FIITJEE (JEE-Advanced)

BATCHES – All 2022 batches (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 :_____

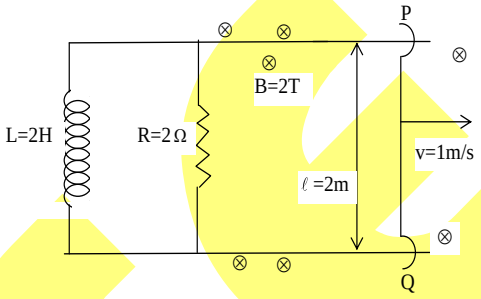
SECTION-1 : PHYSICS

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.

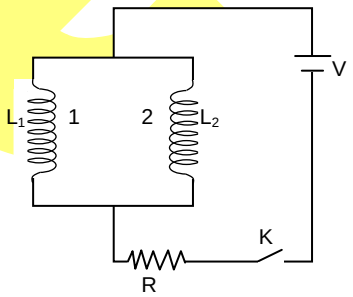
1. The given figure shows an inductor and resistance fixed on a conducting wire. A movable wire PQ starts moving on the fixed rails from t = 0 with constant velocity 1 m/s. A constant magnetic field (B = 2T) exist perpendicular to the plane of paper. The work done by the external force on the wire PQ in 2 second is



(A) 16 J (B) 32 J
(C) 48 J (D) 64 J

1. **B**

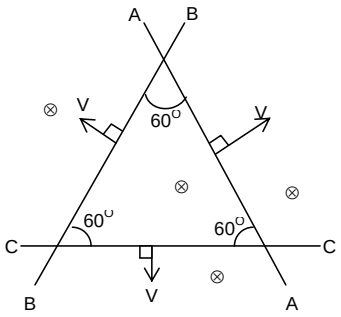
2. In the figure shown the key is switched on at t = 0. Let I_1 and I_2 be the currents through inductors having self inductances L_1 and L_2 at any time t respectively. The magnetic energy stored in the inductors 1 and 2 be U_1 and U_2. Then $\frac{U_1}{U_2}$ at any instant of time is



(A) $\frac{L_1}{L_2}$ (B) $\frac{L_2}{L_1}$ (C) $\frac{I_1}{I_2}$ (D) $\frac{I_2}{I_1}$

2. **BC**

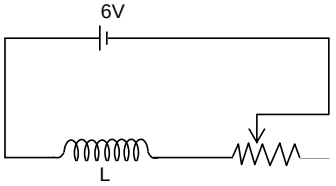
3. Three long rods AA, BB, CC are moving with a speed v in a uniform magnetic field B_0 perpendicular to the plane of paper as shown in the figure. The triangle formed between the three wires is always an equilateral triangle. The induced the three wires is always an equilateral triangle. The induced current in the triangle is (resistance per unit length of wire is λ)



(A) $B_0v/3\lambda$ (B) $2B_0v/3\lambda$
(C) $B_0v/\sqrt{3\lambda}$ (D) vB_0/λ

3. **D**

4. In the circuit shown, sliding contact is moving with uniform velocity towards right. Its value at some instance is 12 Ω. The current in the circuit at this instant of time will be



(A) 0.5 A
(B) More than 0.5 A
(C) Less than 0.5 A
(D) May be less or more than 0.5 A depending on the value of L

4. **B**

5. A circular coil of n turns and radius r is placed in a uniform magnetic field B. Initially the plane of the coil is perpendicular to the field. The coil is rotated through 180° in time T about one of its diameter such that its plane is still perpendicular to the field. If the resistance of the coil is R. Then

(A) the average emf induced in the coil = $\frac{2n\pi r^2B}{T}$

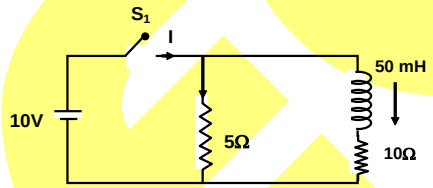
(B) the average current induced in the coil = $\frac{2n\pi r^2B}{RT}$

