FIITJEE (JEE-Advanced)

BATCHES – 2022 Batches (B & E – 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. An emf is produced in a coil, which is not connected to an external voltage source. This can be due to:
(A) the coil being in a time-varying magnetic field.
(B) the coil moving in a time-varying magnetic field.
(C) the coil is rotating in constant magnetic field.
(D) the coil is stationary in external spatially varying magnetic field, which does not change with time.

1. **ABC**

2. A current carrying infinitely long wire is kept along the diameter of a circular wire loop, without touching it. The correct statements are:
(A) the emf induced in the loop is zero if the current is constant.
(B) the emf induced in the loop is finite if the current is constant.
(C) the emf induced in the loop is zero if the current decreases at steady rate.
(D) the emf induced in the loop is finite if the current decreases at steady rate.

2. **AC**

3. The mutual inductance M_{12} of coil 1 w.r.t. coil 2 is:
(A) increases when they are brought together.
(B) depends upon the current passing through the coils.
(C) increases when one them is rotated about an axis.
(D) is the same M_{21} of coil 2 w.r.t. coil 1.

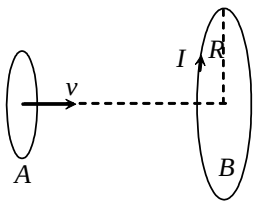
3. **AD**

4. Two different coils have self inductances L_1 = 8 mH and L_2 = 2 mH. The current in one coil is increased at a constant rate. The current in the second coil is also increased at the same constant rate. At a certain instant of time, the power given to the two coils is the same.
At this time the current, the induced voltage and the energy stored in the first coil are i_1, V_1 and U_1 respectively. Corresponding values for the second coil at the same instant are i_2, V_2 and U_2 respectively. Then

(A) $\frac{i_1}{i_2}=\frac{1}{4}$ (B) $\frac{i_1}{i_2}=4$ (C) $\frac{U_2}{U_1}=4$ (D) $\frac{V_2}{V_1}=\frac{1}{4}$

4. **ACD**

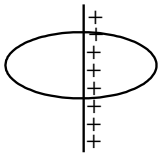
5. Loop A of radius $r(r \ll R)$ moves towards a constant current carrying loop B with a constant velocity v in such a way that their planes are parallel and coaxial. The distance between the loops when the induced emf in loop A is maximum is



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

5. **C**

6. A very long uniformly charged rod falls with a constant velocity V through the center of a circular loop. Then the magnitude of induced emf in loop is (charge per unit length of rod = λ)



(A) $\frac{\mu_0}{2\pi}\lambda V^2$ (B) $\frac{\mu_0}{2}\lambda V^2$

(C) $\frac{\mu_0}{2\lambda}V$ (D) zero

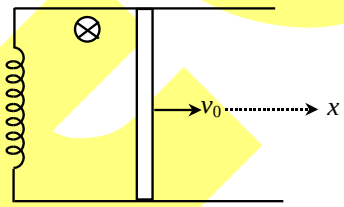
6. **D**

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 = 2 H and a conducting rod of mass m = 8 kg 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 V_o = 2m/s directed to the right. Find the minimum time (in second) in which it will come to initial position if the resistance of loop is negligible.

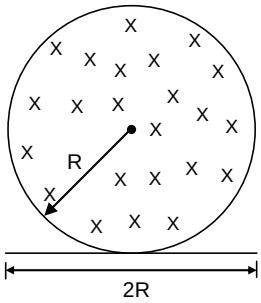


7. **2**

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 2kQ = 1 S.I. unit and R = 1m)

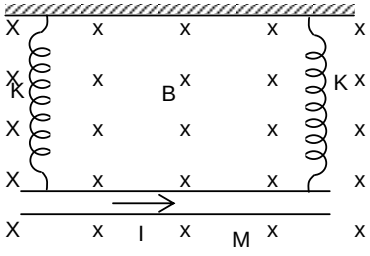
8. **3**

9. A uniform but time varying magnetic field is present in a circular region of radius R = 4 m. The magnetic field is perpendicular and into the plane of the paper and the magnitude of the field is increasing at a constant rate $\alpha = \frac{1}{\pi}$ T sec^{-1}. There is a straight conducing rod of length 2R placed as shown in the figure. Find the magnitude of induced emf (in volt) across the rod.



