



## Heisenberg's Uncertainty Principle

Failing doesn't give you a reason to give up, as long as you believe." — Naruto Uzumaki

---

Even if you fail an exam or struggle, it doesn't mean you should stop trying.

---

**Useful constants :**  $h = 6.626 \times 10^{-34} \text{ J s}$ ,  $c = 3.00 \times 10^8 \text{ m s}^{-1}$ ,  $N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$ ,  $1 \text{ eV} = 1.602 \times 10^{-19} \text{ J}$

### MCQs (All Levels)

|

**The uncertainty in position of an electron and a helium atom are the same. If the uncertainty in momentum for the electron is  $32 \times 10^{-5}$  (same units for both), then the uncertainty in momentum of the helium atom will be**

- (A)  $32 \times 10^5$
- (B)  $16 \times 10^5$
- (C)  $8 \times 10^5$
- (D) None of these

**\* Calculate the uncertainty in position of an electron ( $m = 9.1 \times 10^{-28} \text{ g}$ ) moving with velocity  $3 \times 10^4 \text{ cm s}^{-1}$ , if the uncertainty in velocity is 0.011%.**

- (A) 1.92 cm
- (B) 7.68 cm
- (C) 0.175 cm
- (D) 3.84 cm

**Heisenberg uncertainty principle is *not* valid for**

- (A) Moving electron
- (B) Motor car
- (C) Stationary particles
- (D) Both (B) and (C)

**What should be the momentum (in  $\text{g cm s}^{-1}$ ) of a particle if its de Broglie wavelength is  $1 \text{ \AA}$  and  $h = 6.6252 \times 10^{-27} \text{ erg s}$ ?**

- (A)  $6.6252 \times 10^{-19}$
- (B)  $6.6252 \times 10^{-21}$
- (C)  $6.6252 \times 10^{-23}$
- (D)  $6.6252 \times 10^{-27}$

**What should be the mass of a sodium photon of wavelength  $5894 \text{ \AA}$ ? ( $c = 3 \times 10^8 \text{ m s}^{-1}$ ,  $h = 6.6252 \times 10^{-34} \text{ kg m}^2 \text{ s}^{-1}$ )**

- (A)  $3.746 \times 10^{-26} \text{ kg}$
- (B)  $3.746 \times 10^{-30} \text{ kg}$
- (C)  $3.746 \times 10^{-35} \text{ kg}$
- (D)  $3.746 \times 10^{-36} \text{ kg}$

**Uncertainty in position of a  $0.25 \text{ g}$  particle is  $10^{-5} \text{ m}$ . Then the uncertainty in its velocity is ( $h = 6.6 \times 10^{-34} \text{ J s}$ )**

- (A)  $1.2 \times 10^{-33} \text{ m s}^{-1}$
- (B)  $2.1 \times 10^{-28} \text{ m s}^{-1}$
- (C)  $1.6 \times 10^{-20} \text{ m s}^{-1}$
- (D)  $4.7 \times 10^{-9} \text{ m s}^{-1}$

The positions of an electron and a helium atom are each known within 1.0 nm. If the electron's momentum is known within  $5.0 \times 10^{-28} \text{ kg m s}^{-1}$ , the minimum uncertainty in the momentum of the helium atom is

- (A)  $80 \times 10^{-28} \text{ kg m s}^{-1}$
- (B)  $80 \text{ kg m s}^{-1}$
- (C)  $50 \text{ kg m s}^{-1}$
- (D)  $5.0 \times 10^{-28} \text{ kg m s}^{-1}$

If the uncertainties in position and momentum are equal in magnitude, then the uncertainty in velocity is

- (A)  $\sqrt{\frac{h}{m\pi}}$
- (B)  $\frac{1}{2m} \sqrt{\frac{h}{\pi}}$
- (C)  $\sqrt{\frac{h}{2\pi}}$
- (D)  $\frac{1}{m} \sqrt{\frac{h}{\pi m}}$

Measurement of an electron's position is associated with an uncertainty in momentum of  $1 \times 10^{-18} \text{ g cm s}^{-1}$ . The corresponding uncertainty in electron velocity is ( $m_e = 9 \times 10^{-28} \text{ g}$ )

