DU PhD in Physics

Topic:- PHY PHD S2

1) A small mass *m* with a charge *q* is attached to a spring of spring- constant *k* and allowed to oscillate with amplitude *A*. Assuming that the amplitude of the oscillations and the speed of the mass is small, the time averaged power radiated by the system in Gaussian units is

[Question ID = 1426]

1. $\frac{q^2k^2A^2}{3c^3m^2}$

   [Option ID = 5698]
2. $\frac{q^2k^2A^2}{3c^4m^2}$

   [Option ID = 5699]
3. $\frac{2q^2k^2A^2}{3c^3m^2}$

   [Option ID = 5700]
4. None of these

   [Option ID = 5701]

Correct Answer :-

- $\frac{q^2k^2A^2}{3c^3m^2}$

  [Option ID = 5698]

2) A sphere of radius *a* made of a material of dielectric constant $\epsilon_r = \frac{\epsilon}{\epsilon_0}$ has a uniform charge density (ρ). Assuming V(∞) = 0, the potential V(0) at the center of the sphere is

[Question ID = 1427]

1. $V(0) = \frac{\rho a^2}{6\epsilon_0\epsilon_r}(2\epsilon_r + 1)$

   [Option ID = 5702]
2. $V(0) = 0$

   [Option ID = 5703]
3. $V(0) = \frac{\rho a^2}{4\pi\epsilon_0}(2\epsilon_r + 1)$

   [Option ID = 5704]
4. $V(0) = \frac{4\pi a^2\rho}{3\epsilon_0\epsilon_r}$

   [Option ID = 5705]

Correct Answer :-

- $V(0) = \frac{\rho a^2}{6\epsilon_0\epsilon_r}(2\epsilon_r + 1)$

  [Option ID = 5702]

3) In the planetary model of the hydrogen atom, the time taken for the electron of charge e and mass *m* in the first Bohr orbit ($a_o = \frac{\hbar^2}{me^2}$) to spiral into the nucleus is given by

[Question ID = 1428]

1. $\frac{m^2c^3a_0^3}{4e^4}$

[Option ID = 5706]

2. $\frac{m^2c^3a_0^3}{2e^4}$

[Option ID = 5707]

3. $\frac{m^2c^3a_0^3}{2\hbar e^4}$

[Option ID = 5708]

4. None of these

[Option ID = 5709]

Correct Answer :-

- $\frac{m^2c^3a_0^3}{4e^4}$

[Option ID = 5706]

4) **A particle of mass *m* and charge *q* is accelerated from rest in a uniform electric field E = $E\hat{x}$ for a time t. Assuming relativistic motion, the speed of the particle at time t is given by**

[Question ID = 1429]

1. $\frac{qEct}{\sqrt{(qEt)^2 + (mc)^2}}$

[Option ID = 5710]

2. $(\frac{qE}{m})t$

[Option ID = 5711]

3. $\frac{qEct}{2\sqrt{(qEt)^2 + (mc)^2}}$

[Option ID = 5712]

4. $\frac{qEct^2}{\sqrt{(qEt)^2 + (mc)^2}}$

[Option ID = 5713]

Correct Answer :-

- $\frac{qEct}{\sqrt{(qEt)^2 + (mc)^2}}$

[Option ID = 5710]

5) **A circular air filled parallel plate capacitor of radius R and separation d has an electric field $E(t)$ which varies as $\frac{\partial E}{\partial t}$. Ignoring edge effects, the magnitude of the magnetic field is given by**

[Question ID = 1430]

1. $B = \frac{R}{2c}\frac{\partial E}{\partial t}$

[Option ID = 5714]

2. $B = \frac{R^2}{2cd}\frac{\partial E}{\partial t}$

[Option ID = 5715]

3. $B = \frac{d^2}{Rc}\frac{\partial E}{\partial t}$

[Option ID = 5716]

4. $B = \frac{R^2}{2d}\frac{\partial E}{\partial t}$

[Option ID = 5717]

Correct Answer :-

- $B = \frac{R}{2c}\frac{\partial E}{\partial t}$

[Option ID = 5714]

6) **The first-order correction to the ground state energy of an isotropic 3-dimensional harmonic oscillator with the perturbation $V = \lambda xyz^2$ is**

[Question ID = 1431]

1. 0

   [Option ID = 5718]
2. $\lambda^2 \left(\frac{\hbar}{2m\omega}\right)$

   [Option ID = 5719]
3. ∞

   [Option ID = 5720]
4. $\left(\frac{\hbar}{2m\omega}\right)^2 \lambda^2$

   [Option ID = 5721]

Correct Answer :-

- 0

  [Option ID = 5718]

7) **Consider a particle of mass *m* constrained in the segment -*a* ≤ *x* ≤ *a* and subject to the repulsive potential $V(x) = \lambda\delta(x), \lambda > 0$. Consider *V (x)* as a perturbation and calculate the 1st order correction $\Delta E_0^{(1)}$ and $\Delta E_1^{(1)}$ to the energies of the ground and first excited states**

[Question ID = 1432]

1. $\Delta E_0^{(1)} = \frac{\lambda}{a}$ and $\Delta E_1^{(1)} = 0$

   [Option ID = 5722]
2. $\Delta E_0^{(1)} = 0$ and $\Delta E_1^{(1)} = \frac{\hbar^2\pi^2}{8ma^2}$

   [Option ID = 5723]
3. $\Delta E_0^{(1)} = \frac{\lambda}{a}$ and $\Delta E_1^{(1)} = \frac{\lambda}{a}$

   [Option ID = 5724]
4. $\Delta E_0^{(1)} = \frac{\hbar^2\pi^2}{8ma^2}$ and $\Delta E_1^{(1)} = \frac{\lambda}{a}$

   [Option ID = 5725]

Correct Answer :-

- $\Delta E_0^{(1)} = \frac{\lambda}{a}$ and $\Delta E_1^{(1)} = 0$

  [Option ID = 5722]

8) **If the scattering amplitude $f(\theta) = 4\sin(\theta) + i5\cos(\theta)$, the total cross-section σ_T is**

[Question ID = 1433]

1. $\frac{20\pi}{k}$

   [Option ID = 5726]
2. $\frac{5}{k^2}$

   [Option ID = 5727]
3. $\frac{4}{k^2}$

   [Option ID = 5728]
4. 0

   [Option ID = 5729]

Correct Answer :-

- $\frac{20\pi}{k}$

[Option ID = 5726]

9) Find the first order probability of transition of a harmonic oscillator to go from its ground state |0 > to the first exited state |1 > for a time-dependent perturbation $H(t) = xe^{\frac{-t}{\tau}}$, $t \geq 0, \tau > 0$, for $t \to \infty$ late time, and $\tau \to 0$. $P_{0\to1}^{(1)}$ is therefore equal to

[Question ID = 1434]

1. 0

   [Option ID = 5730]
2. $\dfrac{1}{2m\hbar\omega^3}$

   [Option ID = 5731]
3. 1

   [Option ID = 5732]
4. ∞

   [Option ID = 5733]

Correct Answer :-

- 0

  [Option ID = 5730]

10) The angle between two *(hkl)* planes corresponding to (100) and (110) is

[Question ID = 1435]

1. 45°

   [Option ID = 5734]
2. 60°

   [Option ID = 5735]
3. 30°

   [Option ID = 5736]
4. 15°

   [Option ID = 5737]

Correct Answer :-

- 45°

  [Option ID = 5734]

11) The Madelung constant of a one dimensional crystal consisting of alternate positive and negative ions with interatomic distance R is given by the expression α = 2 ln2. The Madelung constant for a divalent ion can be expressed as:
[Question ID = 1436]

1. α = 8 ln2 [Option ID = 5738]
2. α = 4 ln2 [Option ID = 5739]
3. α = ln2 [Option ID = 5740]
4. 0 [Option ID = 5741]

Correct Answer :-

- α = 8 ln2 [Option ID = 5738]

12) The total scattering amplitude of reflection from (h,k,l) plane is given by the expression

$F(h,k,l) = \sum_j e^{2\pi i(u_j h + v_j k + w_j l)}$. Where (u_j, v_j, w_j) represent the coordinates of the jth atom. The allowed reflections for (h,k,l) values for a FCC structure are

[Question ID = 1437]

1. all odd or all even

   [Option ID = 5742]
2. all odd

   [Option ID = 5743]
3. all even

   [Option ID = 5744]
4. zero

   [Option ID = 5745]

Correct Answer :-

- all odd or all even

  [Option ID = 5742]

13) A one dimensional lattice chain consists of periodic arrangement of atoms with lattice spacing ‘*a*’. Each atom is represented by the potential $V(x) = aV_0\delta(x)$. the energy gaps between the bands in the nearly free electron approximation is

[Question ID = 1438]

1. $2V_0$

   [Option ID = 5746]
2. V_0

   [Option ID = 5747]
3. $V_0/2$

   [Option ID = 5748]
4. $\sqrt{V_0}$

   [Option ID = 5749]

Correct Answer :-

- $2V_0$

  [Option ID = 5746]

14) If an AC current of frequency 1 GHz is observed through a Josephson junction, then the applied dc voltage is, (Given h = 6.625 x 10 $^{-34}$)

[Question ID = 1439]

1. 2.07 μV [Option ID = 5750]
2. 3.8 μV [Option ID = 5751]
3. 1 μV [Option ID = 5752]
4. 5.48 μV [Option ID = 5753]

Correct Answer :-

- 2.07 μV [Option ID = 5750]

15) Suppose that Newton’s theory of gravitation is modified for short range. In this modified theory the potential energy between two masses m_1 and m_2 are given by,

$$V(r) = -\frac{Gm_1m_2}{r}(1 - ae^{-r/\lambda})$$

Where *a* is a constant and other symbols have their usual physical significance. For short distances $r \ll \lambda$ calculate the force between m_1 and m_2 .

[Question ID = 1440]

1. $F = -Gm_1m_2\,(1-a)/r^2$

   [Option ID = 5754]
2. $F = -Gm_1m_2\,a/\lambda r$

   [Option ID = 5755]
3. $F = -Gm_1m_2\,(1+a)/r^2$

   [Option ID = 5756]
4. $F = -Gm_1m_2\,a/r^2$

   [Option ID = 5757]

Correct Answer :-

- $F = -Gm_1m_2\,(1-a)/r^2$

  [Option ID = 5754]

16) A statistical system is composed of two ultra-relativistic particles moving in a segment of length L. The Hamiltonian of the system is given by,

$$H(p_1, p_2) = c(|p_1| + |p_2|)$$

Where, p_1 and p_2 are the momenta of the particles and *c* is the speed of light in vacuum. The volume of phase space enclosed by the surface of constant energy *E* is given by,

[Question ID = 1441]

1. $\Sigma(E, L) = \frac{2E^2L^2}{c^2}$

   [Option ID = 5758]

2. $\Sigma(E, L) = \frac{E^2L^2}{c^2}$

[Option ID = 5759]

3. $\Sigma(E, L) = \frac{2EL^2}{c^2}$

[Option ID = 5760]

4. $\Sigma(E, L) = 2E^2L^2$

[Option ID = 5761]

Correct Answer :-

- $\Sigma(E, L) = \frac{2E^2L^2}{c^2}$

[Option ID = 5758]

17) Consider an ensemble of *N* distinguishable particles distributed in two energy levels *ε* and *-ε*, with number of particles in them *N+* and *N-* , respectively in equilibrium. The ensemble is isolated and has a fixed energy *E* at temperature *T* given by, $E = -N\varepsilon \tanh(\frac{\varepsilon}{k_B T})$, where *kB* is the Boltzmann Constant.

If $\varepsilon = k_B \ln 2$, find out the temperature at which $N_+/N_- = 1/2$.

[Given, $\tanh x = \frac{e^x - e^{-x}}{e^x + e^{-x}}$]

[Question ID = 1442]

1. +2K

[Option ID = 5762]

2. -2K

[Option ID = 5763]

3. +1K

[Option ID = 5764]

4. -4K

[Option ID = 5765]

Correct Answer :-

- +2K

[Option ID = 5762]

18) Primary advantage of a crystal oscillator is that
[Question ID = 1443]

1. it can oscillate at any frequency [Option ID = 5766]
2. it gives a high output voltage [Option ID = 5767]
3. its frequency of oscillation remains almost constant [Option ID = 5768]
4. it gives a constant a d.c. output voltage [Option ID = 5769]

Correct Answer :-

- its frequency of oscillation remains almost constant [Option ID = 5768]

19) In the spectrum of a frequency-modulated wave -
[Question ID = 1444]

1. the carrier frequency disappears when the modulation-index is large [Option ID = 5770]
2. the amplitude of any sideband depends on the modulation-index [Option ID = 5771]
3. the total number of sidebands depends on the modulation-index [Option ID = 5772]
4. the carrier frequency cannot disappear [Option ID = 5773]

Correct Answer :-

- the amplitude of any sideband depends on the modulation-index [Option ID = 5771]

20) The largest value of output voltage from an 8-bit digital-to-analog converter that produces 1.0 V for a digital input of 00110010 is
[Question ID = 1445]

1. 5.1 V [Option ID = 5774]
2. 10.2 V [Option ID = 5775]
3. 20.4 V [Option ID = 5776]
4. 2.5 V [Option ID = 5777]

Correct Answer :-

- 5.1 V [Option ID = 5774]

21) Which of the following statement is NOT correct for a Depletion type n-channel MOSFET
[Question ID = 1446]
1. Channel width can be increased [Option ID = 5778]
2. Channel width can be decreased [Option ID = 5779]
3. Can work with both positive and negative gate bias [Option ID = 5780]
4. Initially the channel between drain and source is completely blocked by a p-region [Option ID = 5781]

Correct Answer :-
- Initially the channel between drain and source is completely blocked by a p-region [Option ID = 5781]

22) If an inverter is placed between the inputs of an S-R Flip-Flop, the resulting Flip-Flop is a
[Question ID = 1447]
1. D-Flip Flop [Option ID = 5782]
2. J-K Flip Flop [Option ID = 5783]
3. Master Slave Flip Flop [Option ID = 5784]
4. Remains a S-R Flip-Flop [Option ID = 5785]

Correct Answer :-
- D-Flip Flop [Option ID = 5782]

23) The Carnot engines X and Y are operating in series. The first engine X receives heat at 1200 K and rejects to a reservoir at temperature T. The second engine Y receives the heat rejected by X, and thereafter re-ejects to a heat reservoir at 300 K. Calculate the temperature (in Kelvin) for the situation, when the work output of the two engines is equal.
[Question ID = 1448]
1. 750 K [Option ID = 5786]
2. 600 K [Option ID = 5787]
3. 0 K [Option ID = 5788]
4. 450 K [Option ID = 5789]

Correct Answer :-
- 750 K [Option ID = 5786]

24) The quantum mechanical energy states of an atom are described by the energy states such as 0 and ϵ at the thermal equilibrium temperature T. Now the system has partition function Q such that its total internal energy will be:

[Question ID = 1449]
1. $U = \frac{\epsilon}{e^{\frac{\epsilon}{kT}}+1}$

   [Option ID = 5790]
2. $U = \frac{2\epsilon}{e^{\frac{2\epsilon}{kT}}+1}$

   [Option ID = 5791]
3. $U = \frac{kT}{e^{\frac{\epsilon}{kT}}+1}$

   [Option ID = 5792]
4. $U = \frac{\epsilon kT}{e^{\frac{2\epsilon}{kT}}+1}$

   [Option ID = 5793]

Correct Answer :-
- $U = \frac{\epsilon}{e^{\frac{\epsilon}{kT}}+1}$

  [Option ID = 5790]

25) 1 Kg of water at 273 K is brought in contact with a heat reservoir at 373 K. Now after the transfer of heat to the heat reservoir, there is a change of entropy in the system when the water reaches 373 K. What is the change in entropy.

[Given specific heat $s = 10^3$ cal/Kg-K]

[Question ID = 1450]
1. $2.303 \log_{10}(\frac{373}{273})\ cal/K$

[Option ID = 5794]
2. $10^3 \times 2.303 \log_{10}(\frac{373}{273})\ cal/K$

[Option ID = 5795]
3. $10^3 \times \log_{10}(\frac{373}{273})\ cal/K$

[Option ID = 5796]
4. None of these

[Option ID = 5797]

Correct Answer :-

- $10^3 \times 2.303 \log_{10}(\frac{373}{273})\ cal/K$

[Option ID = 5795]

26) Roughing vacuum range is

[Question ID = 1451]
1. $10^{-7} - 10^{-5}$ mbar

[Option ID = 5798]
2. $10^{-11} - 10^{-9}$ mbar

[Option ID = 5799]
3. $10^{-3} - 10^{-1}$ mbar

[Option ID = 5800]
4. $10^{3} - 10^{1}$ mbar

[Option ID = 5801]

Correct Answer :-

- $10^{-3} - 10^{-1}$ mbar

[Option ID = 5800]

27) Pirani gauge works in pressure range of

[Question ID = 1452]
1. $10^{5} - 10^{1}$ Torr

[Option ID = 5802]
2. $10^{-4} - 10^{-1}$ Torr

[Option ID = 5803]
3. $10^{-8} - 10^{-4}$ Torr

[Option ID = 5804]
4. $10^{-12} - 10^{-3}$ Torr

[Option ID = 5805]

Correct Answer :-

- $10^{-4} - 10^{-1}$ Torr

[Option ID = 5803]

28) 3 Isospin (I) of elementary particle Ω^- is

[Question ID = 1453]
1. $\frac{1}{2}$

[Option ID = 5806]
2. $\frac{3}{2}$

[Option ID = 5807]
3. 1

[Option ID = 5808]
4. 0

[Option ID = 5809]

Correct Answer :-

- 0

  [Option ID = 5809]

29) Which one of the following particle has a strangeness quantum number 1 ?
[Question ID = 1454]

1. π^+ [Option ID = 5810]
2. Λ^0 [Option ID = 5811]
3. K^+ [Option ID = 5812]
4. Ω^- [Option ID = 5813]

Correct Answer :-

- K^+ [Option ID = 5812]

30) Hypercharge (Y) of elementary particle K^+ is

[Question ID = 1455]

1. 0

   [Option ID = 5814]
2. +1

   [Option ID = 5815]
3. -1

   [Option ID = 5816]
4. -2

   [Option ID = 5817]

Correct Answer :-

- +1

  [Option ID = 5815]

31) Quark structure of elementary particle Σ^+ is

[Question ID = 1456]

1. uus

   [Option ID = 5818]
2. uds

   [Option ID = 5819]
3. sds

   [Option ID = 5820]
4. sus

   [Option ID = 5821]

Correct Answer :-

- uus

  [Option ID = 5818]

32) Total number of down quarks in $^{7}_{3}Li$ are

[Question ID = 1457]

1. 9

   [Option ID = 5822]
2. 10

   [Option ID = 5823]
3. 11

   [Option ID = 5824]
4. 12

   [Option ID = 5825]

Correct Answer :-

- 11

  [Option ID = 5824]

33) If the probability that a problem will be solved by three students is 1/2, 1/3 and 1/6, then what is the probability that the problem will be solved?

[Question ID = 1458]

1. 13/18,

   [Option ID = 5826]
2. 1/36

   [Option ID = 5827]
3. 1/18

   [Option ID = 5828]
4. none of these

   [Option ID = 5829]

Correct Answer :-

- 13/18,

  [Option ID = 5826]

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34) Find the eigenvalues of $4A^{-1}+3A+2I$, where I is the identity matrix and $A=\begin{pmatrix}1 & 0\\2 & 4\end{pmatrix}$

[Question ID = 1459]

1. 9,15

   [Option ID = 5830]
2. 9,36

   [Option ID = 5831]
3. 7,28

   [Option ID = 5832]
4. None of these

   [Option ID = 5833]

Correct Answer :-

- 9,15

  [Option ID = 5830]

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35) If $u=x^2+y^2+z^2$ and $\vec{r}=x\vec{i}+y\vec{j}+z\vec{k}$ then $div(u\,\vec{r})$ is

[Question ID = 1460]

1. u

   [Option ID = 5834]
2. 2u

   [Option ID = 5835]
3. 4u

   [Option ID = 5836]
4. 5u

   [Option ID = 5837]

Correct Answer :-

- 5u

  [Option ID = 5837]

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36) The value of complex integral $\oint \frac{z}{z^2+9}dz$ with the closed contour $|z-2i|=4$ is

[Question ID = 1461]

1. πi

   [Option ID = 5838]
2. $2\pi i$

   [Option ID = 5839]
3. $3\pi i$

   [Option ID = 5840]
4. $4\pi i$

   [Option ID = 5841]

Correct Answer :-

- πi

[Option ID = 5838]

37) The Fourier transform of $f(x) = \begin{cases} 0, & x \leq 0 \\ e^{-ax}, & x > 0 \end{cases}$ is

[Question ID = 1462]

1. $\frac{1}{2\pi is+a}$

[Option ID = 5842]

2. $\frac{1}{2\pi is+2a}$

[Option ID = 5843]

3. $\frac{1}{2\pi is-a}$

[Option ID = 5844]

4. None of these

[Option ID = 5845]

Correct Answer :-

- $\frac{1}{2\pi is+a}$

[Option ID = 5842]

38) **Given the operator** $\hat{\vec{J}} = \hat{J}_x\hat{i} + \hat{J}_y\hat{j} + \hat{J}_z\hat{k}$ **, where the commutator** $[\hat{J}_j, \hat{J}_k] = i\sum_{l=1}^{3}\epsilon_{jkl}\hat{J}_l$ **, as well as two constant vector** $\vec{u}$ **and** $\vec{v}$ **, then the commutator** $[\vec{u}.\hat{\vec{J}}, \vec{v}.\hat{\vec{J}}]$ **is equal to,**

[Question ID = 1463]

1. $i(\vec{u} \times \vec{v}).\ \hat{\vec{J}}$

[Option ID = 5846]

2. $i\left(\sum_{k=1}^{3} u_k v_k \hat{J}_k\right)^2$

[Option ID = 5847]

3. $i\sum_{k=1}^{3} u_k v_k \hat{J}_k$

[Option ID = 5848]

4. $i\sum_{k=1}^{3} u_k v_k\ \hat{\vec{J}}.\hat{\vec{J}}$

[Option ID = 5849]

Correct Answer :-

- $i(\vec{u} \times \vec{v}).\ \hat{\vec{J}}$

[Option ID = 5846]

39) **For** $-1 \leq x \leq +1$ **, the series** $\sum_{n=0}^{\infty}(-1)^n\frac{x^{2n+1}}{2n+1}$ **is equal to:**

[Question ID = 1464]

1. $\tan^{-1} x$

[Option ID = 5850]

2. $\frac{xexpx}{\pi}$

[Option ID = 5851]

3. $\sin^2 x$

[Option ID = 5852]

4. $\cos^2 x$

[Option ID = 5853]

Correct Answer :-

- $\tan^{-1} x$

[Option ID = 5850]

40) The integral, $\int_{-\infty}^{+\infty} \frac{d(\delta(y))}{dy} \sin y \; dy$ is equal to,

[Question ID = 1465]

1. -1

[Option ID = 5854]

2. $\cos y$

[Option ID = 5855]

3. +1

[Option ID = 5856]

4. π

[Option ID = 5857]

Correct Answer :-

- -1

[Option ID = 5854]

41) The solution of the differential equation, $(1+x^2)\frac{df}{dx} + xf(x) = 0$ is given by, A being an arbitrary constant,

[Question ID = 1466]

1. $A(x^2+1)^{-1/2}$

[Option ID = 5858]

2. $\ln\left(A(x^2+1)\right)$

[Option ID = 5859]

3. $\ln\left(A(x^2+1)^{-1/2}\right)$

[Option ID = 5860]

4. $\cos\left(A(x^2+1)\right)$

[Option ID = 5861]

Correct Answer :-

- $A(x^2+1)^{-1/2}$

[Option ID = 5858]

42) If $\nabla \times \vec{F}(\vec{r}) \neq 0$ but $\nabla \times \left(g(\vec{r})\vec{F}(\vec{r})\right) = 0$ then,

[Question ID = 1467]

1. $\vec{F}(\vec{r}).\left(\nabla \times \vec{F}(\vec{r})\right) = 0$

[Option ID = 5862]

2. $\nabla \times \left(\nabla \times \vec{F}(\vec{r})\right) = 0$

[Option ID = 5863]

3. $\nabla.\vec{F}(\vec{r}) = 0$

[Option ID = 5864]

4. $\nabla g(\vec{r}).\left(\nabla \times \vec{F}(\vec{r})\right) = 0$

[Option ID = 5865]

Correct Answer :-

- $\vec{F}(\vec{r}).\left(\nabla \times \vec{F}(\vec{r})\right) = 0$

[Option ID = 5862]

43) $\frac{d(\delta(y))}{dy}$ equals to:

[Question ID = 1468]

1. $\frac{i}{2\pi}\int_{-\infty}^{+\infty} xe^{ixy}\,dx$

   [Option ID = 5866]
2. $\int_{-\infty}^{+\infty} \frac{e^{ixy}}{x}\,dx$

   [Option ID = 5867]
3. $\frac{1}{\pi}\int_{-\infty}^{+\infty} xe^{ixy}\,dx$

   [Option ID = 5868]
4. $\frac{i}{2\pi}\int_{-\infty}^{+\infty} x^2e^{ixy}\,dx$

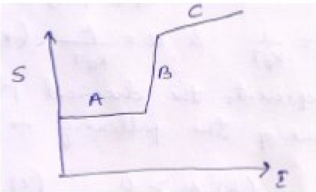
   [Option ID = 5869]

Correct Answer :-

- $\frac{i}{2\pi}\int_{-\infty}^{+\infty} xe^{ixy}\,dx$

  [Option ID = 5866]

44) The entropy S of a thermodynamic system as a function of energy E is given by the following graph



If T_A, T_B and T_C are the temperatures for the phases A, B, and C respectively, then
[Question ID = 1469]

1. $T_B > T_C > T_A$

   [Option ID = 5870]
2. $T_A > T_B > T_C$

   [Option ID = 5871]
3. $T_C > T_A > T_B$

   [Option ID = 5872]
4. $T_C > T_B > T_A$

   [Option ID = 5873]

Correct Answer :-

- $T_B > T_C > T_A$

  [Option ID = 5870]

45) If the half-life of radium is about 1600 years, then for a given ball of pure radium weighing 4 gm now, what would be the amount of time required to have only 0.125 gm of radium to be left,
[Question ID = 1470]

1. 9600 yrs [Option ID = 5874]
2. 4800 yrs [Option ID = 5875]
3. 7200 yrs [Option ID = 5876]
4. 8000 yrs [Option ID = 5877]

Correct Answer :-

- 8000 yrs [Option ID = 5877]

46) **The Hamiltonian for a 1-dimensional system is given to be** $H(x,p) = \alpha p + \beta x$, where α and β are positive real numbers, respectively. The phase space trajectory in the position -momentum $(x-p)$ plane is given by,

[Question ID = 1471]

1. An ellipse

   [Option ID = 5878]
2. A straight line with a positive slope

   [Option ID = 5879]
3. A parabola

   [Option ID = 5880]

4. A straight line with a negative slope

[Option ID = 5881]

Correct Answer :-

- A straight line with a negative slope

[Option ID = 5881]

47) The Lagrangian for a system is given by $L = \alpha e^{-bt}\dot{x}^2 - e^{-bt}\beta x$, where α and β are positive real numbers. The constant b is also a positive real number. The equation of motion that follows from this Lagrangian is

[Question ID = 1472]

1. $2\alpha\ddot{x} - b\dot{x} + \beta e^{-bt} = 0$

   [Option ID = 5882]
2. $e^{-bt}(\alpha\ddot{x} - 2b\dot{x}) + \beta = 0$

   [Option ID = 5883]
3. $\alpha(\ddot{x} + b\dot{x}) + \beta = 0$

   [Option ID = 5884]
4. $2\alpha(\ddot{x} - b\dot{x}) + \beta = 0$

   [Option ID = 5885]

Correct Answer :-

- $2\alpha(\ddot{x} - b\dot{x}) + \beta = 0$

[Option ID = 5885]

48) The Hamiltonian of a system is given by,

$H = ap^3 + bp + x^2$

where a and b are positive constants. The corresponding Lagrangian is

[Question ID = 1473]

1. $\pm\frac{2}{\sqrt{3a}}(\dot{x} - b)^2 - x^2$

   [Option ID = 5886]
2. $\frac{2}{3\sqrt{3a}}(\dot{x} - bx)^{3/2} - x^2$

   [Option ID = 5887]
3. $\pm(\dot{x} - b)^{3/2} + x^2$

   [Option ID = 5888]
4. $\pm\frac{2}{3\sqrt{3a}}(\dot{x} - b)^{3/2} - x^2$

   [Option ID = 5889]

Correct Answer :-

- $\pm\frac{2}{3\sqrt{3a}}(\dot{x} - b)^{3/2} - x^2$

[Option ID = 5889]

49) Consider the transformation,

$q \rightarrow Q = \alpha_1 q + \beta_1 p$

$p \rightarrow P = \alpha_2 q + \beta_2 p$,

where, α_1 , α_2 , β_1 , and β_2 are real constants. This transformation is:

[Question ID = 1474]

1. Always canonical as it is a linear transformation.

   [Option ID = 5890]
2. Never a canonical transformation since it is linear.

   [Option ID = 5891]
3. A canonical transformation if $\beta_1 = 1$ and , $\alpha_2 = 1$ while $\alpha_1 = 0$ and $\beta_2 = 0$.

   [Option ID = 5892]
4. A canonical transformation if $\alpha_1\beta_2 - \beta_1\alpha_2 = 1$

   [Option ID = 5893]

Correct Answer :-

- A canonical transformation if $\alpha_1\beta_2 - \beta_1\alpha_2 = 1$

  [Option ID = 5893]

50) A free-particle moving in 1-dimension is described by the wavefunction,

$\psi(x,t)\left[Ae^{\frac{ipx}{\hbar}} + Be^{\frac{-ipx}{\hbar}}\right]e^{\frac{-ip^2t}{2m\hbar}}$,

which of the following options is correct?

[Question ID = 1475]

1. $\psi(x,t)$ is an eigenstate of the momentum operator

   [Option ID = 5894]
2. $\psi(x,t)$ is not a solution of the Schrodinger equation, but is an eigenstate of the Hamiltonian.

   [Option ID = 5895]
3. $\psi(x,t)$ is an eigenstate of the momentum operator as well as an eigenstate of the Hamiltonian.

   [Option ID = 5896]
4. $\psi(x,t)$ is a solution of the Schlrodinger equation and is an eigenstate of the Hamiltonian.

   [Option ID = 5897]

Correct Answer :-

- $\psi(x,t)$ is a solution of the Schlrodinger equation and is an eigenstate of the Hamiltonian.

  [Option ID = 5897]