Atomic models and Planck's quantum theory

22. (c) Most part of the atom is empty space

β-particles are just electrons (high-speed).

The experimental result that *most particles pass straight through, and only a few get deflected* comes from Rutherford's scattering experiment (although he used α-particles).

The conclusion was: most of the atom is empty space, with a small dense nucleus in the center.

Options (a), (b), and (d) are irrelevant to why particles pass straight — the real reason is the atomic structure.

23. (d) $\frac{E_4}{E_2} = \frac{2^2}{4^2} = \frac{4}{16} = \frac{1}{4}; E_4 = \frac{E_2}{4} = \frac{-328}{4} = -82 kJ/mol.$

24. In Bohr's model, electrons in stationary orbits do not radiate energy. They remain in fixed energy levels unless they jump to another orbit. Hence, the energy of the electron remains constant.
Answer: (d) Its energy remains constant

25. According to de Broglie, λ = h / (mv). Wave nature becomes significant when mass is very small and velocity is not too large. