# JEE Advanced 2024 Internal Phase Test

## SECTION – I : PHYSICS

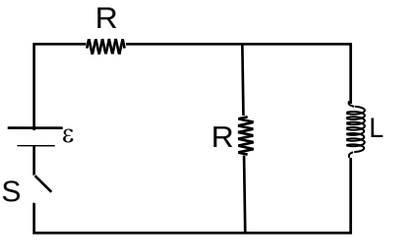
### (PART – A)

**(Single Correct Answer Type)**

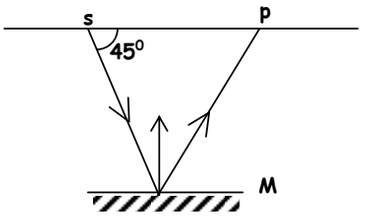
This section contains **4 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

1. Light of wavelength 3500A$^o$ is incident on two metals A and B, A of work function 4.2 eV and B of work function 1.19 eV respectively. The photoelectrons will be emitted by
   (A) metal A only (B) metal B only
   (C) both A and B (D) neither metal A nor metal B

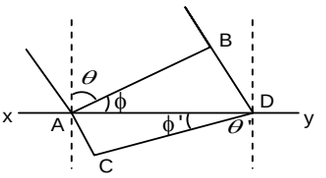
2. In the given circuit switch S is closed at t = 0, then the rate of change of current through the inductor initially is
   (A) 0
   (B) $\varepsilon/L$
   (C) $\varepsilon/2L$
   (D) $2\varepsilon/L$




3. A flat mirror M is arranged parallel to a wall and light from a point source S on the wall is reflected back to the wall. With what velocity will be spot move along the wall if the mirror is brought up to the wall with a velocity v?
   (A) Zero (B) 2v
   (C) v/2 (D) v



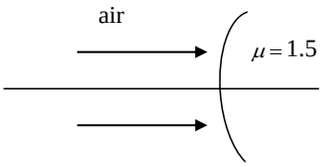

4. In the given diagram a wavefront AB moving in air is incident on a plane glass surface xy. Its position CD after refraction through the glass slab is shown also along with normals drawn at A and D. The refractive index of glass will not be equal to :
   (A) (BD/AC) (B) (AB/CD)
   (C) $(\sin\phi/\sin\phi')$ (D) $(\cos\theta/\cos\theta')$




**(One or More Than One Options Correct Type)**

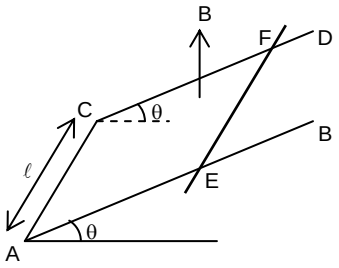
This section contains **3 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D), out of which **ONE** or **MORE THAN ONE is correct.**

5. Parallel rays of light are falling on convex spherical surface of radius of curvature R = 20 cm. Refractive index of the medium is $\mu = 1.5$. After refraction from the spherical surface parallel rays :
   (A) actually meet at some point.
   (B) appears to meet after extending the refracted rays backwards.
   (C) meet (or appears to meet) at a distance of 30 cm from the spherical surface.
   (D) meet (or appears to meet) at a distance of 60 cm from the spherical surface.




***Space For Rough Work***

6. AB and CD are smooth parallel rails, separated by a distance $\ell$, and inclined to the horizontal at an angle $\theta$. A uniform magnetic field of magnitude B, directed vertically upwards, exists in the region. EF is a conductor of mass m, carrying a current i. For EF to be in equilibrium,




(A) i must flow from E to F (B) Bi$\ell$ = mg$\tan\theta$

(C) Bi$\ell$ = mg$\sin\theta$ (D) Bi$\ell$ = mg

7. The electron in the hydrogen atom make a transition from an excited state to the ground state. Which of the following statement is true?
(A) Its kinetic energy increases and its potential and total energies decrease
(B) Its kinetic energy decreases, potential energy increases and its total energy remains the same
(C) Its kinetic and total energies decrease and its potential energy increases
(D) Its kinetic potential and total energies decreases

## (**PART – B)**

This section contains Two paragraphs. Each paragraph having TWO questions Numerical answer type with answer XXXX.XX. For each question, enter the correct numerical value. If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.