(C) the charge passing through the coil = $\frac{2n\pi r^2B}{R}$

(D) none of these

5. **ABC**

6. In the given circuit, key S_1 is closed at t = 0, then the current I is



(A) at t = 0, I = 3A
(B) at t = 0, I = 2A
(C) at t = ∞, I = 3A
(D) at t = ∞, I = 2A

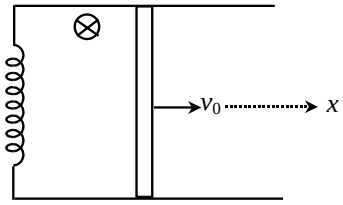
6. **BC**

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. A loop is formed by two parallel conductors connected by a solenoid with inductance L = 2H and a conducting rod of mass m = 8kg which can freely (without friction) slide over the conductors. The conductors are located in a horizontal plane and in a uniform vertical magnetic field B= πT. The distance between the conductors is l = 2m. At the moment t = 0, the rod is imparted on initial velocity v0 = 2m/s directed to the right. Find the time period of oscillation of rod in sec if the resistance of loop is negligible.

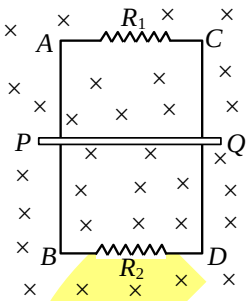


7. **4**

8. A uniform disc of radius R having charge Q distributed uniformly all over its surface is placed on a smooth horizontal surface. A magnetic field, B = kxt^2, where k is a constant, x is the distance (in metre) from the centre of the disc and t is the time (in second), is switched on perpendicular to the plane of the disc. Find the torque (in N-m) acting on the disc after 15 sec. (Take 4kQ = 1 S.I. unit and R = 1 m)

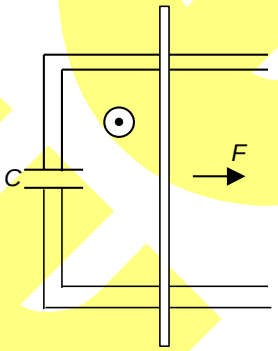
8. **1**

9. Two parallel vertical metallic rails AB and CD are separated by 1 m. They are connected at the two ends by resistances R_1 and R_2 as shown. A horizontal metallic bar PQ of mass 0.2 kg slides without friction, vertically down the rails under the action of gravity. There is uniform horizontal magnetic field of 0.6 T perpendicular to plane of the rails. It is observed that when the terminal velocity attained, the power dissipated in R_1 and R_2 are 0.76 W and 1.2 W respectively. Find the terminal velocity of bar in m/s. ($g = 9.8\ m/s^2$)



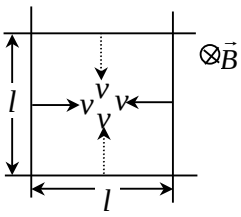
9. **1**

10. A conductor of mass $\frac{1}{4}$ kg and length 2 m can move without friction along two metallic parallel tracks in a horizontal plane and connected across a capacitor C = 1000 μF. The whole system is in a magnetic field of magnetic inductance B = 2 tesla directed outward to the plane. A constant force F = 1.33 N is applied to the middle of conductor perpendicular to it and parallel to the tracks. Find the acceleration of conductor neglecting all resistances. Assume that the conductor started from rest.



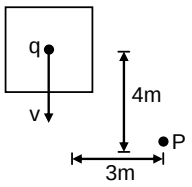
10. **5**

11. In the figure shown the four rods have λ = 0.5 Ω/m resistance per unit length. The arrangement is kept in a magnetic field of constant magnitude B = 2T and directed perpendicular to the plane of the figure and directed inwards. Initially the rods form a square of side length l = 15m as shown. Now each wire starts moving with constant velocity v = 5 m/s towards opposite wire. The force required in newton on each wire to keep its velocity constant at t = 1 sec is 100 K. The value of 'K' is



11. **2**

12. An elevator carrying a charge of 0.5 C is moving down with a velocity of 5×10^3 m/s. The elevator is 4 m from the bottom find out magnetic field (in μT) does it produce at point P.

