FIITJEE (JEE-Advanced)

BATCHES – All 2123 batches (X & A – Iot)

PHYSICS, CHEMISTRY & MATHEMATICS

QP Code:

Common 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 **Three Parts**: **Part-A, B & Part-C** 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 Three Parts.

(i) **Part-A (01-06) –** 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*: –1 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 **–1** marks, as a wrong option is also darkened.

(ii) **Part-B (07-12)** contains Six (06) Numerical based questions with single digit integer as answer, ranging from 0 to 9 (both inclusive) and each question carries **+3 marks** for correct answer and **-1 marks** for wrong answer.

(iii) **Part-C (13-18)** 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 :_____

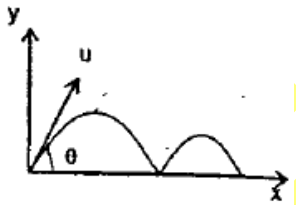
SECTION-1 : PHYSICS

PART – A

(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.

1. 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

1. **AB**

2. Ball A of mass m strikes a stationary ball B of mass M and undergoes an elastic collision. After collision ball A has a speed one third of its initial speed. The ratio of $\frac{M}{m}$ can be

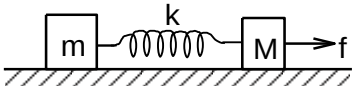
(A) $\frac{1}{4}$ (B) $\frac{1}{2}$ (C) 2 (D) 4

2. **BC**

3. If the external forces acting on a system have zero resultant, the centre of mass
(A) must not move (B) must not accelerate
(C) may move (D) may accelerate

3. **BC**

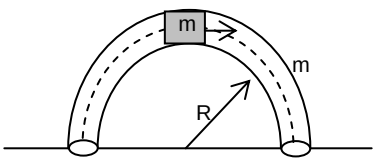
4. A block of mass m is connected to another block of mass M by a massless spring of spring constant k. A constant force f starts acting as shown in figure, then
(A) as observed from ground both blocks will come to momentarily rest simultaneously
(B) as observed from their centre of mass blocks will come to monetarily rest simultaneously



(C) maximum extension in spring will $\frac{2mf}{k(m+M)}$
(D) maximum extension in spring will $\frac{mf}{k(m+M)}$

4. **BC**

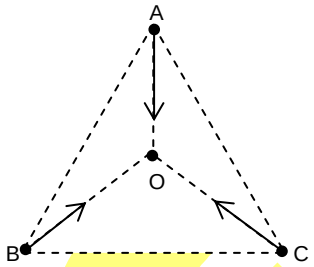
5. In a vertical plane inside a smooth hollow thin tube, a block of same mass as that of tube is released as shown. When it is slightly disturbed it moves towards right. By the time the block reaches the right end of the tube, the displacement of the tube will be (where 'R' is the mean radius of tube the assume that the tube remains in vertical plane) towards left



(A) $\frac{2R}{\pi}$ (B) $\frac{4R}{\pi}$ (C) $\frac{R}{2}$ (D) R

5. **C**

6. Three particle A,B and C of equal masses move with equal speeds v along the medians of an equilateral triangle . After collision A comes to rest while B retraces its path with speed v. The velocity of C is then



(A) V (B) direction $\overrightarrow{OA}$

(C) 2V (D) direction $\overrightarrow{BO}$

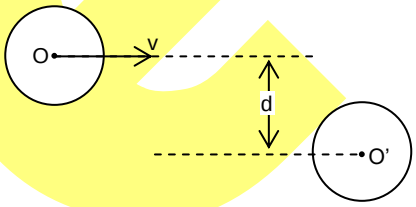
6. **AD**

PART – B

Integer Answer Type

This section contains **6 questions**. The answer to each of the questions is a single digit integer, ranging from **0 to 9**.

7. 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 2m. the magnitude of velocity (in m/s) of the first disc after the collision will be(given d= $\frac{8r}{5}$)

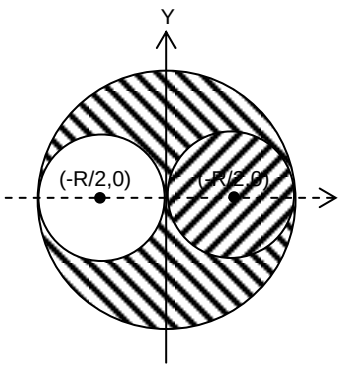


7. **3**

8. Two blocks of masses m_1 = 2 kg and m_2 = 5 kg are moving in the same direction along a frictionless surface with speeds 10 m/s and 3 m/s respectively, m_2 being ahead of m_1. An ideal spring with k = 1120 N/m is attached to the back side of m_2. The maximum compression of the spring when the blocks collide is $\left(\frac{1}{n}\right)$ metre.

