# NTA Joint CSIR UGC NET JUNE 2026_ 17th and 18th July

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|---|---|
| Application No | 261610001366 |
| Candidate Name | SANDEEP SADHUKHAN |
| Roll No. | WB060100170 |
| Test Date | 17/07/2026 |
| Test Time | 3:00 PM - 6:00 PM |
| Subject | PHYSICAL SCIENCES |

Section : **PART A**

**Q.1** There are four towns P, Q, R and T. Q is to the South-West of P, R is to the East of Q and South-East of P and T is to the North of R in line with Q, P. In which direction of P is T located?

1. South-East
2. North
3. North-East
4. East

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **458908999**
Option 1 ID : **4589083993**
Option 2 ID : **4589083994**
Option 3 ID : **4589083995**
Option 4 ID : **4589083996**
Status : **Answered**
Chosen Option : **2**

**Q.2**

In which of the following, entropy will decrease?

1. Water is boiled
2. Sugar is dissolved in water
3. Ice is heated to melt
4. Egg is boiled in water

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081006**
Option 1 ID : **4589084021**
Option 2 ID : **4589084022**
Option 3 ID : **4589084023**
Option 4 ID : **4589084024**
Status : **Answered**
Chosen Option : **3**

**Q.3**

Suppose there are '9' identical gold-coins out of which 8 coins have same weight. One of the coin is counterfeit and weighs slightly less than other coins. You have a classical balance scale for weighing.

What is the minimum number of weighings required to definitively isolate and identify the counterfeit coin?

1. 3
2. 4
3. 2
4. 8

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081001**
Option 1 ID : **4589084001**
Option 2 ID : **4589084002**
Option 3 ID : **4589084003**
Option 4 ID : **4589084004**
Status : **Not Answered**
Chosen Option : **--**

**Q.4**

Three alarm bells ring at intervals 30 sec, 40 sec and 45 sec respectively. They started ringing simultaneously at 4:00 am in the morning.

At what time will they all ring simultaneously:

1. 4:06 am
2. 4:36 am
3. 4:40 am
4. 5:00 am

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081010**
Option 1 ID : **4589084037**
Option 2 ID : **4589084038**
Option 3 ID : **4589084039**
Option 4 ID : **4589084040**
Status : **Answered**
Chosen Option : **1**

**Q.5**

The largest possible triangle is inscribed in a semi-circle of diameter 14 cm. What would be the area inside the semi-circle which is not occupied by the triangle?

1. 35 sq. cm
2. 30 sq. cm
3. 28 sq. cm
4. 48 sq. cm

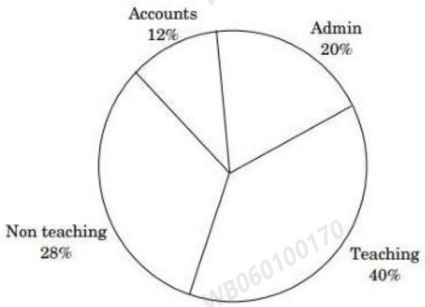
**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081012**
Option 1 ID : **4589084045**
Option 2 ID : **4589084046**
Option 3 ID : **4589084047**
Option 4 ID : **4589084048**
Status : **Not Answered**
Chosen Option : **--**

**Q.6**

The pie chart shows the percentage of employees working in different departments of a University. The table shows the ratio of males to females in each of these departments.

If the total number of employees = 2000, what is the ratio between female employees in Admin and non teaching departments?




| Category | Male : Female |
|---|---|
| Accounts | 7 : 5 |
| Admin | 2 : 3 |
| Teaching | 5 : 3 |
| Non teaching | 3 : 4 |

1. 3 : 4
2. 5 : 3
3. 2 : 3
4. 4 : 3

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081002**
Option 1 ID : **4589084005**
Option 2 ID : **4589084006**
Option 3 ID : **4589084007**
Option 4 ID : **4589084008**
Status : **Not Answered**
Chosen Option : **--**

**Q.7**

Consider the relationship statement between two natural numbers :

A. the difference between them is 6.

B. the difference between their squares is 60.

Find the sum of the cubes of these two numbers.

1. 620
2. 520
3. 720
4. 820

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081014**
Option 1 ID : **4589084053**
Option 2 ID : **4589084054**
Option 3 ID : **4589084055**
Option 4 ID : **4589084056**
Status : **Not Answered**
Chosen Option : **--**

**Q.8**

The present population of a city is 6000. If the number of males increases by 14% and the number of females increases by 22%, then the population will become 6900. What is the present population of females in the city?

1. 900
2. 700
3. 750
4. 850

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081008**
Option 1 ID : **4589084029**
Option 2 ID : **4589084030**
Option 3 ID : **4589084031**
Option 4 ID : **4589084032**
Status : **Not Answered**
Chosen Option : **--**

**Q.9** Candidate in a competitive examination consisted of 60% men and 40% woman. 70% of men and 75% of women cleared the qualifying test and entered the final test where 80% men and 70% women were successful. Which of the following statement is correct?

1. Overall success rate is below 50%
2. Success rate is higher for women
3. More men cleared the examination than women
4. Both 1 and 2

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081015**
Option 1 ID : **4589084057**
Option 2 ID : **4589084058**
Option 3 ID : **4589084059**
Option 4 ID : **4589084060**
Status : **Not Answered**
Chosen Option : **--**

**Q.10** A certain sum of money becomes double of itself in 5 years at simple rate of interest. In how many years will it become 16 times of itself at the same rate of simple interest?

1. 80
2. 70
3. 75
4. 90

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081013**
Option 1 ID : **4589084049**
Option 2 ID : **4589084050**
Option 3 ID : **4589084051**
Option 4 ID : **4589084052**
Status : **Not Answered**
Chosen Option : **--**

**Q.11** In a certain code if '1000' is written as '1728' and '125' is written as '343'. And '343' is written as '729', in the same code '512' will be written as:

1. 1000
2. 1331
3. 990
4. 1010

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **458908998**
Option 1 ID : **4589083989**
Option 2 ID : **4589083990**
Option 3 ID : **4589083991**
Option 4 ID : **4589083992**
Status : **Answered**
Chosen Option : **1**

**Q.12** There are four positive integers say A, B, C and D such that $A \leq B \leq C \leq D$. Consider the following statements :

A. The unique mode of the data is 6.

B. The median score of the data is 7.

What is the minimum possible value of the largest number D?

1. 6
2. 7
3. 8
4. 9

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081011**
Option 1 ID : **4589084041**
Option 2 ID : **4589084042**
Option 3 ID : **4589084043**
Option 4 ID : **4589084044**
Status : **Not Answered**
Chosen Option : **--**

**Q.13** Select a figure from amongst the four alternatives which when placed in the blank space of fig (X) would complete the pattern?

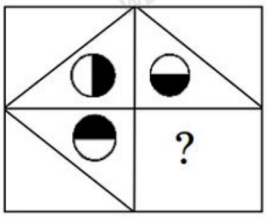
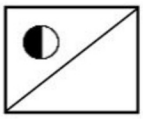
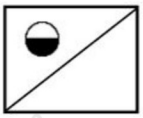
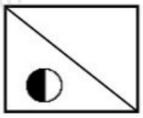
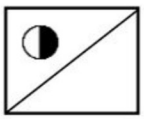



Fig (X)

1. 
2. 
3. 
4. 