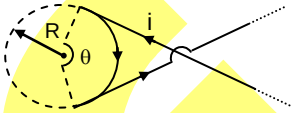


12. **6**

PART – C
(Numerical based)

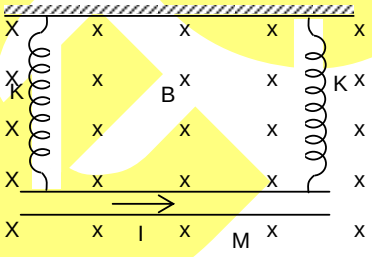
This section contains **6 questions**, numerical based questions, (answer of which maybe positive or negative numbers or decimals).

13. A wire carrying current i has the configuration shown in figure. Two semi-infinite straight section, each tangent to the same circle, are connected by a circular arc, of angle θ, along the circumference of the circle, with all sections lying in the same plane. What must θ (in rad) be in order for B to be zero at the centre of circle?



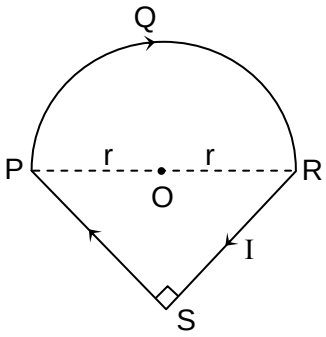
13. **2**

14. A metal rod of mass 10gm and length 25 cm is suspended on two springs as shown in figure. The springs are extended by 4 cm. When a 20 ampere current passes through the rod it rises by 1 cm. The magnetic field is $x \times 10^{-2}$ T ($g = 10$ m/s^2). Find the value of 2x.



14. **1**

15. A steady current I = 10 A goes through a wire loop PQRS. Part PQR is semi-circle of radius r = 1 m. RS = SP and $\angle$RSP = 90°. Find the magnetic field at O in 10^{-6}T to the nearest integer.



15. **7**

16. An L-C-R series circuit with 100 Ω resistance is connected to an *ac* source. When only the capacitance is removed, the current lags behind voltage by $\frac{\pi}{4}$. When only the inductance is removed, the current leads voltage by $\frac{\pi}{4}$. Then find out Inductive reactance.

16. **100**

17. The current in ampere in an inductor is given by I = 5 + 16t where t is in s. The self induced e.m.f. in it is 100V. Then find out self inductance.

17. **6.25**

18. A conducting circular loop of radius 5.0 cm is placed perpendicular to a magnetic field of 0.50 T. It is removed from the field in 0.5 sec. Then find out average emf induced in the loop during this time in mV.

18. **7.86 (range 7.84 to 7.88)**

SECTION-2 : CHEMISTRY

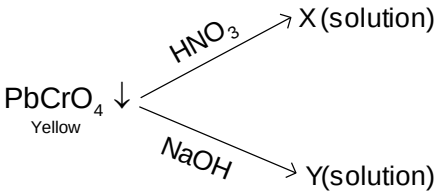
PART – A

(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. The crystal structure of diamond is similar (with respect to the number of species per unit cell) to that of
(A) ZnS (B) NaCl
(C) CsCl (D) Silicon(Si)

1. AD

2. 

The correct statement(s) regarding above reactions is/are
(A) HNO_3 behaves as an oxidizing agent
(B) colour of solution(X) is orange
(C) solution(Y) contains two type of anions
(D) colour of solution(Y) is yellow

2. BCD

3. A metal crystallizes in simple cubic, body centre cubic and face centre cubic unit cells with identical edge length(assume), depending on temperature. Choose correct statements
(A) simple cubic unit cells are called primitive unit cells
(B) the density of metal is maximum in fcc unit cell
(C) volume of bcc unit cell is less than fcc unit cell
(D) Schottky defect is most prominent in fcc unit cell of covalent solids.

