PU Ph D Physics

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195 PU_2015_122
Consider the electrical conductivity of silver, copper, gold and aluminum. Then, arrange them in the decreasing order of decreasing conductivity.

- Ag > Cu >Al > Au
- Ag > Cu >Au > Al
- Cu > Ag > Al > Au
- Cu > Au > Ag > Al

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112 PU_2015_122

If we substitute $u=\sqrt{y}$ in the differential equation

$$\frac{dy}{dx}-2y=x\sqrt{y}$$

we get _____.

- $\frac{du}{dx}-u=\frac{x}{2}$.
- $\frac{du}{dx}-u=-\frac{x}{2}$.
- $\frac{du}{dx}=2u\frac{dy}{dx}$.
- $\frac{du}{dx}-y=\frac{x}{2}$.

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What is a red shift?

- The shifting of an absorption to shorter wavelength.
- The shifting of an absorption to higher energy.
- The shifting of an absorption to lower energy.
- The shifting of an absorption towards the blue end of the spectrum.

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133 PU_2015_122

SI unit of electric flux density $\vec{E}$ is :-

- C/m^2

- N / C
- Ampere/m^2
- Ampere/m

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Let $0 \le \phi \le 2\pi$. Determine the nature of the operator $\hat{Q}$ where

$$\hat{Q} = i\frac{d}{d\phi}$$

- Hermitian and real eigenvalues
- Hermitian and complex eigenvalues
- Non Hermitian and complex eigenvalues
- Non Hermitian

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The Hamiltonian for a collection of anharmonic oscillators of a solid is

$$H = \sum_{i=1}^{3N} \frac{p_i^2}{2m} + \frac{\lambda}{4} x_i^4 \ .$$

Molar specific heat of such a solid is

- $\frac{3}{4}R$
- $\frac{9}{4}R$
- $\frac{5}{2}R$
- $\frac{3}{2}R$

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181 PU_2015_122

The electric charge labels a representation of a local gauge symmetry group that is gauged to give QED. What is it?

- SU(2)

- U(1)
- SU(3)
- SU(1)

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105 PU_2015_122

Which quantum number describes the shape of the region of space occupied by the electron?

- Azimuthal quantum number, *l*
- Principal quantum number, *n*
- Magnetic quantum number, m_l
- All of the above

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125 PU_2015_122

The Lagrangian of a particle moving in a central potential $V(\vec{r})$ is given by

$$L = \frac{1}{2}m\left(\dot{r}^2 + r^2\dot{\theta}^2\right) - V(\vec{r}).$$

In addition to this potential, if a velocity dependent potential of the form $V(\vec{r}, \vec{v}) = \lambda r|\vec{v}|$ where λ is some constant, is introduced, then

- only the equation of motion in θ is changed.
- only the equation of motion in r is changed.
- both equations of motion are changed.
- equations of motion remain the same.

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The Rutherford scattering experiment is used to determine the atomic number Z_x of an unknown target nucleus. Cadmium with atomic number $Z_{Cd} = 48$ is taken as a reference nucleus. A beam of α particles of same energy is used as incident beam and the scattering cross sections for cadmium and the unknown element are respectively denoted by σ_{Cd} and σ_x. If σ_{Cd}/σ_x is equal to 9/4, then Z_x is equal to

- 30

- 26
- 32
- 72

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Which is the correct order that electrons will fill orbitals?

- 3*s* 3*p* 4*s* 4*d*
- 3*d* 4*p* 5*s* 4*d*
- 3*d* 3*p* 4*s* 4*d*
- 4*s* 4*p* 4*d* 5*s*

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The use of negative feedback in the op-amp is to:-

- A) Reduce the voltage gain of an op-amp
- B) Make linear operation possible
- C) Both (A) & (B)
- D) Make the op-amp oscillate

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How many normal modes of vibrational are possible for a benzene molecule?

- 31
- 30
- 12
- 6

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205 PU_2015_122

The magnetic vector potential $\bar{A}$ in some region of space is equal to $10\hat{a}_\phi$ where $\hat{a}_\phi$ is the unit vector in the ϕ-direction in cylindrical polar coordinate system (ρ, ϕ, z). Then, the magnetic field in that region is:-

- Inversely proportional to radial distance ρ
- Zero.
- Inversely proportional to the square radial distance, ρ^2
- Uniform or non-zero constant.