### Paragraph for Question no. 1 to 2

Read the following passage and answer the following questions on the basis of the paragraph.

In a photoelectric experiment using a sodium surface, you find a stopping potential of 1.85 V for a wavelength of 300 nm and a stopping potential of 0.820 V for a wavelength of 400 nm.

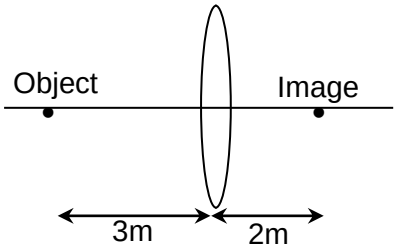
1. The value of the work function of sodium from the above data is (in eV) _____.

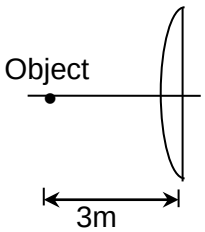
2. If a radiation of 200 nm wavelength is incident on the sodium surface the stopping potential will be (in V) _____.

***Space For Rough Work***

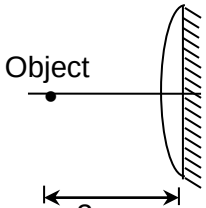
**Paragraph for Question no. 3 to 4**

An object is placed at a distance 3 meter form an equi-convex lens. Its image is formed at 2 m form the lens as shown in the figure



(b)



(b)

3. If lens is cut into two symmetrical plano-convex lens and one of the plano convex lens is removed then what is the distance of the image from the lens as shown in fig.(a) (in m)

4. If the plane surface of plano-convex lens is silvered then what is the distance of the image from the silvered lens as shown in fig.(b) (in m)

## (PART – B)

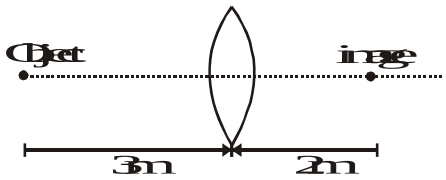
**(Non – Negative Integer)**

5. Hydrogen (H), deuterium (D), singly ionised helium $(He)^{+}$ and doubly ionised $(Li^{++})$ all have one electron round the nucleus. Consider n = 2 to n = 1 transition. The wavelength of emitted radiations are $\lambda_1$, $\lambda_2$, $\lambda_3$ and $\lambda_4$ respectively. Then $\lambda_1 = \lambda_2 = k\lambda_3 = 9\lambda_4$. Find 'k'.

6. A point source of power 4W is placed 1m below the free surface of liquid whose refractive index is '$\frac{2}{\sqrt{3}}$'. Find the rate of transfer of energy (in watt) from the liquid surface to air. Ignore any absorption or scattering of light energy.

***Space For Rough Work***

7. An object is placed at a distance 3 meter from a symmetrical convex lens. Its image is formed at 2 m from the lens as shown in the figure.
The position of image if lens is cut into two symmetrical plano convex lens and one of the plano convex lens is removed is $\frac{24}{x}$, then x will be




8. The mass defect for the nucleus of helium is 0.0302 amu. The binding energy per nucleon for helium in MeV is approximately.

9. An imaginary particle has a charge equal to that of an electron and mass 100 times the mass of the electron. It moves in a circular orbit around a nucleus of charge (+4e). Take the mass of nucleus to be infinite. Assuming that the Bohr's model is applicable to this system. Find the wavelength of the radiation emitted, when the particle jumps from fourth orbit to the second orbit. (In Å)

10. A wire of length l = 6 $\pm$0.06 cm and radius r = 0.5 $\pm$0.005 cm and mass m = 0.3 $\pm$0.003 gm. Find maximum percentage error in density.