3. AB

4. Which of the following reaction(s) is/are accompanied with decrease in entropy?
(A) $Fe^{2+}(aq)+\left[Fe(CN)_6\right]^{3-}(aq)\longrightarrow Fe^{3+}(aq)+\left[Fe(CN)_6\right]^{4-}(aq)$
(B) $Ba^{2+}(aq)+SO_4^{2-}(aq)\longrightarrow BaSO_4(s)$
(C) $Co^{2+}(aq)\longrightarrow Co^{3+}(aq)$
(D) $CO_3^{2-}(aq)+2H^{+}(aq)\longrightarrow CO_2(g)+H_2O(\ell)$

4. AC

5. The correct statement(s) regarding Frenkel defect is/are
(A) it takes place in compounds containing small size cations and large size anions
(B) density of the solid remains constant in this defect
(C) the defected solids are more soluble in water than the undefected or pure ones
(D) KCl is more prone to Frenkel defect than NaCl

5. ABC

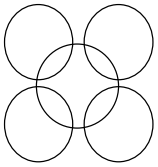
6. $CO_3^{2-} + 2Ag^+ \longrightarrow \underset{\text{White}}{Ag_2CO_3} \downarrow$

The white precipitate in above reaction
(A) becomes soluble in HNO_3 and NH_4OH
(B) become brown upon addition of excess NH_4OH
(C) turns brown if heated
(D) form silver carbide if heated with excess oxygen

6. ABC

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. 

What is the coordination number of a cubic metallic solid, if the packing is done in above way?

7. 8

8. If the oxidation number of iron in $Na_4[Fe(CN)_5NOS]$ is +x, what is x?

8. 2

9. A metal crystal contains face centre cubic unit cell. The edge-length of the unit cell is $6\sqrt{2}$ pm. What is the radius of the metal atoms in pm unit?

9. 3

10. $Pb(NO_3)_2 \xrightarrow{OH^-(\text{excess})} \left[Pb(OH)_x\right]^{y-}$

What is the value of (x + y)?

10. 6

11. How many of the following reagent(s) can produce Br_2 from KBr?
Conc. H_2SO_4, Conc.H_3PO_4, Conc. HCl, Cl_2 water, H_2S, HNO_3, Charcoal, I_2, NaOH

11. 3

12. If the ratio of tetrahedral voids occupied by S^{2-} ions to the total number of tetrahedral voids in the zinc blend structure of ZnS is x: y, then (x + y) is

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 interionic distance in CsCl is 356 pm. The radius of Cs^+ and Cl^- ions are respectively 167 and 202 pm. By what percentage is the interionic distance smaller than the sum of ionic radii?

13. 3.5(range 3.4 to 3.7)

14. How many moles of NaOH can completely react with 0.1 mole of $Fe_4[Fe(CN)_6]$ to form brown colour precipitate?

14. 1.2

15. A metal crystal contains b.c.c unit cell. If x% of the edge length of the unit cell is not covered by atoms, what is the value of x?

15. 13.4(range 13.4 to 13.5)

16. A mixture of sodium salt of anions A and B are treated with excess $CaCl_2$ solution. A white precipitate of CaA is formed. After filtration, when NH_3 is added to the filtrate, the same precipitate CaA is again formed. What is the mass of the anion B in g mol^{-1} unit?

16. 61

17. Upon heating, a metal changes it's b.c.c crystalline form to f.c.c. crystal, without changing it's radius. If the ratio of densities of the crystal, before heating and after heating is $\frac{\left(\sqrt{2}\right)\left(\sqrt{3}\right)(x)}{(y)}$, then x + y is

17. 11

18. $SO_3^{2-} + Zn + H_2SO_4 \longrightarrow Zn^{2+} + A\uparrow + H_2O$

What is the molar mass of the gas evolved in above reaction in g mol^{-1} unit?