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174 PU_2015_122
Lasers rod have to have cut at _____angle to produce polarized light

- At an angle of 45° to that of the optic axis
- Perpendicular to the optic axis
- Brewster angle
- Critical angle

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193 PU_2015_122
Consider a process A + B → C + D. Assuming that C and D belong to isospin zero multiplets and further that, A and B each belong to an isospin 1/2 multiplet and if I_3 for A is +1/2, then:-

- can go only via electromagnetic interactions
- this reaction cannot go via strong interaction
- this reaction can go via strong interaction
- can go via strong and electromagnetic interactions

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180 PU_2015_122
The color group SU(3) corresponds to a local gauge symmetry. Its gauging gives rise to:-

- QED
- Electro weak
- QCD.
- GUT

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156 PU_2015_122
Which of the following type of bonds are directional?

- Van Der Waals.
- Covalent.
- Metallic.
- Ionic.

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144 PU_2015_122

An n-channel FET having a pinch-off voltage V_p = -5V shows a trans-conductance g_m of 1mA/V, when the applied gate to source voltage V_{GS} = -3V. Its maximum trans-conductance (in mA/V) will be:-

- 2.0

- 2.5
- 1.5
- 3.0

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100 PU_2015_122

A solution of 0.001 mol dm^{-3} $NiSo_4$ is placed in an optical cell of path length 1 cm, and the absorption spectrum is recorded. The absorptions have characteristic λmax and ϵmax values. What is the correct unit of ϵmax?

- cm mol dm^{-3}
- cm dm^3 mol^{-1}
- mol dm^{-3} cm^{-1}
- dm^3 mol^{-1} cm^{-1}

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If light (electromagnetic wave) falls on a perfect conductor, then:-

- Any magnetic field, if present, on the surface of the perfect conductor should be normal to its surface.
- The tangential component of magnetic field $\vec{H}$ on the surface of the perfect conductor is zero.
- The tangential component of electric field $\vec{E}$ on the surface of the perfect conductor is zero.
- Electric field, if present, on the surface of the perfect conductor should be normal to its surface.

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The depletion region in diode is created by:-

- Ionization
- Recombination
- Diffusion
- All of these

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200 PU_2015_122

Differentiate with respect to x the function $y(x)$ where

$$y(x) = 3^{\log(x)}$$

- $\frac{3^{\log x}}{x} \log 3$

- $(\log x)3^{\log x-1}$
- $\log\frac{3}{x}$
- $3^{\log x}/x$

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118 PU_2015_122

Let $f(t)$ be defined and integrable over intervals within $0 \le t \le \infty$ and let δ represent delta function. Then, the value of $\int_0^\infty f(t)\,\delta(t-a)dt$ is equal to

- a
- 1
- $f(a)$
- 0

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207 PU_2015_122
When compared to experimental values of heat capacity of solids, the Einstein's theory gives lower values at:-

- Absolute zero of temperature.
- All temperatures
- Low temperatures
- High temperatures

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204 PU_2015_122

Consider an unpolarized solid dielectric sphere of radius a and permittivity ϵ which is uniformely charged with a volume charge density ρ_0. Then, the electric displacement vector $\vec{D}$ on the surface of the sphere is-

- A constant and proportional to the radius of the sphere.
- A constant independent of permittivity of the sphere.
- Directly proportional to dielectric constant and radius of the sphere.
- Inversely proportional to square of the radius of the sphere.

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117 PU_2015_122

Let $L[f(t)] = F(s)$ represent the Laplace transform. If $k > 0$ then:-

- $L[f(kt)] = \frac{1}{k} F\left(\frac{k}{s}\right)$
- $L[f(kt)] = \frac{1}{s} F\left(\frac{s}{k}\right)$
- $L[f(kt)] = \frac{1}{k} F\left(\frac{s}{k}\right)$
- $L[f(kt)] = \frac{1}{s} F\left(\frac{k}{s}\right)$

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At absolute zero of temperature, all the allowed states of energy up to Fermi level will be:-

- Partially filled.
- Half filled.
- Empty.
- Occupied.