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **458908996**
Option 1 ID : **4589083981**
Option 2 ID : **4589083982**
Option 3 ID : **4589083983**
Option 4 ID : **4589083984**
Status : **Answered**
Chosen Option : **1**

**Q.14**

XUR, TQN, PMJ, _____?_____, HEB.

Which of the following options will complete the above series by replacing the question mark?

1. KHE
2. LIF
3. LJH
4. MJG

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **458908997**
Option 1 ID : **4589083985**
Option 2 ID : **4589083986**
Option 3 ID : **4589083987**
Option 4 ID : **4589083988**
Status : **Not Answered**
Chosen Option : **--**

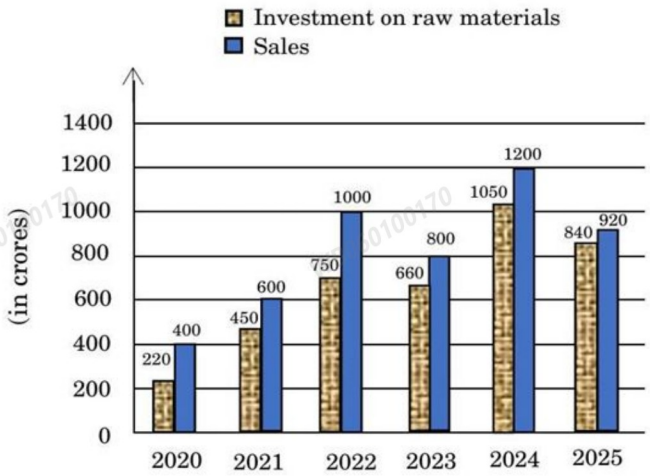
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**Q.15**

The graph represents investment on raw material and sales of an organization from 2020 to 2025 (calendar year)

Study the bar graph and answer the question.

In which year was there a maximum percentage increase in the sales of products as compared the previous year?




1. 2021
2. 2023
3. 2022
4. 2024

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081003**
Option 1 ID : **4589084009**
Option 2 ID : **4589084010**
Option 3 ID : **4589084011**
Option 4 ID : **4589084012**
Status : **Not Answered**
Chosen Option : **--**

**Q.16** There are two numbers such that the difference between them is 10 and their ratio is 5:3. Find the product of these two numbers

1. 150
2. 375
3. 275
4. 80

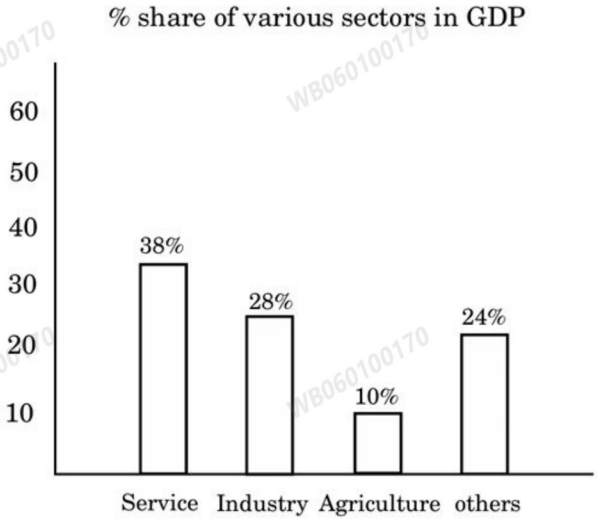
**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081009**
Option 1 ID : **4589084033**
Option 2 ID : **4589084034**
Option 3 ID : **4589084035**
Option 4 ID : **4589084036**
Status : **Answered**
Chosen Option : **2**

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**Q.17** The following chart shows the sector wise percentage break up of Rs. 650 crore, which is the GDP of a small country with a population of 1 billion people. 80% of the population constitutes its working population engaged in various sector and contributing to GDP.

Which of the following has lowest contribution to GDP?




1. Service
2. Industry
3. Agriculture
4. Non working population

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081004**
Option 1 ID : **4589084013**
Option 2 ID : **4589084014**
Option 3 ID : **4589084015**
Option 4 ID : **4589084016**
Status : **Not Answered**
Chosen Option : **--**

**Q.18** Read the following information to answer the question

P + Q means P is the brother of Q;

P × Q mean P is the father of Q;

P – Q means P is the sister of Q.

Which of the following relation shows that I is the niece of K?

1. K + Y + Z – I
2. K + Y × I – Z
3. Z – I × Y + K
4. K × Y + I – Z

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081000**
Option 1 ID : **4589083997**
Option 2 ID : **4589083998**
Option 3 ID : **4589083999**
Option 4 ID : **4589084000**
Status : **Not Answered**
Chosen Option : **--**

**Q.19** A process is used to separate substances in chemical mixtures. What is this process known as?

1. Distillation
2. Filtration
3. Chromatography
4. Crystallisation

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081005**
Option 1 ID : **4589084017**
Option 2 ID : **4589084018**
Option 3 ID : **4589084019**
Option 4 ID : **4589084020**
Status : **Answered**
Chosen Option : **1**

**Q.20** During the interaction of population of two different species identify the type where only one species is benefited and is detrimental to the other species.

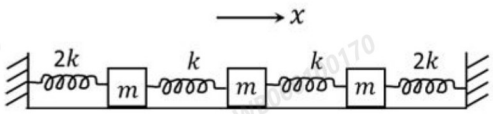
1. Commensalism and Amensalism
2. Commensalism and Competition
3. Parasitism and Predation
4. Parasitism and Amenalism

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081007**
Option 1 ID : **4589084025**
Option 2 ID : **4589084026**
Option 3 ID : **4589084027**
Option 4 ID : **4589084028**
Status : **Not Answered**
Chosen Option : **--**

Section : **PART B**

**Q.21** Three equal masses $m$ are free to move along $x$-axis on a frictionless surface. The masses are coupled together, and to a rigid wall, by springs as shown in the figure. If $\omega_0 = \sqrt{\frac{k}{m}}$, and the angular frequencies of the three normal modes of this system are $\omega_1$, $\omega_2$ and $\omega_3$ then the value of $\omega_1^2 + \omega_2^2 + \omega_3^2$ is:




1. $9\omega_0^2$
2. $6\omega_0^2$
3. $10\omega_0^2$
4. $8\omega_0^2$

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081021**
Option 1 ID : **4589084081**
Option 2 ID : **4589084082**
Option 3 ID : **4589084083**
Option 4 ID : **4589084084**
Status : **Not Answered**
Chosen Option : **--**

**Q.22**

A linearly polarized electromagnetic wave is incident normally on a material of refractive index $n_R$ for right circular polarization and $n_L$ for left circular polarization, where $n_R \neq n_L$. The reflected wave's polarization is :

1. Linear
2. Elliptical
3. Circular
4. Random

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081031**
Option 1 ID : **4589084121**
Option 2 ID : **4589084122**
Option 3 ID : **4589084123**
Option 4 ID : **4589084124**
Status : **Not Answered**
Chosen Option : **--**

**Q.23**

The value of the integral:

$$\oint \frac{d\theta}{5 - 4\cos\theta}$$

over the circle $|z| = 1$ in the anti-clockwise direction can be calculated by substituting $z = e^{i\theta}$. The value of the integral is:

1. $\frac{2\pi}{3}$
2. $\frac{\pi}{3}$
3. $\pi$
4. $\frac{4\pi}{3}$

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081038**
Option 1 ID : **4589084149**
Option 2 ID : **4589084150**
Option 3 ID : **4589084151**
Option 4 ID : **4589084152**
Status : **Answered**
Chosen Option : **1**

**Q.24** The Lagrangian of a system is given by $L = x^2 + x\,\dot{x} + \frac{\dot{x}^2}{2}$. If $p$ is the generalized momentum, then the corresponding Hamiltonian is:

1. $\frac{(p^2 - x^2 - 2xp)}{2}$
2. $\frac{(p^2 - x^2 + 2xp)}{2}$
3. $\frac{(p^2 + x^2 + 2xp)}{2}$
4. $\frac{(p^2 + x^2 - 2xp)}{2}$

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081019**
Option 1 ID : **4589084073**
Option 2 ID : **4589084074**
Option 3 ID : **4589084075**
Option 4 ID : **4589084076**
Status : **Not Answered**
Chosen Option : **--**

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**Q.25** A three-state system is described by a certain Hamiltonian having eigen energies $E_0$, $2E_0$ and $3E_0$ with the corresponding eigen states $\begin{pmatrix}1\\1\\1\end{pmatrix}, \begin{pmatrix}1\\0\\-1\end{pmatrix}$ and $\begin{pmatrix}1\\-2\\1\end{pmatrix}$, respectively. If the state of the system at time $t = 0$ is $\begin{pmatrix}1\\0\\0\end{pmatrix}$, then what is the probability of finding the system in the same state at time $t = \frac{\pi\hbar}{2E_0}$?

1. $1$
2. $\frac{1}{3}$
3. $\frac{5}{18}$
4. $\frac{2}{9}$

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081026**
Option 1 ID : **4589084101**
Option 2 ID : **4589084102**
Option 3 ID : **4589084103**
Option 4 ID : **4589084104**
Status : **Not Answered**
Chosen Option : **--**

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**Q.26** Consider the spin matrix $S_r$ projected along the radial direction in spherical polar coordinates $(r, \theta, \varphi)$ . The probability that a measurement of $S_r$ on the state $|\beta\rangle = \begin{pmatrix} \sin\frac{\theta}{2} \\ e^{i\varphi}\cos\frac{\theta}{2} \end{pmatrix}$ will yield the value $\frac{\hbar}{2}$ is:

1. $\sin^2\theta$
2. $\cos^2\theta$
3. $\frac{1}{2}$
4. $\cos^2\frac{\theta}{2}$

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081037**
Option 1 ID : **4589084145**
Option 2 ID : **4589084146**
Option 3 ID : **4589084147**
Option 4 ID : **4589084148**
Status : **Not Answered**
Chosen Option : **--**

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**Q.27** A particle with charge $q$, which is confined to move in the $xy$-plane, is subjected to a magnetic field with magnitude $B$ pointing in the $+z$ direction. The particle moves in a circle $(C)$ of radius $R$. If $\vec{p}$ is the canonical momentum then the following integral

$$\oint_C \vec{p}.d\vec{l}$$

has the magnitude:

($d\vec{l}$ is in the direction of motion)

1. $qB\pi R^2$
2. $2qB\pi R^2$
3. $3qB\pi R^2$
4. $4qB\pi R^2$

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081039**
Option 1 ID : **4589084153**
Option 2 ID : **4589084154**
Option 3 ID : **4589084155**
Option 4 ID : **4589084156**
Status : **Answered**
Chosen Option : **2**

**Q.28** A micro-canonical ensemble consists of six non-interacting and distinguishable spin 1 particles in a uniform magnetic field. Each particle can thus be in energy states $-E_0$, 0 and $E_0$. The number of microstates in the state with total energy zero is:

1. 51
2. 191
3. 141
4. 55

**Options** 1. 1
2. 2
3. 3
4. 4

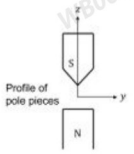
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Question ID : **4589081022**
Option 1 ID : **4589084085**
Option 2 ID : **4589084086**
Option 3 ID : **4589084087**
Option 4 ID : **4589084088**
Status : **Not Answered**
Chosen Option : **--**

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**Q.29**

A beam of copper atoms (Cu: $[Ar]4s^1 3d^{10}$) is passed through a Stern-Gerlach setup (see figure). If the gradient of the $z$-component of the magnetic field in the $z$-direction is $10^3$ Tesla/m, then the magnitude of the $z$-component of the force on an atom is:

($\mu_B$ is the Bohr magneton)




1. $5 \times 10^2\ \mu_B$
2. $10^3 \mu_B$
3. 0
4. $2\pi \times 10^3 \mu_B$

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081029**
Option 1 ID : **4589084113**
Option 2 ID : **4589084114**
Option 3 ID : **4589084115**
Option 4 ID : **4589084116**
Status : **Not Answered**
Chosen Option : **--**

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**Q.30** An analog-to-digital converter monitors the dc voltage output from a battery. The output of the converter is a three-digit binary number ABC, corresponding to battery voltage in steps of 0.5 V, with A as the most significant bit (MSB). The output of the converter is fed into a logic circuit which produces a HIGH output when the battery voltage exceeds 2 V. The expression for this logic circuit is:

1. AB+AC
2. AB+BC+AC
3. ABC
4. AC

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081035**
Option 1 ID : **4589084137**
Option 2 ID : **4589084138**
Option 3 ID : **4589084139**
Option 4 ID : **4589084140**
Status : **Not Answered**
Chosen Option : **--**

**Q.31** Vanadium has electron configuration $[Ar]3d^3 4s^2$. In $LS$ coupling, its ground state configuration is

1. ${}^4F_{\frac{9}{2}}$
2. ${}^2P_{\frac{1}{2}}$
3. ${}^4F_{\frac{3}{2}}$
4. ${}^4S_{\frac{3}{2}}$

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081027**
Option 1 ID : **4589084105**
Option 2 ID : **4589084106**
Option 3 ID : **4589084107**
Option 4 ID : **4589084108**
Status : **Answered**
Chosen Option : **3**

**Q.32** The eigen energies and the normalized eigenfunctions in the $n^{th}$ state of a particle, confined in a one-dimensional infinite potential well, are denoted by $E_n$ and $\psi_n$ , respectively. If $E_1 = 1.2$ eV then the expectation value of energy in the state $\psi = 3\psi_1 + 2\psi_2 + \sqrt{3}\,\psi_4$ is close to:

1. 5.5 eV
2. 5.0 eV
3. 4.5 eV
4. 6.0 eV

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081040**
Option 1 ID : **4589084157**
Option 2 ID : **4589084158**
Option 3 ID : **4589084159**
Option 4 ID : **4589084160**
Status : **Not Answered**
Chosen Option : **--**

**Q.33**

In spherical polar coordinates $(r, \theta, \phi)$, $\frac{\partial \hat{\theta}}{\partial \phi}$ is :

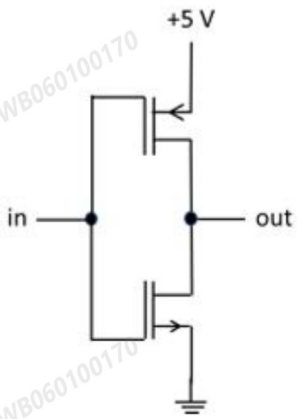
1. $\cos\theta\,\hat{\phi}$
2. $0$
3. $\sin\theta\,\hat{\phi}$
4. $-\cos\theta\,\hat{r}$

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081028**
Option 1 ID : **4589084109**
Option 2 ID : **4589084110**
Option 3 ID : **4589084111**
Option 4 ID : **4589084112**
Status : **Not Answered**
Chosen Option : **--**

**Q.34**

The circuit shown below could be used as a:




1. TTL NOT Gate
2. TTL Buffer
3. CMOS NOT Gate
4. CMOS Buffer

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081036**
Option 1 ID : **4589084141**
Option 2 ID : **4589084142**
Option 3 ID : **4589084143**
Option 4 ID : **4589084144**
Status : **Not Answered**
Chosen Option : **--**

**Q.35** In a 4-dimensional vector space $V_4$, three linearly independent vectors are given by $\boldsymbol{e_1} = (1,1,0,0)$, $\boldsymbol{e_2} = (0,1,1,0)$ and $\boldsymbol{e_3} = (0,0,1,1)$. Which of the following vector $\boldsymbol{e_4}$ will make $\{\boldsymbol{e_1}, \boldsymbol{e_2}, \boldsymbol{e_3}, \boldsymbol{e_4}\}$ a basis of $V_4$ ?

1. $(1,1,1,1)$
2. $(1,1,1,0)$
3. $(1,0,-1,0)$
4. $(0,1,1,0)$

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081020**
Option 1 ID : **4589084077**
Option 2 ID : **4589084078**
Option 3 ID : **4589084079**
Option 4 ID : **4589084080**
Status : **Answered**
Chosen Option : **3**

**Q.36** Consider the Poisson's equation $\nabla^2 V = -\frac{q}{\epsilon_0}\delta^3(\vec{r} - \vec{a})$ in half-space $z > 0$ with boundary condition $V = 0$ in the $z = 0$ plane. Here, $\vec{a} = a_0\hat{k}$ with $a_0 > 0$. If $\frac{q}{4\pi\epsilon_0 a_0} = 24$ Volt, then which of the following is correct?

1. At $\vec{r} = (0,0,2a_0)$, $V = 16$ Volt
2. At $\vec{r} = (0,0,3a_0)$, $V = 8$ Volt
3. At $\vec{r} = (0,0,4a_0)$, $V = 4$ Volt
4. At $\vec{r} = (0,0,a_0/2)$, $V = 32$ Volt

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081023**
Option 1 ID : **4589084089**
Option 2 ID : **4589084090**
Option 3 ID : **4589084091**
Option 4 ID : **4589084092**
Status : **Not Answered**
Chosen Option : **--**

**Q.37**

Internal energy of one mole of a non-ideal gas is given by $U = \frac{3}{2}RT - \frac{a}{V}$, where $V$ is volume of the gas at temperature $T$ and $a$ is a positive constant. An insulated container of volume $V_2$ contains this gas confined in a volume $V_1$ at temperature $T_1$. The remaining volume $V_2 - V_1$ of this container, which is in vacuum, is separated by a wall. The wall is suddenly removed which makes the gas volume $V_2$ and temperature $T_2$. The temperature $T_2$ is:

($R$ is the molar gas constant)

1. $T_1 + \frac{2a}{3R}\left(\frac{1}{V_2} + \frac{1}{V_1}\right)$
2. $T_1 - \frac{2a}{3R}\left(\frac{1}{V_2} + \frac{1}{V_1}\right)$
3. $T_1 + \frac{2a}{3R}\left(\frac{1}{V_2} - \frac{1}{V_1}\right)$
4. $T_1 - \frac{2a}{3R}\left(\frac{1}{V_2} - \frac{1}{V_1}\right)$

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081016**
Option 1 ID : **4589084061**
Option 2 ID : **4589084062**
Option 3 ID : **4589084063**
Option 4 ID : **4589084064**
Status : **Answered**
Chosen Option : **3**

**Q.38**

A particle is in the ground state of a one-dimensional infinite well potential with walls at $x = 0$ and at $x = a$. The wall at $x = a$ is moved to $x = 2a$ in two separate, sudden and adiabatic, protocols so that $\langle E \rangle_s$ and $\langle E \rangle_a$ are the respective expectation values of the energy in the final states. Then the ratio $\frac{\langle E \rangle_s}{\langle E \rangle_a}$ is :

1. 4:1
2. 2:1
3. 1:1
4. 1:4

**Options** 1. 1
2. 2
3. 3
4. 4

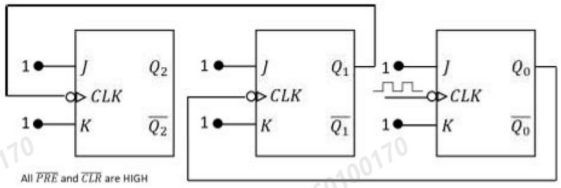
Question Type : **MCQ**
Question ID : **4589081033**
Option 1 ID : **4589084129**
Option 2 ID : **4589084130**
Option 3 ID : **4589084131**
Option 4 ID : **4589084132**
Status : **Not Answered**
Chosen Option : **--**

WB060100170

**Q.39**

Three J-K flip-flops are connected together to make a counter as shown in the figure. The J and K inputs are tied to logical 1 and a clock pulse is applied only to CLK input of the flip flop $Q_0$. If the counter is initially in the state $Q_2Q_1Q_0 = 100$, then the state of the counter after 9 clock cycles is:

Figure:




1. $Q_2Q_1Q_0 = 001$
2. $Q_2Q_1Q_0 = 110$
3. $Q_2Q_1Q_0 = 101$
4. $Q_2Q_1Q_0 = 111$

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081034**
Option 1 ID : **4589084133**
Option 2 ID : **4589084134**
Option 3 ID : **4589084135**
Option 4 ID : **4589084136**
Status : **Not Answered**
Chosen Option : **--**

**Q.40**

Water, having density 1 gm/cm$^3$, freezes into ice at 273 K temperature and 1 atm pressure. The latent heat of melting of ice is 334 J/gm and the density of ice is 0.917 gm/cm$^3$. Then for the melting temperature ($T_m$) which of the following options is correct?

1. At 140 atm pressure, $T_m \simeq 274$ K.
2. At 420 atm pressure, $T_m \simeq 274$ K.
3. At 140 atm pressure, $T_m \simeq 272$ K.
4. At 420 atm pressure, $T_m \simeq 272$ K.