***Space For Rough Work***

# SECTION – II : CHEMISTRY

## (PART – A)

**(Single Correct Answer Type)**

This section contains **4 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

1. $NO_2 \xrightarrow{H_2O} A + B$

   $NO_2 \xrightarrow{H_2O(\text{saturated with } O_2)} A$

   $(B) \xrightarrow[(\text{in absence of air})]{\text{Heat}} A + C(\text{gas}) + H_2O$

   Molar mass of gas(C) in g $mol^{-1}$ unit is

   (A) 46 (B) 30

   (C) 44 (D) 76

2. Which reaction produces $SO_3$?

   (A) Roasting of ZnS (B) Burning of sulphur

   (C) Heating of $Li_2SO_4$ (D) Acidification of $Na_2SO_3$

3. The metal that is not extracted by complex formation method is

   (A) Ag (B) Ni

   (C) Au (D) Al

4. The back donation of electrons from metal atom (or ion) to CO in metal carbonyls is less probable for tetrahedral complexes than for octahedral complexes. This is due to

   (A) availability of less number of d-electrons in tetrahedral carbonyls

   (B) improper orientation of non-bonding d-orbitals ('e' orbitals) of metal (ion) and the $\pi^*$ antibonding molecular orbitals of CO.

   (C) due to low crystal field splitting energy($\Delta_t$)

   (D) due to formation high spin carbonyls as $\Delta_t$ is very low

**(One or More Than One Options Correct Type)**

This section contains **3 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D), out of which **ONE** or **MORE THAN ONE is correct.**

5. Between which of the following substance(s) potential difference is observed in the following electrochemical cell.

   Zn(s) | $ZnSO_4$(aq) || $CuSO_4$(aq) | Cu(s)

   (A) Zn and $ZnSO_4$ (B) Cu and $CuSO_4$

   (C) Zn and Cu (D) $ZnSO_4$ and solution of salt bridge

***Space For Rough Work***

6. The correct statement(s) regarding complex $[Cu(NH_3)_4(H_2O)_2]^{2+}$ is/are
   (A) it shows geometrical isomerism.
   (B) the Cu-N bond is stronger than the Cu – O bond.
   (C) upon heating the initial products formed are $[Cu(NH_3)_4]^{2+}$ and $H_2O$.
   (D) if it is crystallized as the salt of $SO_4^{2-}$ ions, the colour of crystal will change from blue to white.

7. The characteristics property(ies) of Lyophobic sol is/are
   (A) it can be easily coagulated than Lyophilic colloids
   (B) it shows more prominent Tyndall effect than Lyophilic colloid
   (C) it is thermodynamically less stable than Lyophilic colloid
   (D) the dispersed phase has lower affinity for dispersion medium than that of Lyophilic colloids

## (**PART – B)**

This section contains Two paragraphs. Each paragraph having TWO questions Numerical answer type with answer XXXX.XX. For each question, enter the correct numerical value. If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.

### Paragraph for Question no. 1 to 2

The covalent character of the carbonyls of 3d-series metal(ions) are higher than that of the 4d and 5d-series metal(ions). Metals prefer to form carbonyls with lower oxidation number (generally zero or negative oxidation number). Metals like Ni, Fe, Mn and Co forms carbonyls in zero oxidation states. Complex like $Ni(CO)_4$, $Fe(CO)_5$, $Mn_2(CO)_{10}$ and $Co_2(Co)_8$ are classified as mononuclear [$Ni(CO)_4$, $Fe(CO)_5$ and dinuclear [$Mn_2(CO)_{10}$, $Co_2(CO)_8$]. The metal carbonyl gain extra stability due to synergic bonds which are also called back bonds. They are formed by the overlap of non-bonding metal orbitals with the $\pi^*$ molecular orbital of CO group. The geometry of carbonyl depends on their co-ordination number e.g., $Ni(CO)_4$ is tetrahedral and $Fe(CO)_5$ is trigonal bipyramidal.