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An anisotropic dielectric material is characterized by the electric permittivity tensor

$$[\epsilon] = \epsilon_0 \begin{pmatrix} 7 & 2 & 0 \\ 2 & 4 & 0 \\ 0 & 0 & 3 \end{pmatrix}$$

If we apply an electric field $\vec{E} = E_0 \hat{a}_z$ to this material, then the electric displacement vector $\vec{D}$ will be

- Parallel to $\left(\hat{a}_x + \hat{a}_y\right)$ vector.
- Equal to $\epsilon_0 \vec{E}\, \hat{a}_y$.
- Paralled to $\vec{E}$.
- Parallel to $\left(7\hat{a}_x + 4\hat{a}_y + 3\hat{a}_z\right)$ vector.

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126 PU_2015_122

A rod moves at a relativistic speed. The direction of its velocity makes an angle of 45° with its length in its rest frame. If l_0 is the proper length of the rod and l is its contracted length, then the condition that maximum speed cannot exceed c corresponds to:-

- l cannot be less than $\sqrt{2}\,l_0$.
- l cannot be less than $l_o/\sqrt{2}$
- l cannot be greater than $l_o/\sqrt{2}$
- l cannot be less than l_0.

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218 PU_2015_122

Two operators $\hat{O}_1$ and $\hat{O}_2$ are found to be commuting. The eigenstates of operator $\hat{O}_1$ are non-degenerate. Then what can you say about the eigenstates/eigenvalues of operator $\hat{O}_2$?

- Eigenstates of $\hat{O}_2$ are not orthogonal to each other.
- Eigenvalues of $\hat{O}_2$ are necessarily the same as that of $\hat{O}_1$
- Eigenstates of $\hat{O}_2$ are not the same as the eigenstates of $\hat{O}_1$.
- Every eigenstate of $\hat{O}_1$ is also an eigenstate of $\hat{O}_2$.

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145 PU_2015_122

If A and B are two numbers, then, in C or C++ language, A^B can be programmed as:-

- $A**B$
- $\mathrm{pwr}(A, B)$
- $A\hat{}B$
- $\mathrm{pow}(A, B)$

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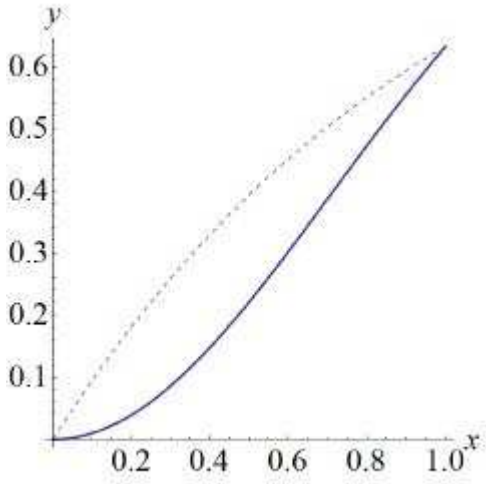
215 PU_2015_122

Two functions f(x) = 1 - e-x^2 and g(x) = 1 -e^{-x} are plotted in the graph shown. Identify the curves in the plot.



- The dotted curve is g(x) while that below dotted curve is f(x)
- The dotted curve is f(x) while that below dotted curve is g(x)
- The smooth curve is f(x) and the dotted curve is not g(x)
- The plots should be shown for larger values of x in order to identify them.

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155 PU_2015_122

In a certain crystal, the volume of primitive cell is V. Then, the volume of the first Brillouin zone is:-

- $8\pi^3/V$
- $2\pi^3/V$
- $1/V$
- $2\pi^3 V$

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166 PU_2015_122

For a free particle, its classical and quantum speeds are related by:-

- $v_{classical} = v_{quantum}$
- $v_{classical} = 2v_{quantum}$
- $v_{classical} << v_{quantum}$
- $v_{classical} >> v_{quantum}$

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203 PU_2015_122

The circle of convergence of the power series

$$S=\sum_{n=1}^{\infty}\frac{(z-i)^n}{n}$$

is given by

- $|z-i|^n<1$
- $\frac{|z-1|^n}{n}<1$
- $|z|<1$
- $|z-i|<1$

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198 PU_2015_122

The problem of determining a polynomial of degree *n* - 1 that will pass through *n* number of data points (x_i, y_i) is known as:-

- Method of divided differences.
- Interpolation.
- Polynomial curve fitting.
- Lagrange polynomial.