- (A)  $1 \times 10^{11} \text{ cm s}^{-1}$
- (B)  $1 \times 10^9 \text{ cm s}^{-1}$
- (C)  $1 \times 10^6 \text{ cm s}^{-1}$
- (D)  $1 \times 10^5 \text{ cm s}^{-1}$

Heisenberg uncertainty principle will be valid for

- (A)  $\Delta v$  and  $\Delta x$  on the same axis
- (B)  $\Delta v$  and  $\Delta x$  on different axes
- (C) Macroscopic particle
- (D) Both (A) and (C)

The uncertainty in momentum of an electron is  $1 \times 10^{-5} \text{ kg m s}^{-1}$ . The uncertainty in its position is ( $h = 6.62 \times 10^{-34} \text{ J s}$ )

- (A)  $5.27 \times 10^{-30} \text{ m}$
- (B)  $1.05 \times 10^{-26} \text{ m}$
- (C)  $1.05 \times 10^{-28} \text{ m}$
- (D)  $5.25 \times 10^{-28} \text{ m}$

The uncertainties in the velocities of two particles A and B are  $0.05$  and  $0.02 \text{ m s}^{-1}$  respectively. If the mass of B is five times that of A, then the ratio of uncertainties in their positions ( $\Delta x_A/\Delta x_B$ ) equals

- (A) 2
- (B) 0.25
- (C) 4
- (D) 1

For an electron, if the uncertainty in velocity is  $\Delta v$ , then the uncertainty in its position is given by

- (A)  $\frac{hm}{4\pi \Delta v}$
- (B)  $\frac{4\pi}{hm \Delta v}$

- (C)  $\frac{h}{4\pi m \Delta v}$   
 (D)  $\frac{4\pi m}{h} \Delta v$

An atom has a mass of 0.02 kg and uncertainty in its velocity is  $9.218 \times 10^{-6} \text{ m s}^{-1}$ . The uncertainty in position is ( $h = 6.626 \times 10^{-34} \text{ J s}$ ) [AIEEE 2002]

- (A)  $2.86 \times 10^{-28} \text{ m}$   
 (B)  $2.86 \times 10^{-32} \text{ m}$   
 (C)  $1.5 \times 10^{-27} \text{ m}$   
 (D)  $3.9 \times 10^{-10} \text{ m}$

Uncertainty in position of a particle of 25 g in space is  $10^{-5} \text{ m}$ . Hence uncertainty in velocity ( $\text{m s}^{-1}$ ) is ( $h = 6.6 \times 10^{-34} \text{ J s}$ ) [AIEEE 2002]

- (A)  $2.1 \times 10^{-28}$   
 (B)  $2.1 \times 10^{-34}$   
 (C)  $5.0 \times 10^{-3}$   
 (D)  $5.0 \times 10^{-24}$

★ The uncertainty in the position of an electron ( $m = 9.1 \times 10^{-31} \text{ kg}$ ) moving with  $300 \text{ m s}^{-1}$ , accurate up to 0.001%, is [AIEEE 2006]

- (A)  $5.76 \times 10^{-2} \text{ m}$   
 (B)  $1.92 \times 10^{-2} \text{ m}$   
 (C)  $3.84 \times 10^{-2} \text{ m}$   
 (D)  $19.2 \times 10^{-2} \text{ m}$

★ In an atom, an electron is moving with a speed of  $600 \text{ m s}^{-1}$  with an accuracy of 0.005%. Certainty with which the position can be located is ( $h = 6.6 \times 10^{-34} \text{ J s}$ ,  $m_e = 9.1 \times 10^{-31} \text{ kg}$ ) [AIEEE 2009]

- (A)  $1.92 \times 10^{-3} \text{ m}$   
 (B)  $3.84 \times 10^{-3} \text{ m}$   
 (C)  $1.52 \times 10^{-4} \text{ m}$   
 (D)  $5.10 \times 10^{-3} \text{ m}$

★ Uncertainty in position of an electron ( $m = 9.1 \times 10^{-28} \text{ g}$ ) moving with velocity  $3 \times 10^4 \text{ cm s}^{-1}$ , accurate up to 0.001%, will be (use  $h/4\pi$ ;  $h = 6.626 \times 10^{-27} \text{ erg s}$ ).

- (A) 5.76 cm  
 (B) 7.68 cm  
 (C) 1.93 cm  
 (D) 3.84 cm