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081024**
Option 1 ID : **4589084093**
Option 2 ID : **4589084094**
Option 3 ID : **4589084095**
Option 4 ID : **4589084096**
Status : **Not Answered**
Chosen Option : **--**

**Q.41**

A particle moves in an orbit $r = k\exp(\alpha\theta)$ under a central force $F(r)$. Here, $k$ and $\alpha$ are constants and $k > 0$. Then $F(r)$ is proportional to:

1. $\frac{1}{r}$
2. $\frac{1}{r^2}$
3. $\frac{1}{r^3}$
4. $\frac{1}{r^4}$

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081018**
Option 1 ID : **4589084069**
Option 2 ID : **4589084070**
Option 3 ID : **4589084071**
Option 4 ID : **4589084072**
Status : **Not Attempted and Marked For Review**
Chosen Option : **--**

**Q.42** A bead of mass $M$ slides along a smooth frictionless and massless wire which is bent in the shape of a parabola $z = cr^2$ in cylindrical coordinates $(r, \phi, z)$. Here $c$ is a positive constant. The wire is made to rotate about z-axis at constant angular velocity. Which of the following statements about this system of the wire and the bead is correct?

1. Energy is conserved but angular momentum is not conserved
2. Energy is not conserved but angular momentum is conserved
3. Both energy and angular momentum are conserved
4. Both energy and angular momentum are not conserved

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081017**
Option 1 ID : **4589084065**
Option 2 ID : **4589084066**
Option 3 ID : **4589084067**
Option 4 ID : **4589084068**
Status : **Answered**
Chosen Option : **1**

**Q.43** Two particles occupy ten degenerate energy levels. There are three possible scenarios where the two particles are either identical bosons or identical fermions or distinguishable particles, with the associated number of accessible microstates denoted as $\Omega_B$, $\Omega_F$ and $\Omega_C$, respectively. Then, which of the following options is correct?

1. $\Omega_B = 55, \Omega_F = 45, \Omega_C = 100$
2. $\Omega_B = 65, \Omega_F = 55, \Omega_C = 100$
3. $\Omega_B = 45, \Omega_F = 25, \Omega_C = 55$
4. $\Omega_B = 55, \Omega_F = 45, \Omega_C = 75$

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081032**
Option 1 ID : **4589084125**
Option 2 ID : **4589084126**
Option 3 ID : **4589084127**
Option 4 ID : **4589084128**
Status : **Answered**
Chosen Option : **1**

**Q.44**

Consider two operators $\hat{R}$ and $\hat{S}$ where $\hat{R}$ commutes with $[\hat{R},\hat{S}]$. If $\alpha$ is a constant, then $\left[ e^{\alpha\hat{R}},\hat{S} \right]$ is:

1. $\left[ \hat{R}^{\alpha},\hat{S} \right]$
2. $\alpha e^{\alpha\hat{R}}\left[ \hat{R},\hat{S} \right]$
3. 0
4. $\alpha e^{\hat{R}}\left[ e^{\alpha}\hat{R},\hat{S} \right]$

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081030**
Option 1 ID : **4589084117**
Option 2 ID : **4589084118**
Option 3 ID : **4589084119**
Option 4 ID : **4589084120**
Status : **Not Answered**
Chosen Option : **--**

WB060100170

**Q.45** You are given a time-independent observable $O$ for a system with time independent Hamiltonian $H$ and a general time dependent state $|\phi(t)\rangle$. If the expectation value $\langle O(t)\rangle_\phi = \langle\phi(t)|O|\phi(t)\rangle$, then consider the following statements (A) to (D) and choose the correct option.

(A) If $O$ commutes with $H$ then $\langle O(t)\rangle_\phi$ is independent of time.

(B) If $|\phi(t)\rangle$ is an eigen state of $H$ then $\langle O(t)\rangle_\phi$ is independent of time.

(C) If $|\phi(t)\rangle$ is an eigen state of $O$ then $\langle O(t)\rangle_\phi$ is independent of time.

(D) If $|\phi(t)\rangle$ is an eigen state of $[O, H]$ then $\langle O(t)\rangle_\phi$ is independent of time.

1. Only (A) and (B) are correct
2. Only (A) is correct
3. Only (B), (C) and (D) are correct
4. Only (A), (B) and (C) are correct

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081025**
Option 1 ID : **4589084097**
Option 2 ID : **4589084098**
Option 3 ID : **4589084099**
Option 4 ID : **4589084100**
Status : **Not Answered**
Chosen Option : **--**

Section : **PART C**

**Q.46** In four dimensions, a rank four tensor is given by $T_{abcd}$. It is symmetric under interchange of the indices $a, b$ and interchange of the indices $c, d$. Moreover, the tensor is anti-symmetric under the interchange of pair of indices $ab$ and $cd$. The number of independent components of the tensor is:

1. 100
2. 45
3. 36
4. 21

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081042**
Option 1 ID : **4589084165**
Option 2 ID : **4589084166**
Option 3 ID : **4589084167**
Option 4 ID : **4589084168**
Status : **Not Answered**
Chosen Option : **--**

WB060100170

**Q.47**

A container has a gas at temperature $T$ with its $N_1$ molecules in the ground state and $N_2$ molecules in the excited state of energy $h\nu$. Both the levels are non-degenerate and A and B are the Einstein coefficients for spontaneous and stimulated emissions, respectively, between the two levels. Then the spectral density $\rho(\nu, T)$ of radiation inside the container is proportional to:

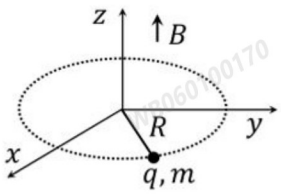
1. $\frac{A}{B}\left(\frac{N_2}{N_1 - N_2}\right)$
2. $\frac{A}{B}\left(\frac{N_2}{N_1 + N_2}\right)$
3. $\frac{N_2}{\left(\frac{A}{B}\right)N_1 - N_2}$
4. $\frac{N_2}{\left(\frac{A}{B}\right)N_1 + N_2}$

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081061**
Option 1 ID : **4589084241**
Option 2 ID : **4589084242**
Option 3 ID : **4589084243**
Option 4 ID : **4589084244**
Status : **Not Answered**
Chosen Option : **--**

**Q.48**

A particle of mass $m$ and charge $q$ is fixed at one end of a rigid insulating rod of length $R$. The other end of the rod is pivoted such that it can rotate about the $z$-axis in the $xy$-plane as shown in the figure. A time dependent magnetic field $\vec{B} = \beta t\hat{z}$ is turned on at $t = 0$. Here $\beta$ is a constant. Then the force in the rod at time $t$ will be:




1. Compressive and of magnitude $q^2\beta^2t^2R/m$
2. Zero
3. Compressive and of magnitude $q^2\beta^2t^2R/(4m)$
4. Tensile and of magnitude $q^2\beta^2t^2R/(4m)$