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143 PU_2015_122

An ideal gas of particle density n approaches equilibrium because of collisions. Consider each particle to be a hard sphere of radius r. If the mean free path (distance travelled between two successive collisions) is what is the mean free path if the radius is λ reduced to r/2?

- λ/4
- λ/2
- 4λ
- 2λ

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116 PU_2015_122

The eigenvector $\mathbf{x}$ corresponding to eigenvalue $\lambda=-i$ of A is ___ where

$$A=\begin{pmatrix}1 & 2 & 1\\ 0 & 1 & 1\\ 2 & 0 & 1\end{pmatrix}.$$

- $[i \quad 1 \quad (1+i)]^T$
- $[i \quad 1 \quad -(1+i)]^T$
- $[2 \quad 1 \quad 2]^T$
- $[-i \quad 1 \quad -1+i]^T$

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197 PU_2015_122

Consider the evaluation of roots of a nonlinear algebraic equation f(x) = 0 in the region a ≤ x ≤ b, by bisection method.

- This method requires the condition f(a) . f(b) > 0
- This method requires the condition f(a) . f(b) < 0
- This method requires the condition f(a) . f(b) ≈ 0
- No such condition is required.

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185 PU_2015_122
Because of their charge and large mass, alpha particles are easily:-

- Travel only a few cm in air.
- Absorbed by materials, and they can travel only a few cm in air.
- Absorbed by materials, and they cannot travel only a few cm in air.
- Not absorbed by materials, and they can travel only a few cm in air.

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176 PU_2015_122
Polarization of light proves the:-

- Quantum nature of light
- Corpuscular nature of light
- Longitudinal nature of light
- Transverse nature of light

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102 PU_2015_122
What is a chromophore?

- A coloured compound.
- A group of atoms in a coloured compound.

- A group of atoms in a compound responsible for the absorption of electromagnetic radiation.
- A group of atoms in a compound responsible for smell.

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158 PU_2015_122

In the absence of Umklapp process, the thermal conductivity of an insulating crystal is:-

- Infinite.
- Zero.
- Equal to thermal conductivity of a conducting crystal.
- Non-zero, but finite.

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165 PU_2015_122

Let $\psi_n(x)$ be the eigenfunction of the Hamiltonian $\hat{H}$. Then, the expected value $\langle \hat{H} \rangle$ in the state $\sum_{n=1}^{\infty} c_n \psi_n(x)$ is equal to

- $\sum_n E_n^{\,2}$
- $\sum_n |c_n|^2$
- $E_n \psi_n$
- $\sum_n |c_n|^2 E_n$

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113 PU_2015_122

Simplify the determinant.

$$\begin{vmatrix} \cosh x & \sinh x & 1 \\ \sinh x & \cosh x & 0 \\ \cosh x & \sinh x & 0 \end{vmatrix}$$

- -1
- 1
- $\sinh^2 x + \cosh^2 x$
- 0

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164 PU_2015_122

If three angular momenta are given by $j_1 = j_2 = j_3 = 1/2$, what are the allowed values of total angular momentum **J**?

- 0, 1
- 1/2, 3/2
- 0, 1, 2
- 1/2, 3/2, 5/2

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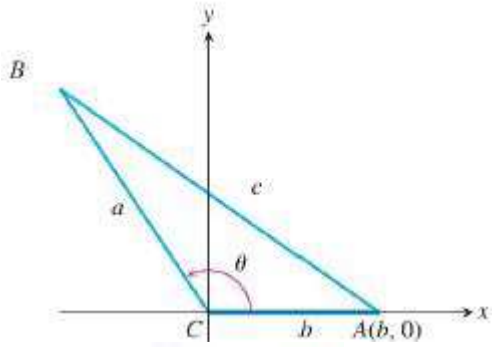
169 PU_2015_122

In the figure shown here, consider C as the origin. Then, the coordinates of the point B(*x*,*y*) is found to be _____.



