	3.05 (range 2.9 to 3.1)		
5.	7.74	6.	1.5		

SECTION – 3 : MATHEMATICS

PART – A

1.	C	2.	B	3.	B	4.	D
5.	B	6.	A	7.	BC	8.	AC
9.	ABC	10.	ABCD	11.	BCD	12.	ABC

PART – B

1.	1.00	2.	12.00	3.	2.50	4.	2.50
5.	4.00	6.	469.00				