1. The synergic bond formation between a metal and the CO ligands takes place by the overlapping of $t_{2g}$ orbital of metal and $\pi^*$-orbital of CO. What is the coordination number of the metal?

2. In the carbonyl $Co_2(CO)_8$,
   If x = Number of bridged CO groups
   y = Number of Co to Co bonds
   What is (x + y)

***Space For Rough Work***

**Paragraph for Question no. 3 to 4**

For the redox-reaction

$2M(s) + Cl_2(g) \xrightarrow{H_2O} 2MCl_2(aq)$

The electrochemical cell is M(s) | $M^{2+}$(1 M) || $Cl_2$(g) | $Cl^-$(aq) | Pt(s)

The reaction takes place at 298 K

The standard electrode potential of the cell at temperature TK, in which above reaction takes place is given as

$E^0_{Cell}$ = 1.36 – 0.0008(T - 300)V

3. What is the standard entropy change $\Delta S^o$ of the reaction in J $K^{-1}$ $mol^{-1}$ unit at constant pressure?

4. What is the value of $(-\Delta G^o)$ of the cell in KJ $mol^{-1}$ unit at 400 K?

## (PART – B)

**(Non – Negative Integer)**

5. Pt(s) | $H_2$(g)(0.01 atm) | $H^+(C_1M)$ || $H^+(C_2M)$ | $H_2$(g), 1 atm | Pt(s)
The value of $E_{Cell}$ is -0.048 V. If the ratio of $(C_1)^2$ to $(C_2)^2$ is x : y, the value of x + y is [log 40 = 1.6]

6. The boiling point of a solvent at 1 bar is 80°C. One mole each of KCl($\alpha$ = 0.9) and NaCl(($\alpha$ = 0.8) are added to one Kg solvent. If the elevation in boiling point of the solvent in the solution is X°C, what is the value of 100 x?
[$K_b$ of solvent = 0.4 K Kg $mol^{-1}$]

7. $\underset{\text{(Brown colour)}}{2A(g)} \xrightarrow{\text{Cooling}} \underset{\text{(Colourless)}}{A_2(g)}$

$\underset{\text{(Oxide of nitrogen)}}{A(g)} \xrightarrow{NaOH} B(soln) + C(soln) + H_2O$

If the oxidation number of nitrogen in (B) is +5 and in (C) is +x, what is the value of (x)?

8. The limiting molar conductivities ($\Lambda^0_m$) of $Ca(OH)_2$, $NH_4Cl$ and $CaCl_2$ are respectively 518, 149 and 260 $ohm^{-1}$ $cm^2$ $mol^{-1}$. What is the $\Lambda^0_m$ value of $NH_4OH$ in $ohm^{-1}$ $cm^2$ $mol^{-1}$ unit?

9. $P_4O_{10} + H_2O \longrightarrow (A)$

$(B) \xrightarrow{Heat} (A) + PH_3$

If the oxidation number of the most acidic substance in above reactions is +x, what is the value of x?

10. The d-orbital electronic configuration of a metal ion in it's octahedral chloro complex is $t^4_{2g}e^2_g$.

How many electrons will be present in the $t_{2g}$ orbital of the metal ion in it's complex with $CN^-$ ions with coordination number equal to six?

***Space For Rough Work***

# SECTION – III : MATHEMATICS

## (PART – A)

**(Single Correct Answer Type)**

This section contains **4 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

1. If A and B are different matrices satisfying $A^3 = B^3$ and $A^2B = B^2A$ then det $\left(A^2 + B^2\right)$ is equal to

(A) 0 (B) 1

(C) 2 (D) none of these

2. Solution of $\left(xy^2 - e^{\frac{1}{x^3}}\right)dx - x^2ydy = 0$ is.

(A) $\frac{x^2}{y^2} = \frac{2}{3}e^{\frac{1}{x^3}} + c$ (B) $\frac{y^2}{x^2} = \frac{2}{3}e^{\frac{1}{x^3}} + c$