- $(a\cos\theta + b,\ a\sin\theta)$
- $(a\cos\theta,\ a\sin\theta)$
- $(c\cos\theta - b,\ a\sin\theta)$
- $(a\sin\theta,\ a\cos\theta)$

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In a finite square-well potential V_0 the number of bound states is:-

- 1
- Finite
- Infinite
- Zero

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114 PU_2015_122

If a and b are constants, the differential equation $x^2\frac{d^2y}{dx^2}+ax\frac{dy}{dx}+by=0$ will be classified as:-

- Linear second order variable coefficient homogeneous differential equation.
- Linear second order variable coefficient inhomogeneous differential equation.
- Nonlinear homogeneous differential equation with variable coefficients.
- Nonlinear homogeneous differential equation with constant coefficients.

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208 PU_2015_122

At T = 0 K, silicon act as a:-

- Insulator
- Semi-conductor
- Metal
- Superconductor

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182 PU_2015_122

The octet of light spin-1/2 baryons described in SU(3) are n = neutron, p = proton, Ξ = Xi baryon and other particles such as

- Quarks and colors.
- Tau and theta particles
- pi = pi meson and omega hadron
- Λ = Lambda baryon and ∑ = Sigma baryon,

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191 PU_2015_122

A quantum particle undergoes small oscillations about its mean position and the force acting on is given by Hooke's law. What can you say about the degeneracy of the energy eigenstate corresponding to nth excited state?

- Degeneracy is equal to *n*
- Non-degenerate
- Degeneracy is equal to *n* + 1
- Infinitely degenerate.

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157 PU_2015_122

Phonon is a quantum of:-

- Electromagnetic wave.
- Micro wave.
- Elastic wave.
- Magnetization wave.

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209 PU_2015_122

How must the two junctions of transistor be biased to be operated in cut-off region?

- V_{BE} forward-biased & V_{CB} forward-biased
- V_{BE} reverse-biased & V_{CB} forward-biased
- V_{BE} forward-biased & V_{CB} reverse-biased
- V_{BE} reverse-biased & V_{CB} reverse-biased

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132 PU_2015_122

Ohm's law gives the relation between current density J, electrical conductivity σ and electric field $\vec{E}$

- $\vec{E} = \vec{J}/\sigma$
- $\vec{E} = \sigma\vec{J}$
- $\vec{E} = \sigma/\vec{J}$
- $\vec{E} = \vec{J}/\sigma^2$

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The SI units for Stefan-Boltzmann constant is:-

- $J \cdot S \cdot m^{-2} \cdot K^{-4}$
- $Wm^{-2}K^4$
- Wm^2K^{-4}
- $Wm^{-2}K^{-4}$

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Given that $y_1(x) = x^2$ is one solution of $x^2y'' - 3xy' + 4y = 0,\ x > 0$, then, the second linearly independent solution is :-

- $y_2(x) = x^2(A + Bx)$
- $y_2(x) = x^2(A + B\log x)$
- $y_2(x) = \log x$
- $y_2(x) = x^2 \log x$

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103 PU_2015_122

The Lyman series of lines in the emission spectrum of hydrogen correspond to transitions from various excited states to the *n* =1 orbit. Calculate the wavelength, in nm, of the transition from the *n* = 3 to the *n* = 1 energy level.

- 102.6 nm
- 975.1 nm
- 452.7 nm
- 678.8 nm

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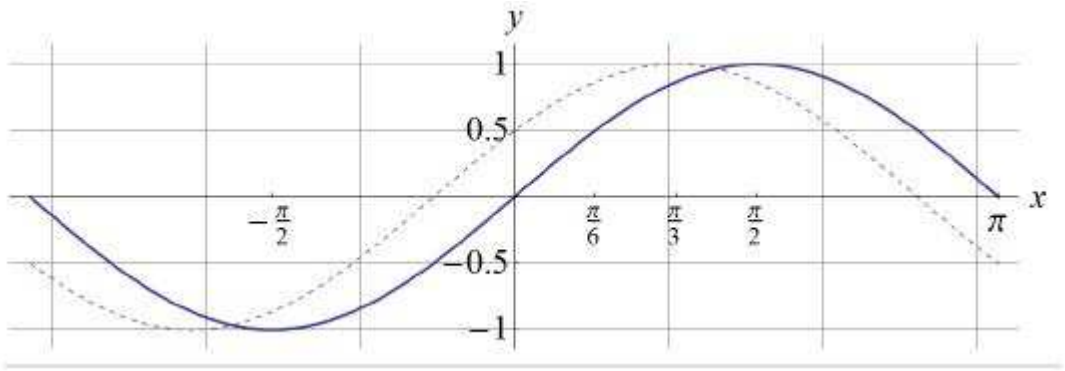
216 PU_2015_122

Find the phase difference between two waveforms shown in the figure.