9. **4**

10. 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 × 10^{-2} T (g = 10 m/s^2). Find the value of 2x.



10. **1**

11. The current in the coil of self inductance two henry is increasing according to $I = 2\sin t^2$. Find the amount of energy spent during the period when the current changes 0 to 2 ampere.

11. **4**

12. Average power in purely inductive circuit is

12. **0**

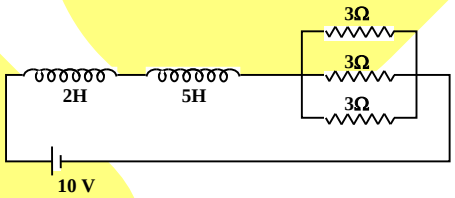
PART – C
(Numerical based)

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

13. A coil of resistance 10 ohm has a flux change of 0.05 Wb to 0.55 Wb in 0.1 sec. What is the induced current? (in Ampere)

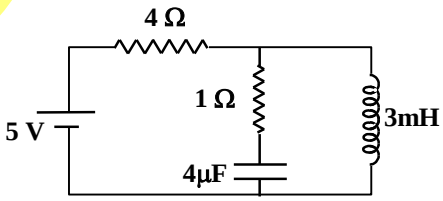
13. **0.5**

14. The time constant for given circuit is (consider coupling constant is zero)



14. **7**

15. In the figure shown the steady state current through the inductor will be



15. **1.25**

16. An average emf of 2.4V is induced in coil, when current of 5.0 Amp is changed to 20 Amp in $\frac{1}{4}$ seconds. The coefficient of self induction (in henry) will be

16. **0.04**

17. A coil of inductance L = 300mH and resistance R = 140 m ohm is connected to a constant voltage source. Current in the coil will reach to 50% of its steady state value after t is equal to

17. **1.5**

18. The self-inductance of two coils is 9 henry and 4 henry respectively. Find the maximum mutual inductance produced by these coils.

18. **6**

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. Which of the following statements is(are) correct for the diamond structure?
   (A) Each atom has 4 nearest neighbours and 12 next nearest neighbours.
   (B) It is relatively empty
   (C) The maximum proportion of the available volume which may be filled by hard spheres is only 0.34
   (D) The maximum proportion of the available volume which may be filled by hard spheres is only 0.46

1. ABC

2. An hcp and a ccp structure for a given element would be expected to have
   (A) the same coordination number (B) the same density
   (C) the same packing fraction (D) all of these

2. AC

3. Which of the following statements is(are) correct for both fluorite and antifluorite structures?
   (A) Cation is present in alternative tetrahedral voids
   (B) Anion constitutes lattice
   (C) Number of formula unit in one unit cell is 4
   (D) 100% tetrahedral voids are occupied

3. CD

4. Select the correct statement(s).
   (A) Solids with F-centres are paramagnetic
   (B) Ferrimagnetic character of Fe_3O_4 at room temperature changes to paramagnetic character at 850 K
   (C) Anti-ferrimagnetic V_2O_3 changes to paramagnetic at 150 K
   (D) Non-stoichiometric Cu_2O is a p-type semiconductor

4. ABCD

5. Which of the following cations will turn borax bead green in an oxidizing flame?
   (A) Fe^{2+} (B) Mn^{2+}
   (C) Cr^{3+} (D) Cu^{2+}