(C) $\frac{y^2}{x} = \frac{2}{3}e^{\frac{1}{x^3}} + c$ (D) None of these

3. The matrix A= $\begin{bmatrix} \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \\ \frac{-1}{\sqrt{2}} & -\frac{1}{\sqrt{2}} \end{bmatrix}$ is a

(A) Unitary matrix (B) Orthogonal matrix

(C) Nil potent matrix (D) Involutary matrix

4. A line passing through (3,3,1) meet the lines $\frac{x-4}{2} = \frac{y+2}{1} = \frac{z-5}{1}$ and $\frac{x+4}{1} = \frac{y-2}{2} = \frac{z+7}{1}$ at A and B so that mid point of AB is (3,3,1) equation of line AB is.

(A) $\frac{x-3}{5} = \frac{y-3}{-3} = \frac{z-1}{6}$ (B) $\frac{x-3}{5} = \frac{y-3}{3} = \frac{z-1}{6}$

(C) $\frac{x-3}{5} = \frac{y-3}{3} = \frac{z-1}{-6}$ (D) None of these

***Space For Rough Work***

**(One or More Than One Options Correct Type)**

This section contains **3 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D), out of which **ONE** or **MORE THAN ONE is correct.**

5. Let $|M|$ denote the determinant of a square matrix M. Let $g:\left[0, \frac{\pi}{2}\right] \to \mathbb{R}$ be the function defined by $g(\theta) = \sqrt{f(\theta)-1} + \sqrt{f\left(\frac{\pi}{2}-\theta\right)} - 1$ where

$$f(\theta) = \frac{1}{2}\begin{vmatrix} 1 & \sin\theta & 1 \\ -\sin\theta & 1 & \sin\theta \\ -1 & -\sin\theta & 1 \end{vmatrix} + \begin{vmatrix} \sin\pi & \cos\left(\theta+\frac{\pi}{4}\right) & \tan\left(\theta-\frac{\pi}{4}\right) \\ \sin\left(\theta-\frac{\pi}{4}\right) & -\cos\frac{\pi}{2} & \log_e\left(\frac{4}{\pi}\right) \\ \cot\left(\theta+\frac{\pi}{4}\right) & \log_e\left(\frac{\pi}{4}\right) & \tan\pi \end{vmatrix}$$

Let p(x) be a quadratic polynomial whose roots are the maximum and minimum values of the function $g(\theta)$, and $p(2) = 2-\sqrt{2}$. Then, which of the following is/are TRUE?

(A) $p\left(\frac{3+\sqrt{2}}{4}\right) < 0$

(B) $p\left(\frac{1+3\sqrt{2}}{4}\right) > 0$

(C) $p\left(\frac{5\sqrt{2}-1}{4}\right) > 0$

(D) $p\left(\frac{5-\sqrt{2}}{4} < 0\right)$

6. A fair coin is tossed n times. Let X = the number of times head occurs. If P(X = 4) , P(X = 5) and P(X = 6) are in A.P. then the value of n can be

(A) 7
(B) 10
(C) 12
(D) 14

7. For any real numbers $\alpha$ and $\beta$, let $y_{\alpha,\beta}(x), x \in \mathbb{R}$, be the solution of the differential equation

$$\frac{dy}{dx} + \alpha y = xe^{\beta x}, y(1) = 1.$$

Let $S = \left\{y_{\alpha,\beta}(x) : \alpha,\beta \in \mathbb{R}\right\}$. Then which of the following functions belong(s) to the set S?

(A) $f(x) = \frac{x^2}{2}e^{-x} + \left(e - \frac{1}{2}\right)e^{-x}$

(B) $f(x) = -\frac{x^2}{2}e^{-x} + \left(e + \frac{1}{2}\right)e^{-x}$

(C) $f(x) = \frac{e^x}{2}\left(x - \frac{1}{2}\right) + \left(e - \frac{e^2}{4}\right)e^{-x}$

(D) $f(x) = \frac{e^x}{2}\left(\frac{1}{2} - x\right) + \left(e + \frac{e^2}{4}\right)e^{-x}$

***Space For Rough Work***

## (PART – B)

This section contains Two paragraphs. Each paragraph having TWO questions Numerical answer type with answer XXXX.XX. For each question, enter the correct numerical value. If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.