- π/9
- π/12
- π/3
- π/6

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245 PU_2015_122

The calcite crystal is placed over a dot on a piece of paper and then rotated. On viewing through calcite, we observe:-

- A single dot
- Two rotating dots
- Two stationary dots

- One dot rotating about the other

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259 PU_2015_122

A multiplet of particles consists of two baryons with strangeness S=0 The charge of each member of this multiplet is:-

- 1/2 and 0
- 1 and -1
- 1/2 and-1/2
- 1 and 0

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222 PU_2015_122

In the case of harmonic oscillator, the normalized ground state wave function $\psi(x)$ is equal to

- $\left(\frac{m\hbar}{\pi\omega}\right)^{1/4} e^{-\frac{m\omega}{2\hbar}x^2}$
- $\left(\frac{\pi\hbar}{m\omega}\right)^{1/4} e^{-\frac{m\omega}{2\hbar}x^2}$
- $\left(\frac{m\omega}{\pi\hbar}\right)^{1/4} e^{-\frac{m\omega}{2\hbar}x^2}$
- $\left(\frac{m\pi}{\hbar\omega}\right)^{1/4} e^{-\frac{m\omega}{2\hbar}x^2}$

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The strongest bond is:-

- Covalent
- Metallic
- Ionic
- Van der Waals

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227 PU_2015_122

The Rank of the matrix

$$\begin{pmatrix} 1 & 2 & 3 \\ 2 & 4 & 6 \\ 3 & 6 & 9 \end{pmatrix}$$ is:-

- 2
- 1
- 3
- 0

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225 PU_2015_122

The dielectric constant of a linear, homogeneous and isotropic medium is 10, while its relative permeability is 0.7. Then, the refractive index of the material is:-

- 3.78
- 3.16
- 2.65
- 1.325

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256 PU_2015_122

Under parity or space inversion transformation, the spherical harmonics $Y_l^m(\theta,\phi)$ becomes

- $-Y_l^m(\theta,\phi)$
- $(-1)^{l+|m|}Y_l^m(\theta,\phi)$
- $Y_l^m(\theta,\phi)$
- $(-1)^l Y_l^m(\theta,\phi)$

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In the rest frame of the positronium atom, after annihilation of the e^- and e^+ which of the following statements is correct?

- two photons are emitted and their wavelength is $h/(2m_ec)$
- only one photon is emitted with wavelength $h/(m_ec)$

- two photons are emitted and their wavelength is $h/(m_e c)$
- only one photon is emitted with wavelength $h/(2m_e c)$

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232 PU_2015_122

If $f(t) = t^{-1/2}$ then its Laplace transform is:-

- $\sqrt{\frac{s}{\pi}}$
- $\sqrt{\frac{\pi}{s}}$
- $\frac{\pi}{s^{3/2}}$
- $-\sqrt{\frac{s}{\pi}}$

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235 PU_2015_122
The Legendre polynomial $P_n(x)$ for n =1 is equal to:-

- $1 - x$
- x
- 1
- $1 - x^2$

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220 PU_2015_122

If α is fine structure constant and m the mass of electron and c the speed of light, then the Bohr radius a can be written as

- $\frac{\alpha\hbar^2}{mc^2}$
- $\frac{\hbar c}{m\alpha}$
- $\frac{\hbar}{mc\alpha}$

- $\frac{\alpha^2\hbar^2}{mc^2}$

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The independent solutions of the equation $y'' - 7y' + 12y = 0$ are:-

- e^{3x} and e^{-3x}
- e^{-x} and e^{-3x}
- $\frac{1}{x}$ and x^3
- $sin(3x)$ and $cos(4x)$

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238 PU_2015_122

Working in the cylindrical coordinates (r, θ ,z) a particle is found to be moving in a potential of the form $V = ar^2$ where is a constant. Which of the following quantities are conserved?

- p_θ and p_z
- p_r and p_θ
- p_r and rp_θ
- p_r and p_z

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253 PU_2015_122

The Hilbert space corresponding to a wave function $\psi(x)$ is

- A three dimensional Euclidean space.
- An infinite dimensional linear vector space.
- A two dimensional phase-space with coordinates x and p
- A finite dimensional liner vector space.