18. 34

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. The area of the region bounded by the curve $[x]+[y]=a$ in first quadrant is (where [.] denotes the greatest function)

(A) $(a+1)$ if $(a \in I^+)$ (B) 0 if $(a \in I^-)$

(C) a^2+1 if $(a \in I^+)$ (D) 1 if $(a=0)$

1. **ABD**

2. The area bounded by the region $x^2+y^2 \le a^2$ and $|x|+|y| \ge a$ is $8(\pi-2)$ sq. units. Then a is (are) equal to

(A) $2\sqrt{2}$ (B) $\sqrt{2}$

(C) $-\sqrt{2}$ (D) $-2\sqrt{2}$

2. **AD**

3. Let the area of the bounded region enclosed between the parabola $y=x-bx^2$ and $y=\frac{x^2}{b}$ is 'A' . Then

(A) $A=\frac{b^2}{6(1+b^2)^2}$ (B) $A_{max}=\frac{1}{12}$

(C) $A=\frac{b^2}{3(1+b^2)^2}$ (D) $A_{max}=\frac{1}{24}$

3. **AD**

4. If $c_1 \equiv y=\frac{1}{1+x^2}$ and $c_2 \equiv y=\frac{x^2}{2}$ be two curve lying in xy plane. Then

(A) area bounded by curve $y=\frac{1}{1+x^2}$ and y = 0 is π

(B) area bounded by C_1 and C_2 is $\frac{\pi}{2}-\frac{1}{3}$

(C) area bounded by C_1 and C_2 is $1-\frac{\pi}{2}$

(D) area bounded by curve $y=\frac{1}{1+x^2}$ and x – axis is $\frac{\pi}{2}$

4. **AB**

5. If area bounded by the curves $y^2=4ax$ and $y=mx$ is $\frac{a^2}{3}$, then the value of m is

(A) 2 (B) –2

(C) 1 (D) –1

5. **AB**

6. For which of the following values of m, the area of the region bounded by the curves $y = x - x^2$ and the line y = mx equals $\frac{9}{2}$?

(A) –4 (B) –2
(C) 2 (D) 4

6. **BD**

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. The area bounded by the curves $y = \left|\left[x - 2\right]\right|$, the x – axis and the lines $x = -1$ and x = 2 is ([.] G.I.F.)

7. 6

8. Area enclosed by the curve $|x-2| + |y+1| = 1$ is equal to

8. 2

9. The area bounded by $y = xe^{|x|}$ and lines $|x| = 1$ and y = 0 is

9. 2

10. The area bounded by the curves $y = \sqrt{x}$, $2y + 3 = x$ and x – axis in the 1st quadrant is

10. 9

11. If the area above the axis, bounded by the curves $y = 2^{kx}$ and x = 0 and $x = 2$ is $\frac{3}{\ln 2}$, then the value of k is

11. 1

12. The area enclosed between the curve $y = \log_e(x + e)$ and the co – ordinate axis is

12. 1

PART – C
(Numerical based)

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

13. The area of the region bounded by two branches of the curve $(y - x)^2 = x^3$ and the straight line x = 1 is

13. 0.80

14. Let f(x) be a continuous function such that the area bounded by the curve $y = f(x)$, axis and the two ordinates x = 0 and x =a is $\frac{a^2}{2} + \frac{a}{2}\sin a + \frac{\pi}{2}\cos a$. Then $f\left(\frac{\pi}{2}\right)$ is

14. 0.50

15. Area of the figure bounded by $y \le 3 - |3 - x|$ and $y \ge |x - 3|$ is equal to

15. 4.5

16. For $0 \le x \le \pi$ the area bounded by y = x and y = x + sin x, is

16. 2

17. Area of the triangle formed by the x – axis and tangent and normal drawn to the curve $y = x^2$ at (1, 1) is equal to

17. 1.25

18. Area bounded by the curve $y = (x-1)(x-2)(x-3)$ and x – axis lying between the ordinates x = 0 and x = 3 is equal to (in sq. units)

18. 2.75

ANSWERS

SECTION-1 : PHYSICS

PART – A

PART – B

SECTION – 2 : CHEMISTRY

PART – A

PART – B

SECTION – 3 : MATHEMATICS

PART – A

PART – B