### Paragraph for Question no. 1 to 2

Given two curves: y = f(x) passing through the point (0,1) and g(x) = $\int_{-\infty}^{x} f(t)dt$ passing through the point $\left(0,\frac{1}{n}\right)$. The tangents drawn to both the curves at the points with equal abscissa intersect on x-axis.

1. $f\left(\frac{\ell n 2}{n}\right)$ equals _____

2. $ng\left(\frac{\ell n 3}{n}\right)$ equals _____

### Paragraph for Question no. 3 to 4

In a class of 10 students, probability of exactly i students passing an examination is directly proportional to $i^2$. Then, answer the following questions:

3. The probability that exactly five students passing an examination be $\frac{p}{q}$ (where p, q are coprime) then $p+q$ is

4. If a student is selected at random, then the probability that he has passed the examination be $\frac{p}{q}$ (where p, q are coprime) then $p+q$ is

***Space For Rough Work***

## (PART – B)
**(Non – Negative Integer)**

5. If $\bar{a},\bar{b},\bar{c}$ are edges of a cube of unit length and $\bar{r}$ any unit vector in the cube $\left|\bar{r}\times\bar{a}\right|^2+\left|\bar{r}\times\bar{b}\right|^2+\left|\bar{r}\times\bar{c}\right|^2=$_____.

6. The order of the differential equation of the family of parabolas with focus at origin and axis along x-axis is _____.

7. Let $f:g:R\to R$ are functions such that $f(x)=3x-\sin\left(\frac{\pi x}{2}\right)$ $g(x)=x^3+2x-\sin\left(\frac{\pi x}{2}\right)$, and if area bounded by $y=f^{-1}(x)$, $y=g^{-1}(x)$ equals A, then 2A equals _____

8. If a, b, c are non-coplanar vectors such that $b\times c=a$, $c\times a=b$, $a\times b=c$, then [a b c] is_____.

9. Let $\beta$ be real number. Consider the matrix $A=\begin{pmatrix}\beta & 0 & 1\\ 2 & 1 & -2\\ 3 & 1 & -2\end{pmatrix}$. If $A^7-(\beta-1)A^6-\beta A^5$ is a singular matrix, then the value of $9\beta$ is _____,

10. Let $L_1$ be the projection and $L_2$ be the image of z axis in $3x-4y+z+1=0$. The distance of (1,2,3) from the plane containing $L_1$ and $L_2$ is _____.

***Space For Rough Work***

# ANSWER KEY

## ANSWER KEYS

## Physics

**PART – A**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1. | B | 2. | C | 3. | B | 4. | B |
| 5. | AD | 6. | AB | 7. | BD | | |

**PART – B**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1. | 2.27 | 2. | 3.91 | 3. | 12 | 4. | 2 |
| 5. | 4 | 6. | 1 | 7. | 2 | 8. | 7 |
| 9. | 3 | 10. | 4 | | | | |

## Chemistry

**PART – A**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1. | B | 2. | C | 3. | D | 4. | B |
| 5. | ABD | 6. | ABC | 7. | ABCD | | |

**PART – B**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1. | 6 | 2. | 3 | 3. | 154.4 (range 154.3 to 154.5) | | |
| 4. | 247.04 (range 247 to 247.2) | | | 5. | 7 | 6. | 148 |
| 7. | 3 | 8. | 278 | 9. | 3 | 10. | 6 |

## Mathematics

**PART – A**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1. | A | 2. | B | 3. | C | 4. | A |
| 5. | AC | 6. | AD | 7. | AC | | |

**PART – B**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1. | 2 | 2. | 3 | 3. | 82 | 4. | 25 |
| 5. | 2 | 6. | 1 | 7. | 1 | 8. | 1 |
| 9. | 3 | 10. | 2 | | | | |