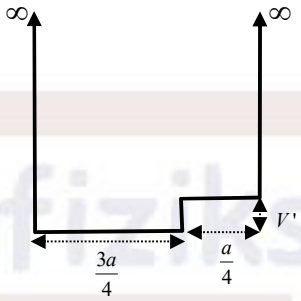
Test Your fiziks concepts!

Topic: Quantum Mechanics

(For CSIR NET-JRF, GATE, JEST and TIFR Aspirants)

Q. A particle of mass m in an infinite potential well of width a is subjected to a perturbation, $V' = \frac{h^2}{40ma^2}$ as shown in figure, where h is Planck's constant.



The first order energy shift of the fourth energy eigenstate due to this perturbation is

(a) $\frac{h^2}{40ma^2}$ (b) $\frac{h^2}{80ma^2}$ (c) $\frac{h^2}{120ma^2}$ (d) $\frac{h^2}{160ma^2}$

Ans.: (d)

Solution.:

$$E_n^{(1)} = \frac{\text{Strength of perturbation} \times \text{length of the perturbation}}{\text{length of the well}} = \frac{\frac{h^2}{40ma^2} \times \frac{a}{4}}{a} = \frac{h^2}{160ma^2}$$

Note:

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Test Your fiziks concepts!

Topic: Electronics

(For IIT-JAM, JEST, TIFR and CUET Aspirants)

Q. What is the 2′s complement representation of 11010110?

(a) 11010101 (b) 00101001

(c) 00101010 (d) 01101011

Ans.: (c)

Solution.: 1′s complement representation of 00101001

2′s complement representation of 00101001+1=00101010

Note:

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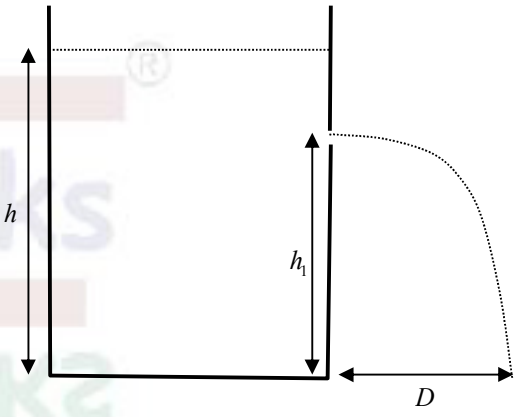
Test Your fiziks concepts!

Topic: Modern Physics

(For PGT: KVS, NVS, DSSSB, State Education Boards, etc.)

Q. A tank, placed on the ground, is filled with water up to a height h. A small hole is made at a height h_1 such that $h_1 < h$. The water jet emerging from the hole strikes the ground at a horizontal distance D, as shown schematically in the figure. Which of the following statements is correct? (g is the acceleration due to gravity)



(a) Velocity at h_1 is $\sqrt{2gh_1}$

(b) $D = 2(h - h_1)$

(c) D will be maximum when $h_1 = \frac{2}{3}h$

(d) The maximum value of D is h

Ans: (d)

Solution:

(a) The velocity of water exiting the hole is: $v = \sqrt{2g(h-h_1)}$.

Thus option (a) is incorrect

(b) The time taken for the water to reach the ground is determined by the vertical motion:

$$t = \sqrt{\frac{2h_1}{g}}$$

The horizontal distance traveled by the water is: $D = v.t = \sqrt{2g(h-h_1)}.\sqrt{\frac{2h_1}{g}} = 2\sqrt{h_1(h-h_1)}$

Thus, the option (b) is incorrect.

(c) To maximize D, take the derivative of D and set it equal to zero

$\frac{dD}{dh_1} = \frac{2}{2\sqrt{h_1(h-h_1)}}[(h-h_1)-h_1] = 0 \Rightarrow h - 2h_1 = 0 \Rightarrow \quad h_1 = \frac{h}{2}$. Thus option (c) incorrect.

(d) Maximum Value of D: At $h_1 = \frac{h}{2}$, substitute into $D = 2\sqrt{h_1(h-h_1)} = 2\sqrt{\frac{h}{2}(h-\frac{h}{2})} = h$

Thus, the option (d) is correct.

