Course: BSO 203 Instructor: S. Raychaudhuri

Session 2002-2003, Semester I

QUIZ VIII

(10× **1**)

Answer the questions by putting a mark in the circle ◯ adjacent to the most appropriate (or most fundamental) alternative. No credit will be given if more than one alternative is marked.

1. Scattering states are seen in quantum mechanics if
   (a) ◯ the energy E is positive.
   (b) ◯ the energy E is greater than the potential $V(x)$.
   (c) ✓ the potential is confined.
   (d) ◯ the wavefunction vanishes at large distances.
2. Barrier tunnelling occurs because
   (a) ◯ the wavefunction must be continuous.
   (b) ◯ wave-particle duality is real.
   (c) ◯ Schrödinger's equation must be satisfied.
   (d) ✓ the uncertainty principle holds.
3. The Geiger-Nuttall rule for α-decay holds because
   (a) ◯ α-decay is an extremely rare process.
   (b) ◯ α-decay is classically forbidden.
   (c) ✓ the tunnelling probability falls off exponentially.
   (d) ◯ α particle energies are small.
4. Scanning tunnelling microscopy works because
   (a) ◯ the electron has a wave nature.
   (b) ◯ it is possible to measure nanoampere currents.
   (c) ◯ the tip of the probe is just a few atoms thick.
   (d) ✓ tunnelling current is sensitive to barrier width.
5. The tunnel diode differs from the ordinary diode because
   (a) ◯ it has negative resistance.
   (b) ◯ it has different I–V characteristics.
   (c) ✓ it is doped much more heavily.
   (d) ◯ it operates on a different principle.

6. The harmonic oscillator problem is important because
   (a) ◯ the potential is a confining potential with no scattering states.
   (b) ◯ the energy eigenvalues are $E_n = nh\nu + E_0$ and hence verify Planck's theory.
   (c) ◯ there is a zero point energy which can explain the third law of thermodynamics.
   (d) ✓ any small oscillations can be reduced to the harmonic oscillator for small amplitudes.
7. The energy levels of a harmonic oscillator are quantised because
   (a) ◯ the solutions are Hermite polynomials.
   (b) ◯ the wavefunction must be continuous at the classical turning points.
   (c) ◯ the potential is even under parity.
   (d) ✓ the wavefunction must vanish at infinity.
8. The central force problem is relatively easy to solve because
   (a) ◯ the potential depends on a single variable.
   (b) ◯ it is possible to separate variables in spherical polar coordinates.
   (c) ✓ orbital angular momentum is conserved.
   (d) ◯ the total energy is conserved.
9. The angular momentum eigenvalues are quantised because
   (a) ✓ the wavefunction must be regular in all directions.
   (b) ◯ the wavefunction must vanish at large distances.
   (c) ◯ space quantisation is a real phenomenon.
   (d) ◯ every classically conserved quantity has discrete eigenvalues in quantum mechanics.
10. The hydrogen atom problem gives energy eigenvalues identical with Bohr's theory because
    (a) ◯ both are fundamantal theories.
    (b) ✓ the Bohr theory has been tailored to give these values.
    (c) ◯ the Schrödinger equation has been tailored to give these values.
    (d) ◯ the agreement is accidental.