5. AC

6. A mixture of two salts is used to prepare a solution 's' which gives the following results

$$\text{White ppt(s) only} \xleftarrow[\text{Room temp}]{\text{Dil NaOH}} \underset{\text{(aq. sol of the salts)}}{\text{s}} \xrightarrow[\text{Room temp}]{\text{Dil.HCl}} \text{White ppt(s) only}$$

   The correct option(s) for the salt mixture is(are)
   (A) $Pb(NO_3)_2$ and $Zn(NO_3)_2$ (B) $Pb(NO_3)_2$ and $Bi(NO_3)_2$
   (C) $AgNO_3$ and $Bi(NO_3)_2$ (D) $PbNO_3$ and $Hg(NO_3)_2$

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. The number of next nearest neighbour in fcc unit cell is

7. 6

8. The coordination number of Na^+ in Na_2O is

8. 4

9. Two ions A^+ and B^- have ionic radii 88 and 200 pm respectively. In the close-packed crystal of compound AB, predict the coordination number of A^+.

9. 6

10. A compound forms hcp structure. What is the number of moles of tetrahedral voids in 0.5 mol of it?

10. 1

11. Among PbS, CuS, HgS, MnS, Ag_2S, NiS, CoS, CdS, the total number of black coloured sulphides is

11. 6

12. If the oxidation state of iron in $[Fe(H_2O)_5NO]SO_4$ is +x, then x 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. Gold crystallizes in fcc lattice and has atomic radius 0.144 nm. What will be the nearest neigbour distance 'd' in nm?

13. 0.29

14. If the simplest fraction of voids occupied by Zn^{2+}ion in the unit cell of ZnS is expressed as x/y, then (x + y) is

14. 4

15. Experimentally it is found that a metal oxide has formula $M_{0.98}O$ metal M is present in M^{2+} and M^{3+} in it. The % fraction of metal which exists as M^{3+} would be

15. 4.08

16. The unit cube length for LiCl(NaCl structure) is 5.14 $\overset{o}{A}$. Assuming anion-anion contact, calculate the ionic radius for Cl^- ion in $\overset{o}{A}$.

16. 1.81

17. The average oxidation state of Fe in Prussian blue coloured complex $Fe_4[Fe(CN)_6]_3$ is

17. 2.57

18. A solution of Hg^{2+} ion on treatment with a solution of cobalt(II) thiocyanate give rise to a deep blue crystalline precipitate. The coordination number of Hg in the deep blue coloured compound is

18. 4.0

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. A point 'P' moves in xy – plane in such a way that $\left[|x|\right]+\left[|y|\right]=1$, where [·] denotes the G.I .F. Area of the region representing all possible positions of the point 'P' is a multiple of
(A) 8 (B) 4
(C) 16 (D) 2

1. ABD

2. The area of the region for which $0 < y < 3 - 2x - x^2$ and $x > 0$ is ***not equal to***

(A) $\int_1^3 (3-2x-x^2)dx$ (B) $\int_0^3 (2-2x-x^2)dx$

(C) $\int_0^1 (3-2x-x^2)dx$ (D) $\int_{-1}^3 (2-2x-x^2)dx$

2. ABD

3. Let A_1 be the area of the region bounded by the curves y = sinx, y = cosx and y-axis in the first quadrant. Also, let A_2 be the area of the region bounded by the curves y = sinx, y = cosx, x-axis and $x=\frac{\pi}{2}$ in the first quadrant. Then,

(A) $A_1 = A_2$ (B) $A_1 : A_2 = 1 : \sqrt{2}$
(C) $A_1 + A_2 = 1$ (D) $A_1 + A_2 = 1 + \sqrt{2}$

3. BC

4. Consider the region R = {(x, y) $\in R^2$: $x^2 \le y \le 2x$}. If a line $y = \alpha$ divides the area of region R into two equal parts, then which of the following is/ are **not true**?
(A) $\alpha^3 - 6\alpha^{3/2} - 16 = 0$ (B) $3\alpha^2 - 8\alpha + 8 = 0$
(C) $\alpha^3 - 6\alpha^2 + 16 = 0$ (D) $3\alpha^2 - 8\alpha^{3/2} + 8 = 0$