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081060**
Option 1 ID : **4589084237**
Option 2 ID : **4589084238**
Option 3 ID : **4589084239**
Option 4 ID : **4589084240**
Status : **Not Answered**
Chosen Option : **--**

**Q.49** An inertial observer $S$ finds the electric field due to a large rectangular parallel plate capacitor to be directed along the $y$-axis. For another observer, moving at a relativistic speed with respect to $S$ along the positive $x$-axis, which of the following statements is correct for the electric field:

1. Direction remains same but magnitude increases
2. Direction remains same but magnitude decreases
3. Direction and magnitude both remain the same
4. Direction tilts towards $x$-axis but the magnitude remains same

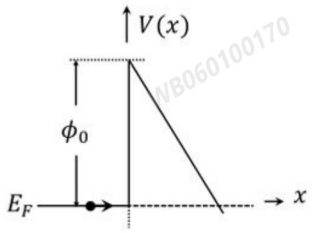
**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081044**
Option 1 ID : **4589084173**
Option 2 ID : **4589084174**
Option 3 ID : **4589084175**
Option 4 ID : **4589084176**
Status : **Answered**
Chosen Option : **4**

WB060100170

**Q.50** The surface of a metal of work function $\phi_0$ is subjected to an electric field $\mathcal{E}$. As a result, the electric potential profile just outside the surface is given by $V(x) = \phi_0 - x\mathcal{E}$ as shown in the figure. For electric field $\mathcal{E}$, the probability $p(\mathcal{E})$ of tunneling of an electron moving at the Fermi energy $(E_F)$ can be found using the WKB approximation. If $\lambda = \sqrt{\frac{2me\phi_0^3}{\hbar^2}}$, then the value of the ratio $\frac{p(\mathcal{E}=2\lambda)}{p(\mathcal{E}=\lambda)}$ will be:

(Here, $e$ and $m$ are electron's charge and mass, respectively)




1. 1.36
2. 2.73
3. 1.94
4. 5.13

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081059**
Option 1 ID : **4589084233**
Option 2 ID : **4589084234**
Option 3 ID : **4589084235**
Option 4 ID : **4589084236**
Status : **Not Answered**
Chosen Option : **--**

**Q.51** Newton-Raphson method is used for finding the roots of the polynomial $(x^2-1)(x-2)$. If the initial trial solutions are chosen as 0 and 0.5, the algorithm converges to $p$ and $q$, respectively. Then, which of the following is correct?

1. $p=1\,,q=-1$
2. $p=-1\,,q=1$
3. $p=2\,,q=1$
4. $p=1\,,q=2$

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081054**
Option 1 ID : **4589084213**
Option 2 ID : **4589084214**
Option 3 ID : **4589084215**
Option 4 ID : **4589084216**
Status : **Not Answered**
Chosen Option : **--**

**Q.52** A kaon $(K^0)$ decays into two neutral pions $(\pi^0)$. Given that the mass of the $K^0$ is $495\,MeV/c^2$ and the mass of the $\pi^0$ is $135\,MeV/c^2$, the final momentum of the $\pi^0$ (in $MeV/c$) in the center of mass frame is approximately:

1. 207
2. 359
3. 157
4. 103

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081047**
Option 1 ID : **4589084185**
Option 2 ID : **4589084186**
Option 3 ID : **4589084187**
Option 4 ID : **4589084188**
Status : **Not Answered**
Chosen Option : **--**

**Q.53**

The table shows the $g$-factors of proton $(p)$ and neutron $(n)$ for orbital $(g_l)$ and spin $(g_s)$ angular momentum.

| | $g_l$ | $g_s$ |
|---|---|---|
| $p$ | 1 | 5.58 |
| $n$ | 0 | −3.82 |

The magnetic moment of $^{17}_{8}O$ nucleus, according to the single particle shell model, in units of nuclear magneton $(\mu_N)$ is:

1. 0.55
2. 4.79
3. −1.91
4. −3.82

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081065**
Option 1 ID : **4589084257**
Option 2 ID : **4589084258**
Option 3 ID : **4589084259**
Option 4 ID : **4589084260**
Status : **Answered**
Chosen Option : **3**

**Q.54**

For a one-dimensional system the Hamiltonian is given by $H = \frac{p^2}{2} - \frac{1}{2q^2}$. If a constant of motion of the system is $\left(apq + bp^2t + \frac{ct}{q^2}\right)$, where $a, b$ and $c$ are constants and $t$ denotes the time, then which of the following options is correct:

1. $a = b = c$
2. $a = -b = c$
3. $a = -b = -c$
4. $a = b = -c$

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081043**
Option 1 ID : **4589084169**
Option 2 ID : **4589084170**
Option 3 ID : **4589084171**
Option 4 ID : **4589084172**
Status : **Answered**
Chosen Option : **2**

**Q.55**

Potassium chloride (KCl) crystallizes in NaCl structure. The atomic form factors of $K^+$ and $Cl^-$ are the same. Then the first four X-ray diffraction peaks for KCl are:

1. (100), (110), (111), (200)
2. (110), (200), (222), (310)
3. (111), (200), (220), (311)
4. (200), (220), (222), (400)

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081069**
Option 1 ID : **4589084273**
Option 2 ID : **4589084274**
Option 3 ID : **4589084275**
Option 4 ID : **4589084276**
Status : **Answered**
Chosen Option : **3**

**Q.56**

Consider the following decay processes of $\rho^0$:

(A) $\rho^0 \rightarrow \pi^+ + \pi^-$

(B) $\rho^0 \rightarrow \pi^0 + \pi^0$

For the conservation of angular momentum and parity, which of the following options is correct?

1. Both processes (A) and (B) are allowed
2. Both processes (A) and (B) are forbidden
3. Only process (A) is allowed
4. Only process (B) is allowed

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081067**
Option 1 ID : **4589084265**
Option 2 ID : **4589084266**
Option 3 ID : **4589084267**
Option 4 ID : **4589084268**
Status : **Not Answered**
Chosen Option : **--**

**Q.57**

Transverse electric modes $TE_{mn}$ propagate in a hollow straight infinite metallic waveguide having rectangular cross section of sides 3 cm and 2 cm. The frequency (in GHz) of the lowest degenerate mode is:

(Given: speed of light = $3 \times 10^8$ m/s)

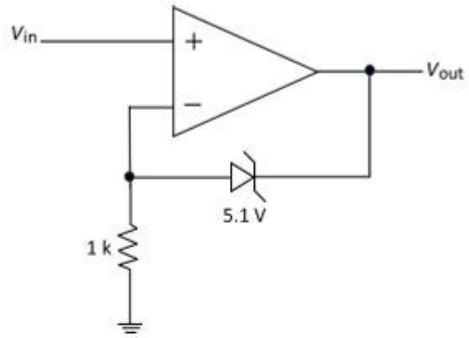
1. 5.0
2. 7.5
3. 9.0
4. 15.0

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081053**
Option 1 ID : **4589084209**
Option 2 ID : **4589084210**
Option 3 ID : **4589084211**
Option 4 ID : **4589084212**
Status : **Not Answered**
Chosen Option : **--**

**Q.58**

In the circuit shown below, if $V_{in}$ = 2.0 V then $V_{out}$ is



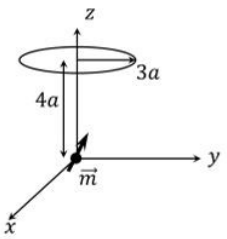

1. 2.0 V
2. 3.1 V
3. 5.1 V
4. 7.1 V

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081049**
Option 1 ID : **4589084193**
Option 2 ID : **4589084194**
Option 3 ID : **4589084195**
Option 4 ID : **4589084196**
Status : **Answered**
Chosen Option : **4**

**Q.59** A magnetic dipole $\vec{m}$ is kept at the origin with its direction along $+z$-axis. At time $t = 0$ it starts spinning about $x$-axis with angular speed $\omega$. A wire loop of radius $3a$ is kept with its plane parallel to $xy$-plane and centered at $z = 4a$ as shown in the figure. The emf $E$ induced in the loop for $t > 0$ is:

(Note that the magnetic flux through the given loop will be the same as through an appropriate section of a spherical shell of radius $5a$ with its center at the origin.)




1. $\left(\frac{9\mu_0 m\omega}{500a}\right)\sin\omega t$
2. $\left(\frac{9\mu_0 m\omega}{500a}\right)\cos\omega t$
3. $\left(\frac{9\mu_0 m\omega}{250a}\right)\sin\omega t$
4. $\left(\frac{9\mu_0 m\omega}{250a}\right)\cos\omega t$

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081058**
Option 1 ID : **4589084229**
Option 2 ID : **4589084230**
Option 3 ID : **4589084231**
Option 4 ID : **4589084232**
Status : **Not Answered**
Chosen Option : **--**

**Q.60**

A particle of mass $m$ with momentum $\hbar\vec{k}$ scatters elastically to momentum $\hbar(\vec{k}+\vec{q})$ from a spherical potential

$$V(\vec{r}) = \begin{cases} V_0 & \text{for } r \le R \\ 0 & \text{for } r > R \end{cases}.$$

Here, $q^2 = 4\,k^2 \sin^2\frac{\theta}{2}$ with $\theta$ being the scattering angle. Within the first-order Born approximation and for $qR \ll 1$, the differential scattering cross-section to the leading order in $R$ is proportional to:

1. $R^2$
2. $R^4$
3. $R^6$
4. $R^8$

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081052**
Option 1 ID : **4589084205**
Option 2 ID : **4589084206**
Option 3 ID : **4589084207**
Option 4 ID : **4589084208**
Status : **Answered**
Chosen Option : **2**

**Q.61**

Resistivity of a monovalent metal, having atomic density $4 \times 10^{22}$ atoms/cm$^3$, is found to be 1 $\mu\Omega$-cm. The approximate value of the mean free path of electrons in this metal is:

(Given: $\hbar = 10^{-34}$ J-s and $e = 1.6 \times 10^{-19}$ C)

1. 1 nm
2. 100 nm
3. $10^4$ nm
4. $10^6$ nm

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081056**
Option 1 ID : **4589084221**
Option 2 ID : **4589084222**
Option 3 ID : **4589084223**
Option 4 ID : **4589084224**
Status : **Not Answered**
Chosen Option : **--**

**Q.62**

In a superconductor, the current density $\vec{j}$ and magnetic field $\vec{B}$ are related by the equation:

(Here, $n$ is the number density of electrons, $e$ is electron charge, $m_e$ is electron mass and $\mu_0$ is permeability of vacuum.)

1. $\frac{\partial}{\partial t}\left(\vec{\nabla}\times\vec{j}-\frac{ne^2}{m_e}\vec{B}\right)=0$
2. $\left(\vec{\nabla}\times\vec{j}+\frac{ne^2}{m_e}\vec{B}\right)=0$
3. $\left(\nabla^2\vec{B}-\mu_0\vec{\nabla}\times\vec{j}\right)=0$
4. $\left(\nabla^2\vec{j}-\mu_0\vec{\nabla}\times\vec{B}\right)=0$

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081057**
Option 1 ID : **4589084225**
Option 2 ID : **4589084226**
Option 3 ID : **4589084227**
Option 4 ID : **4589084228**
Status : **Not Answered**
Chosen Option : **--**

**Q.63**

The integral

$$\int_0^4 x^4\,dx$$

when computed numerically using Simpson's 1/3rd method and trapezoidal method, each with unit step size, yields values $I_s$ and $I_t$, respectively. Then which of the following options is correct?

1. $I_s = 205.3, \quad I_t = 226.0$
2. $I_s = 205.3, \quad I_t = 205.3$
3. $I_s = 204.8, \quad I_t = 226.0$
4. $I_s = 226.0, \quad I_t = 226.0$

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081068**
Option 1 ID : **4589084269**
Option 2 ID : **4589084270**
Option 3 ID : **4589084271**
Option 4 ID : **4589084272**
Status : **Not Answered**
Chosen Option : **--**

**Q.64**

The Hamiltonian of a quantum mechanical system is given by $\hat{H} = \alpha\hat{L}^2 + \beta\hbar\hat{L}_z$. Here, $\alpha$ and $\beta$ are positive constants and $\hat{L}$ represents the orbital angular momentum operator. If $l$ and $m$ are the azimuthal and magnetic quantum numbers then the lowest energy state for this system is:

1. $l = 1, m = -1$ for $\alpha = \beta$
2. $l = 0, m = 0$ for $\alpha < \frac{\beta}{2}$
3. $l = 1, m = -1$ for $\alpha < \frac{\beta}{2}$
4. $l = 1, m = +1$ for $\alpha < \frac{\beta}{2}$

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081046**
Option 1 ID : **4589084181**
Option 2 ID : **4589084182**
Option 3 ID : **4589084183**
Option 4 ID : **4589084184**
Status : **Answered**
Chosen Option : **3**

**Q.65**

A biased random walker confined to the $x$-axis moves, at each step, with probability $0.6$ to the right and with probability $0.4$ to the left. If the walker takes $1000$ steps starting from the origin, the probability that the walker is found exactly $200$ steps to the right of the origin is close to:

1. $0.026$
2. $0.125$
3. $0.250$
4. $0.375$

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081062**
Option 1 ID : **4589084245**
Option 2 ID : **4589084246**
Option 3 ID : **4589084247**
Option 4 ID : **4589084248**
Status : **Not Answered**
Chosen Option : **--**

**Q.66**

There is a ferromagnetic interaction $J$ between two Ising spins, $S_1, S_2 = \pm 1$, and they are under the influence of an external magnetic field $h$. The Hamiltonian of this system is,

$$H = -JS_1S_2 - h\,S_1 - h\,S_2.$$

The spins are in equilibrium at temperature $T$ and $\beta = 1/k_BT$ with $k_B$ as Boltzmann constant. The average value of either spin, for small $h$, is:

1. $\dfrac{4h\exp(\beta J)}{\cosh(\beta J)}$
2. $\dfrac{h\exp(2\beta J)}{\cos(\beta J)}$
3. $\dfrac{8h\exp(4\beta J)}{\sinh(\beta J)}$
4. $\dfrac{2h\exp(2\beta J)}{\sin(\beta J)}$

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081063**
Option 1 ID : **4589084249**
Option 2 ID : **4589084250**
Option 3 ID : **4589084251**
Option 4 ID : **4589084252**
Status : **Not Answered**
Chosen Option : **--**

**Q.67**

A dynamical system is described by a differential equation $\ddot{x} - \dot{x} + x^2 - 2x = 0$. The nature of the fixed point at the origin is:

1. unstable spiral
2. stable node
3. unstable hyperbola
4. stable spiral

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081055**
Option 1 ID : **4589084217**
Option 2 ID : **4589084218**
Option 3 ID : **4589084219**
Option 4 ID : **4589084220**
Status : **Not Answered**
Chosen Option : **--**

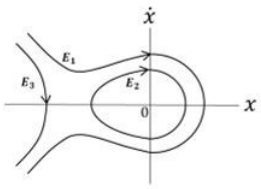
**Q.68**

A particle is moving in one dimension in the potential

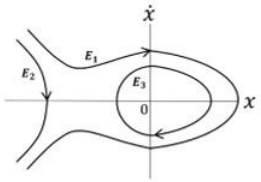
$$V(x) = \frac{1}{2}x^2 + \frac{1}{3}x^3.$$

The schematic phase-space diagrams for the total energies $E_1 > E_2 > E_3$ are best represented by:

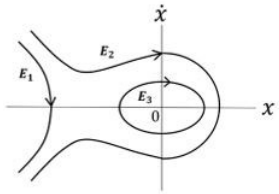
1.



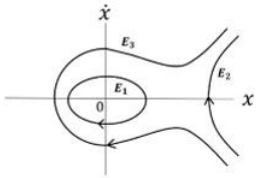

2.




3.




4.




**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081045**
Option 1 ID : **4589084177**
Option 2 ID : **4589084178**
Option 3 ID : **4589084179**
Option 4 ID : **4589084180**
Status : **Answered**
Chosen Option : **1**

**Q.69**

Assume a spherically uniform charge distribution in a nucleus having mass number $A$ and radius $R = R_0 A^{1/3}$ with $R_0 \approx 1.5$ fm. If the difference in electrostatic energy between two mirror nuclei, ${}^{A}_{z}X$ and ${}^{A}_{z-1}Y$, is 3.53 MeV, then the value of atomic number $Z$ is closest to:

(Given: $\frac{e^2}{4\pi\epsilon_0} \approx 1.44$ MeV. fm and 1 fm $= 10^{-15}$ m)

1. 6
2. 8
3. 10
4. 12

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081066**
Option 1 ID : **4589084261**
Option 2 ID : **4589084262**
Option 3 ID : **4589084263**
Option 4 ID : **4589084264**
Status : **Not Answered**
Chosen Option : **--**

**Q.70**

Modulation techniques are used to shift a signal to higher frequencies to

1. remove the effects of white noise.
2. reduce the effects of $1/f$-noise and drift.
3. reduce shot noise and Johnson noise.
4. smoothen the signal and amplify it.

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081064**
Option 1 ID : **4589084253**
Option 2 ID : **4589084254**
Option 3 ID : **4589084255**
Option 4 ID : **4589084256**
Status : **Not Answered**
Chosen Option : **--**

**Q.71**

Given is a set of 5 data points of the form $(x_i, y_i, \sigma_i)$ with $\sigma_i$ as the estimated uncertainty in $y_i$. This data is fitted to the form $y = ax + b$ and the minimized $\chi^2$ (chi-square) is found to be 5.1. The reduced $\chi^2$ for this fitting is:

1. 1.0
2. 1.2
3. 1.5
4. 1.7

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081070**
Option 1 ID : **4589084277**
Option 2 ID : **4589084278**
Option 3 ID : **4589084279**
Option 4 ID : **4589084280**
Status : **Not Answered**
Chosen Option : **--**

**Q.72**

Consider a complex analytic function $f(x, y) = u(x, y) + i\, v(x, y)$. If $u(x, y) = x^3 - 3xy^2$, then $v(x, y)$ is:

1. $y^3 - 3xy^2$
2. $3xy^2 - y^3$
3. $3x^2y - y^3$
4. $y^3 + 3xy^2$

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081048**
Option 1 ID : **4589084189**
Option 2 ID : **4589084190**
Option 3 ID : **4589084191**
Option 4 ID : **4589084192**
Status : **Answered**
Chosen Option : **3**

**Q.73** In an experiment, a student generates 100 random numbers drawn from a uniform distribution in the interval $(0,1)$ and calculates their mean. If the experiment is repeated 100 times, then the standard deviation of the means is:

1. $\frac{1}{20\sqrt{3}}$
2. $\frac{1}{2\sqrt{3}}$
3. $\frac{1}{\sqrt{3}}$
4. $\frac{1}{200\sqrt{3}}$

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081041**
Option 1 ID : **4589084161**
Option 2 ID : **4589084162**
Option 3 ID : **4589084163**
Option 4 ID : **4589084164**
Status : **Not Answered**
Chosen Option : **--**

**Q.74** The Hamiltonian of a particle of mass $m$ , moving in a circle of a fixed radius $R$, is given by $H_0 = \frac{L_z^2}{2mR^2}$, where $L_z = -i\hbar\frac{d}{d\phi}$ and $\phi$ is the azimuthal angle. This particle is perturbed by $H' = V\cos(2\phi)$ with $V \ll \frac{\hbar^2}{2mR^2}$. Within the first-order degenerate perturbation theory, the magnitude of the energy splitting of the first excited state is:

1. $\frac{V}{2}$
2. $V$
3. $2V$
4. $\frac{V}{4}$

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081050**
Option 1 ID : **4589084197**
Option 2 ID : **4589084198**
Option 3 ID : **4589084199**
Option 4 ID : **4589084200**
Status : **Not Answered**
Chosen Option : **--**

**Q.75**

Consider a particle of mass $m$ in an infinite potential well with walls at $x = 0$ and $x = 2L$. The particle is perturbed by a weak perturbation $H' = V_0 L\, \delta(x - 3L/2)$. The first-order correction to its first excited state energy is:

1. $2V_0$
2. $V_0$
3. $\frac{V_0}{2}$
4. $0$

**Options** 1. 1
2. 2
3. 3
4. 4

Question Type : **MCQ**
Question ID : **4589081051**
Option 1 ID : **4589084201**
Option 2 ID : **4589084202**
Option 3 ID : **4589084203**
Option 4 ID : **4589084204**
Status : **Not Answered**
Chosen Option : **--**

**Exam Summary**

**PHYSICAL SCEINCES**

| Section Name | No. of Questions | Answered | Not Answered | Marked for Review | Answered & Marked for Review | Not Visited |
|---|---|---|---|---|---|---|
| PART A | 20 | 7 | 13 | 0 | 0 | 0 |
| PART B | 25 | 7 | 17 | 1 | 0 | 0 |
| PART C | 30 | 9 | 21 | 0 | 0 | 0 |

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