Note:

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Test Your fiziks concepts!

Topic: Quantum Mechanics

(For CSIR NET-JRF, GATE, JEST and TIFR Aspirants)

Q. A particle has wavefunction $\psi(x,y,z) = Nze^{-\alpha\left(x^2+y^2+z^2\right)}$ where N is a normalization constant and α is a positive constant. In this state, which one of the following options represents the eigenvalues of L^2 and L_z respectively?

Some values of Y_ℓ^m are: $Y_0^0 = \sqrt{\frac{1}{4\pi}}$, $Y_1^0 = \sqrt{\frac{3}{4\pi}}\cos\theta$, $Y_1^{\pm1} = \mp\sqrt{\frac{3}{8\pi}}\sin\theta e^{\pm i\phi}$

(a) 0 and 0 (b) $\hbar^2$ and $-\hbar$

(c) $2\hbar^2$ and 0 (d) $\hbar^2$ and $\hbar$

Ans.: (c)

Solution.: In spherical polar coordinate, $z = r\cos\theta$ and $r^2 = x^2+y^2+z^2$

$\because \psi(x,y,z) = Nze^{-\alpha\left(x^2+y^2+z^2\right)} \;\therefore\; \psi(r,\theta,\phi) = Nr\cos\theta\, e^{-\alpha r^2}$

Thus $\ell = 1$ and $m_\ell = 0$

The eigenvalue of $L^2 = \ell(\ell+1)\hbar^2 = 2\hbar^2$

The eigenvlaue of $L_z = m_l\hbar = 0$

Note:

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Test Your fiziks concepts!

Topic: Electronics

(For IIT-JAM, JEST, TIFR and CUET Aspirants)

Q. The sum of three binary numbers, 10110.10, 11010.01, and 10101.11, in decimal system is:

(a) 70.75 (b) 70.25 (c) 70.50 (d) 69.50

Ans.: (c)

Solution.: $(10110.10)_2 = 1\times 2^4 + 0\times 2^3 + 1\times 2^2 + 1\times 2^1 + 0\times 2^0 \cdot \left(1\times 2^{-2} + 0\times 2^{-2}\right)$

$$= (16+0+4+2+0)\cdot\left(\frac{1}{2}+0\right) = 22.5$$

$$(11010.01)_2 = \left(1\times 2^4 + 1\times 2^3 + 0\times 2^2 + 1\times 2^1 + 0\times 2^0\right)\cdot\left(0\times 2^{-1} + 1\times 2^{-2}\right)$$

$$= (16+8+0+2+0)\cdot\left(0+\frac{1}{4}\right) = 26.25$$

$$(10101.11)_2 = 1\times 2^4 + 0\times 2^3 + 1\times 2^2 + 0\times 2^1 + 1\times 2^0 \cdot \left(1\times 2^{-1} + 1\times 2^{-2}\right)$$

$$= (16+0+4+0+1)\cdot\left(\frac{1}{2}+\frac{1}{4}\right) = 21.75$$

Thus $22.5 + 26.25 + 21.75 = 70.50$

Note:

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Test Your fiziks concepts!

Topic: Modern Physics

(For PGT: KVS, NVS, DSSSB, State Education Boards, etc.)

Q. A fission device explodes into two pieces of rest masses m and $0.5m$ with no loss of energy into any other form. These masses move apart respectively with speeds $\frac{c}{\sqrt{13}}$ and $\frac{c}{2}$, with respect to the stationary frame. If the rest mass of the device is

(a) $1.2m$ (b) $1.3m$ (c) $1.4m$ (d) $1.6m$

Ans.: (d)

Solution.:

$$MC^2 = \frac{mc^2}{\sqrt{1-\frac{1}{13}}} + \frac{(0.5m)c^2}{\sqrt{1-\frac{1}{4}}} \Rightarrow M = 1.04m + 0.57m \Rightarrow M = 1.61m \Rightarrow f = 1.61$$

Note:

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