4. ABC

5. The area bounded by $y = x.e^{|x|}$ and lines $|x|=1$, $y=0$ is ***not a multiple*** of
(A) 4 (B) 6
(C) 1 (D) 2

5. AB

6. For $a > 0$, let the curves $C_1 : y^2 = ax$ and $C_2 : x^2 = ay$ intersect at origin O and a point P. Let the line $x = b(0 < b < c)$ intersect the chord OP and the x- axis at points Q and R, respectively. If the line $x = b$ bisects the area bounded by the curves, C_1 and C_2, and the area of $\Delta OQR = \frac{1}{2}$, then 'a' **does not satisfy the equation**:

(A) $x^6 - 12x^3 - 4 = 0$ (B) $x^6 - 12x^3 + 4 = 0$

(C) $x^6+6x^3-4=0$ (D) $x^6-6x^3+4=0$

6. ACD

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. Area bounded by the curves $y=\left[\frac{x^2}{64}+2\right]$ ([ ] denotes the greatest integer function), $y=x-1$ and x=0 above the x-axis is

7. 4

8. Find the area bounded by $y=x+\sin x$ and its inverse function between $x=0$ to $x=2\pi$

8. 8

9. Let $A_1, A_2, A_3, \ldots\ldots$ be squares such that for each $n\geq 1$, the length of the side of A_n equals the length of diagonal of A_{n+1}. If the length of A_1 is 12cm then smallest value of an for which area of A_n is less than one, is …….

9. 9

10. The area enclosed by the region $[x][y]=2$ where [ ] is greatest integer function is

10. 4

11. Let $f(x)=x^2+ax+b, (a^2<4b)$ area bounded by $y=f(x)$, x-axis and lines x = 0 to x = 1 is $\frac{1}{4k}(5f(1)-f(-1)+8f(0))$ sq.units then the value of k

11. 3

12. Value of the parameter k such that area bounded by $y=x^2-3$ and the line y = kx + 2, attains its minimum value is

12. 0

PART – C
(Numerical based)

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

13. Double of the area of the region bounded by the parabola $y=x^2-3x$ with $y\leq 0$ is

13. 9

14. The graphs of sine and cosine functions, intersect each other at a number of points and between two consecutive points of intersection, the two graphs enclose the same area A. Then A^4 is equal to

14. 64

15. The area (in sq. units) of the largest rectangle ABCD whose vertices A and B lie on the x-axis and vertices C and D lie on the parabola, $y = x^2 - 1$ below the x-axis is $\frac{K}{33}$ then K equals to

15. 4

16. Given : $f(x) = \begin{cases} x, & 0 \le x < \frac{1}{2} \\ \frac{1}{2}, & x = \frac{1}{2} \\ 1-x, & \frac{1}{2} < x \le 1 \end{cases}$ and $g(x) = \left(x - \frac{1}{2}\right)^2, x \in R$. Then the area (in sq. units) of the region bounded by the curves, $y = f(x)$ and $y = g(x)$ between the lines $2x = 1$ and $2x = \sqrt{3}$, is: $\frac{\sqrt{3}}{4} - \frac{K}{3}$ then k equals to

16. 1

17. The area (in sq. units) of the region $\{(x, y) : 0 \le y \le x^2 + 1, 0 \le y \le x + 1, \frac{1}{2} \le x \le 2\}$ is k/24 then K equals to

17. 79

18. Straight line y = m x divides the areas bounded by y = axis, x = axis, $y = 3 - |x - 1|$, x =2 in two equal parts then the value of 7m is

18. 9.00

ANSWERS

SECTION-1 : PHYSICS

PART – A

PART – B

SECTION – 2 : CHEMISTRY

PART – A

PART – B

SECTION – 3 : MATHEMATICS

PART – A

PART – B