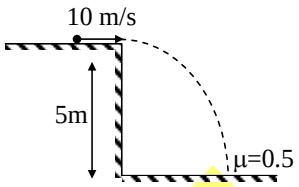
8. **4**

9. Figure shows a uniform disc of radius R from which a hole of radius R/2 has been cut out from left of the centre and is placed on right of the centre of disc. The centre of mass of resulting disc is at a distance R/n from centre of uniform disc. Find the value of n



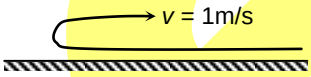
9. **4**

10. 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* = 0.4. Horizontal component of velocity of ball in m/s after Ist impact will be (g = 10 m/s^2)



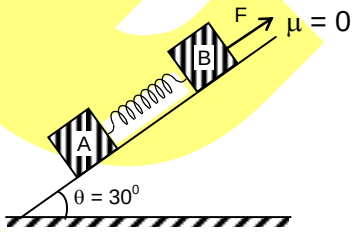
10. **3**

11. 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 $\frac{u}{4}$ m/s, then find the value of 'u' is



11. **3**

12. 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)

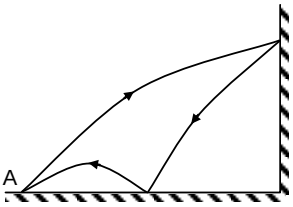


12. **8**

PART – C
(Numerical based)

This section contains **6 questions**, numerical based questions, (answer of which maybe positive or negative numbers or decimals).

13. A small ball is projected from point a on the floor towards a vertical wall as shown in the figure. It hits the wall when its velocity is horizontal. Ball reaches point A after one bounce on the floor. If the coefficient of restitution is the same for the collisions, find its value.

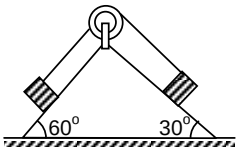


13. **0.50**

14. A body of mass 5m initially at rest explodes into 3 fragments with mass ratio 3 : 1 : 1. Two of fragments each of mass 'm' are found to move with a speed 60 m/s in mutually perpendicular directions. The speed of third fragment is _____. (take $\sqrt{2}$ = 1.414)

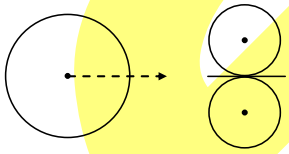
14. **28.28**

15. 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 $\left(\frac{\sqrt{3}-1}{x}\right)g$, then find x. (neglect friction everywhere, take $\sqrt{2}$ = 1.41)



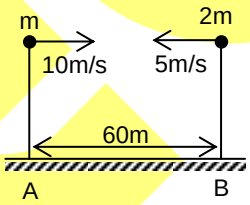
15. **5.64**

16. Two equal discs initially at rest are in contact on a smooth horizontal table. A third disc of same mass but of double radius strikes them symmetrically and comes to rest after impact. the coefficient of restitution is



16. **0.56**

17. Two particles one of mass m and the other of mass 2m are projected horizontally towards each other from the same level above the ground with velocities 10 m/s and 5 m/s respectively. They collide in air and stick to each other. The distance from A where the combined mass finally land is



17. **40.00**

18. If the linear density of the rod of length L varies as $\lambda = A + Bx$, then its centre of mass is given by $X_{CM} = \frac{L(2A+BL)}{x(3A+2BL)}$, then x is _____

18. **3.00**

SECTION-2 : CHEMISTRY

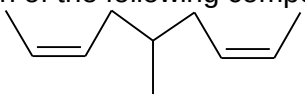
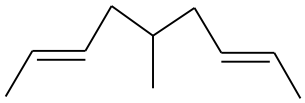
PART – A

(Multi Correct Choice Type)

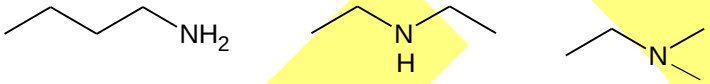
This section contains 6 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

1. In which option(s) the left side molecule boils at higher temperature than the right side molecule?
(A) C_2H_6, CH_4 (B) C_2H_5OH, CH_3OCH_3
(C) CH_3F, CH_3NH_2 (D) n-pentane, neo-pentane