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258 PU_2015_122

If $\pi^0 \to \gamma + \gamma$ and $\pi^+ \to \mu^+ + \nu_\mu$ their lifetimes would be :-

- $\approx 10^{-16}$ sec and $\approx 10^{-23}$ sec respectively
- $\approx 10^{-8}$ sec and $\approx 10^{-23}$ sec respectively
- $\approx 10^{-16}$ sec and $\approx 10^{-8}$ sec respectively
- Almost equal.

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255 PU_2015_122

In quantum mechanics, the total probability of finding a particle in the possible region of space is obviously given by the normalization condition. What is the physical dimension of the wave function of a particle moving in two dimensional space?

- Mass x length x $(\text{Time})^{-1}$
- $(\text{Length})^{-1}$
- $(\text{Length})^{2}$
- It is dimensionless.

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251 PU_2015_122

Let the complex number be $i = \sqrt{-1}$. Then, simplify the expression

$$\left(\sqrt{3}+i\right)^{14}+\left(\sqrt{3}-i\right)^{14}$$

- 2^{14}
- -2^{14}
- 1
- -2^{12}

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257 PU_2015_122

Which of the following statements is incorrect?

- **No eigenstate can be constructed in such a way that it is an eigenstate for both the position and momentum operators.**
- A non-trivial eigenstate cannot be constructed in such a way that it gives non-zero eigenvalue for the x-component of spin angular momentum operator $\hat{S}_x$, and zero eigenvalue for other two components $\hat{S}_y$ and $\hat{S}_z$
- An non-trivial eigenstate can be constructed in such a way that it gives non-zero eigenvalue for the x-component of angular momentum operator $\hat{L}_x$, and zero eigenvalue for other two components $\hat{L}_y$ and $\hat{L}_z$

- **A nontrivial eigenstate can be constructed in such a way that the eigenvalues of all the three components of angular momentum operator are zero.**

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236 PU_2015_122

Consider the Levi-Civita tensor $\epsilon_{\mu\nu\lambda}$. If μ, ν, λ are even-permuting, then the value of the tensor $\epsilon_{\mu\nu\lambda}$ is equal to

- 2
- 0
- -1
- 1

80 of 100
244 PU_2015_122
Polarization cannot occur in:-

- Sound waves
- Light waves
- X-Ray
- Radio waves

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282 PU_2015_122
Since the nuclei have a definite parity, ignoring the weak interactions:-

- only the nuclear electric quadrupole moment vanishes
- both the nuclear electric quadrupole and magnetic moments vanish
- only the nuclear magnetic moment vanishes
- nuclear electric dipole moment vanishes

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Consider a spherical capacitor whose inner conducting surface has a radius of 1 cm while the outer surface has a radius of 2 cm Also, consider a cylindrical capacitor of length *L* whose inner and outer conducting cylinders have 1 cm and 2 cm radii respectively. If the capacitance of these two capacitors should be equal, what should the length of the cylindrical capacitor (in cm)?

- $2 \log_e 2$
- $4 \log_{10} 2$
- $4 \log_e 2$
- 2 cm

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A rigid cubical block rotates in such a way that one corner of the cube is always in contact with the surface on which it rotates. If that point of contact does not move, then how many generalized coordinates do we need to describe its motion?

- 1
- 4
- 2
- 3

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Let Q be an orthogonal matrix. Then:-

- $QQ^T = Q^TQ = I$
- $Q^T = -Q$
- $Q = Q^T$
- $QQ^{-1} = Q^TQ$

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Let $\mathbf{x}$ be a coordinate system and $\mathbf{x}'$ be rotated coordinate system through an angle θ such that $\mathbf{x} = \mathbf{R}\mathbf{x}'$. Then, the corresponding rotation matrix $\mathbf{R}$ is given by

- $\begin{pmatrix} -\cos\theta & \sin\theta \\ \sin\theta & \cos\theta \end{pmatrix}$
- $\begin{pmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{pmatrix}$
- $\begin{pmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{pmatrix}$
- $\begin{pmatrix} \cos\theta & -\sin\theta \\ -\sin\theta & \cos\theta \end{pmatrix}$

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Let S be a oriented piecewise smooth surface and C be a simple, closed, piecewise smooth curve that bounds the surface S. If $\vec{A}$ is a vector function whose components have continuous derivatives, then, the Stokes theorem states that

- $\iint_S \vec{A}\cdot\overrightarrow{ds} = \iiint_V \operatorname{curl}\vec{A}\,dV$
- $\int_C \vec{A}\cdot\overrightarrow{dr} = \iint_S \left(\operatorname{curl}\vec{A}\right)\cdot\overrightarrow{ds}$
- $\int_C \vec{A}\cdot\overrightarrow{dr} = \iiint_V \left(\operatorname{curl}\vec{A}\right)dV$
- $\iint_S \vec{A}\cdot\overrightarrow{ds} = -\oint \operatorname{div}\vec{A}\,dr$

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Let four different vectors in a certain vector space be given by

$\mathbf{x}_1 = (4,\ 0,\ 2),\ \mathbf{x}_2 = (2,\ 2,\ 0),$

$\mathbf{x}_3 = (1,\ 1,\ 0),\ \mathbf{x}_4 = (5,\ 1,\ 2).$

Then, choose the correct option.

- The set of vectors form a basis for the 4-dimensional vector space.
- The information is insufficient to evaluate.
- The set of vectors are linearly independent.
- The set of vectors are linearly dependent.

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The four types of Bravais lattices viz., primitive, body centered, base centered and face centered exists in only one crystal system. Identify the crystal system.

- Cubic
- Trigonal
- Orthorhombic
- Tetragonal

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A scalar is a tensor of rank:-

- One
- Zero
- Three
- Two

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The value of integral $\int_0^{2\pi} \frac{d\theta}{2+\cos\theta}$ is

- $\frac{2\pi}{\sqrt{3}}$
- $\frac{4\pi}{\sqrt{3}}$
- $\frac{\pi}{\sqrt{2}}$
- π

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Given, one ^{235}U nucleus yields an energy of ≈ 200 MeV the complete fission of one gram of ^{235}U nucleus can yield a total energy of:-

- $10^{11}J$
- $10^{11}eV$
- $10^{5}eV$
- $10^{5}J$

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The units of dielectric constant is:-

- FC^{-1}
- Fm^{-1}

- Dimensionless
- CV^{-1}

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Two particles are constrained to move on the surface of a sphere of constant radius. The number of degrees of freedom to describe their motion is equal to:-

- 2
- 3
- 6
- 4

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What is the degeneracy of the energy level with n = 6 in a hydrogenic atom or ion?

- 16
- 25
- 36
- 9

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A particle undergoes simple harmonic oscillation and its motion is described by the equation $\frac{d^2x}{dt^2} + \omega^2 x = 0$. If A and B are two real numbers, then the general trajectory of the particle as a function of time may be written as

- $x(t) = Ae^{i\omega t} + Be^{-i\omega t}$
- $x(t) = Ae^{i\omega t}$
- $x(t) = A\sin(\omega t) + B\cos(\omega t)$
- $x(t) = Be^{-i\omega t}$

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What is the value of Lande g - factor for the state with L=1 and J = 3/2?

- 4/3
- 2/3
- 2
- 1

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A real matrix is unitary if and only if it is:-

- Unitary
- Diagonal
- Orthogonal
- Skew Hermitian

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If f(x) is continuous and even-periodic, then, the trigonometric Fourier series of the function will be:-

- A pure sine series.
- Non-converging series.
- A pure cosine series.
- A series containing both sine and cosine terms.

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Choose the correct statement.

- A matrix A is said to be in echelon form if the nonzero elements in each row is one.
- The determinant of a square matrix of size $n \times n$ has n cofactors.
- If A is a non-singular matrix, then $\left(A^{-1}\right)^m = \left(A^m\right)^{-1}$ for $m = 1, 2, \ldots$
- Let A be any matrix. Then, $\text{rank}(A) \neq \text{rank}\left(A^T\right)$.

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For a rigid body, the sum of the diagonal elements of moment of inertia tensor is found to be equal to 8. After the principal axis transformation, two of the principal moments of inertia are found to be 3 and 1. The third principal moment of inertia is equal to:-

- 1
- 8
- 4
- 2