Uncertainty principle and Schrodinger wave equation

1. (b) The uncertainty principle was enunciated by Heisenberg.

2. (b) According to uncertainty principle, the product of uncertainties of the position and momentum, is $\Delta x \times \Delta p \geq h/4\pi$.

3. **Answer:** (a) Heisenberg uncertainty principle
Explanation: Werner Heisenberg formulated the uncertainty principle which states that certain pairs of physical properties (like position and momentum) cannot both be known to arbitrary precision at the same time. More precisely, the more exactly the position is known, the less exactly the momentum is known, and vice versa.

4. (c) Uncertainty in momentum
Explanation: Δp denotes the uncertainty in momentum (momentum p = m·v). It is not uncertainty in energy, velocity, or mass. The inequality relates the uncertainty in position (Δx) to the uncertainty in momentum (Δp).

5. (c) $\Delta x \times \Delta p = \frac{h}{4\pi}$ is not the correct relation. But correct Heisenberg's uncertainty equation is $\Delta x \times \Delta p \geq \frac{h}{4\pi}$.

6. (c) At an angle of 45° from the x and y-axes
Explanation: The d_{xy} orbital has lobes lying between the x- and y-axes (in the xy plane). The regions of highest electron density are in the quadrants between the axes — that is at ≈45° to the x and y axes; the axes themselves (x or y) are nodal planes for this orbital.

7. (b) According to the Heisenberg's uncertainty principle momentum and exact position of an electron can not be determined simultaneously.

8. (d) $\Delta x . \Delta p \geq \frac{h}{4\pi}$, if $\Delta x = 0$ then $\Delta p = \infty$.

9. (d) Schrödinger

Explanation: Erwin Schrödinger developed wave mechanics and the Schrödinger wave equation; its solutions (wavefunctionsΨ) led to the orbital concept —∣Ψ∣^{2} gives the probability density of finding an electron in space (an orbital). Bohr proposed quantized orbits (old quantum theory), but the probabilistic orbital concept arises from Schrödinger's wave mechanics.

10. (d) All the above

Explanation: The uncertainty principle (together with wave mechanics) led to the probabilistic interpretation of electron location (probability), the concept of orbitals as regions of probability rather than fixed paths, and the interpretation of the wavefunction Ψ where ∣ ∣Ψ∣^{2} gives the probability density.

11. (a) Heisenberg, de Broglie

Explanation: The uncertainty principle was proposed by Werner Heisenberg. The wave nature of matter (de Broglie hypothesis: matter has wave-like properties with λ=h/p\lambda = h/pλ=h/p) was proposed by Louis de Broglie.

12. (c) According to $\Delta x \times \Delta p = \frac{h}{4\pi}$

$$\Delta x = \frac{h}{\Delta p \times 4\pi} = \frac{6.62\times10^{-34}}{1\times10^{-5}\times4\times3.14} = 5.27 \times 10^{-30} m.$$

13. (a) Uncertainty of moving bullet velocity $\Delta v = \frac{h}{4\pi\times m\times\Delta v} = \frac{6.625\times10^{-34}}{4\times3.14\times.01\times10^{-5}}$

$$= 5.2 \times 10^{-28} m \rightleftarrows / \rightleftarrows sec.$$

14. (b) $\Delta x . \Delta p \geq \frac{h}{4\pi}$ This equation shows Heisenberg's uncertainty principle. According to this principle the product of uncertainty in position and momentum of particle is greater than equal to $\frac{h}{4\pi}$.

15. (d) Spin quantum number does not related with Schrodinger equation because they always show $+1/2,-1/2$ value.

16. (b) According to $\Delta x \times m \times \Delta v = \frac{h}{4\pi}$; $\Delta v = \frac{h}{\Delta x \times m \times 4\pi}$

$$= \frac{6.6\times 10^{-34}}{10^{-5}\times 0.25\times 3.14\times 4} = 2.1\times 10^{-29}\ m/s$$

17. (a) Uncertainity in position $\Delta x = \frac{h}{4\pi\times\Delta p}$ $= \frac{6.63\times10^{-34}}{4\times3.14\times(1\times10^{-5})} = 5.28\times10^{-30}m.$

18. (c) Given that mass of electron $= 9.1\times10^{-31}kg$

Planck's constant $= 6.63\times10^{-34}kgm^2s^{-1}$

By using $\Delta x\times\Delta p = \frac{h}{4\pi}$; $\Delta x\times\Delta v\times m = \frac{h}{4\pi}$

where : Δx = uncertainity in position

Δv = uncertainity in velocity

$\Delta x\times\Delta v = \frac{h}{4\pi\times m}$ $= \frac{6.63\times10^{-34}}{4\times3.14\times9.1\times10^{-31}} = 5.8\times10^{-5}m^2s^{-1}.$