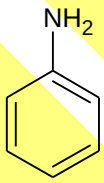
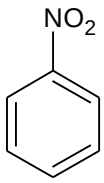
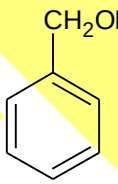
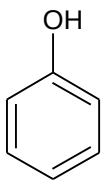
1. ABD

2. Which of the following compound(s) show(s) geometrical as well as optical isomerism?
(A)  (B) 
(C)  (D) 

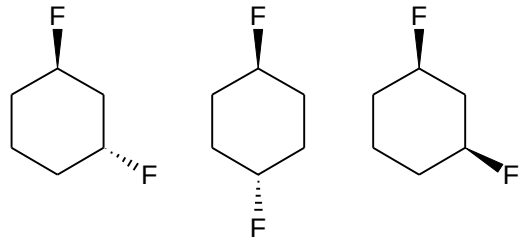
2. BD

3. 
(I) (II) (III)
Which of the following properties is/are different among the above isomers?
(A) Boiling point (B) Solubility in water
(C) Basic strength (D) Reactivity towards HCl

3. ABCD

4. In which molecule(s) both +R and –R effects is/are observed?
(A)  (B) 
(C)  (D) 

4. ABD

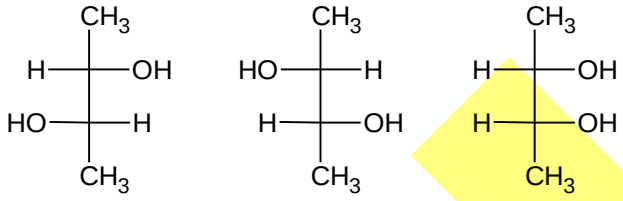
5. 

(I) (II) (III)

The correct statement(s) regarding the above compounds is/are
(A) I and III are geometrical isomers.
(B) 'I' shows geometrical as well as optical isomerism
(C) All the three compounds show geometrical isomerism
(D) Melting point of (II) is higher than that of (III)

5. ABCD

6. The optical isomers of butan-2, 3-diol are given below:



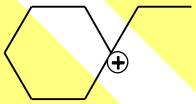
(I) (II) (III)

Which of the following molecules or mixtures show(s) optical rotation?
(A) 50%(I) and 50%(II) (B) 40%(I) and 60%(II)
(C) 50%(I) and 50%(III) (D) 100%(III)

6. BC

PART – B
Integer Answer Type

This section contains **6 questions**. The answer to each of the questions is a single digit integer, ranging from **0 to 9**.

7. 

How many hyperconjugation structure(s) is/are possible for the above reaction intermediate?

7. 6

8. How many isomer(s) containing three-membered monocyclic ring(s) is/are possible with formula C_4H_6?

8. 3

9. What is the sum of the number of C – C and C – N bonds, present in the most basic isomer of formula $C_4H_9NH_2$?

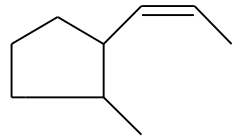
9. 4

10. The formula of a free radical is $C_5H_9^{\odot}$. How many straight chain allylic free radical(s) is/are possible with that formula? [consider stereoisomers, do not consider delocalization of free radicals]

10. 5

11. The formula of an alkyl chloride is C_4H_9Cl. Four structural isomers are possible for it. Treatment of $AgNO_3$ with the isomers, produce carbocations with different yields. How many alpha hydrogen atom(s) is/are present in the product having maximum yield?

11. 9

12. 

How many geometrical isomers is/are possible for the above compound?

12. 4

PART – C
(Numerical based)

This section contains **6 questions**, numerical based questions, (answer of which maybe positive or negative numbers or decimals).

13. An aromatic monochloride(A) upon ionization forms a carbocation that shows aromatic behaviour. What will be the molar mass of (A) in g mol^{-1} if it is only monochloro substituted seven membered ring compound?

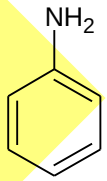
13. 126.5

14. Chlorine exhibits –I and +R effect in a unsubstituted cyclic compound. The compound can contain a maximum of three conjugated (alternate) double bonds. What is the molar mass of the cyclic chloride in g mol^{-1} unit?

14. 112.5

15. Compound(X) is the most acidic chlorosubstituted ethanoic acid. What mass percentage of chlorine is present in(X)?

15. 65.13 (65.12 to 65.23)

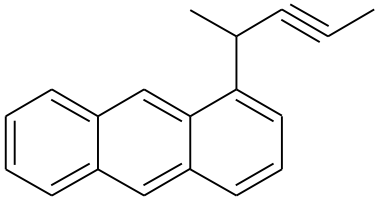
16. The structure of aniline is 

. What is the molar mass of the most stable resonating structure of aniline in g mol^{-1} unit?

16. 93

17. What is the molar mass in g mol^{-1} unit of the most acidic chlorosubstituted product of methane(CH_4)?

17. 119.5

18. 

In the above structure if
x = Number of double bond equivalent
y = Number of pi-electrons
z = Number of asymmetric carbon atoms
What is the sum of (x + y + z)?

18. 31

SECTION-3 : MATHEMATICS

PART – A

(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.

1. Roots of the quadratic equation $(\sin^2\theta)\,x^2 - x + \cos^2\theta = 0$ are given by
   (A) -1 (B) 2
   (C) 1 (D) –2

1. C

2. If a, b, c $\in$R, the roots of quadratic equation $(x-a)(x-b)+(x-b)(x-c)+(x-c)(x-a)=0$ are
   (A) rational (B) irrational
   (C) imaginary (D) real

2. D

3. A quadratic equation whose roots are $\sec^2\alpha$ and $\text{cosec}^2\alpha$ cannot be;
   (A) $x^2 - 2x + 2 = 0$ (B) $x^2 - 3x + 3 = 0$
   (C) $x^2 - 4x + 4 = 0$ (D) none of these

3. AB

4. If discriminant of a quadratic equation $ax^2 + bx + c = 0$ is a perfect square then roots are always
   (A) rational (B) integers
   (C) imaginary (D) none of these

4. D

5. If a, b, c are odd integers, then roots of the quadratic equation $ax^2 + bx + c = 0$ is/are
   (A) are always rational (B) cannot be rational
   (C) are imaginary (D) none of these

5. B

6. Roots of the equation $(a+b-2c)\,x^2 + (b+c-2a)\,x + (c+a-2b) = 0$ is/are
   (A) 1 (B) $\dfrac{c+a-2b}{a+b-2c}$
   (C) 2 (D) None of these

6. AB

PART – B
Integer Answer Type

This section contains **6 questions**. The answer to each of the questions is a single digit integer, ranging from **0 to 9**.

7. If $(1 + m)x^2 - 2(1 + 3m)x + (1 + 8m) = 0$ has equal roots, then number of integral values of m is equal to

7. 2

8. The number of integral values of 'a' for which the quadratic expression $x^2 - ax + 4$ is non–negative for all real values of x; is given by

8. 9

9. If the product of the roots of the equation $x^2 - 3kx + 2e^{2\log_e k} - 1 = 0$ is 7, then the roots are real for k equal to

9. 2

10. If $ax^2 + bx + c = 0$ is satisfied by every value of x, then $a + 2b - 3c + 4$ equals to

10. 4

11. The integer k for which the inequality $x^2 - 2(4k - 1)x + 15k^2 - 2k - 7 > 0$ is valid for any x, is

11. 3

12. The equations $ax^2 + bx + a = 0$, $x^3 - 2x^2 + 2x - 1 = 0$ have two roots in common. Then $a + b + 3$ must be equal to

12. 3

PART – C
(Numerical based)

This section contains **6 questions**, numerical based questions, (answer of which maybe positive or negative numbers or decimals).

13. The value of $81^{\left(\frac{1}{\log_5 3}\right)} + 27^{\log_9 36} + 3^{\frac{4}{\log_7 9}}$ is equal to

13. 890

14. If $\log_{0.3}(x-1) < \log_{0.09}(x-1)$, then number of integral values of x in the interval (0, 20) is

14. 17

15. If x_1, x_2 are roots of $x^2 - 3x + a = 0$, $a \in R$ and $x_1 < 1 < x_2$ then number of integral values of a in interval (–10, 2) equal to

15. 11

16. If α, β roots of $x^2 + (\sin\theta - 1)x - \frac{1}{2}\cos^2\theta = 0$ then maximum value of $\alpha^2 + \beta^2$ is equal to

16. 4

17. If $a \in z$, (the set of integers) and the equation $(x - a)(x - 10) + 1 = 0$ has integral roots, then the sum of values of a is

17. 20

18. If $p, q \in \{1, 2, 3, 4\}$, the number of equations of the form $px^2 + qx + 1 = 0$ having real roots is

18. 7

ANSWERS

SECTION-1 : PHYSICS

PART – A

PART – B

SECTION – 2 : CHEMISTRY

PART – A

PART – B

SECTION – 3 : MATHEMATICS

PART – A

PART – B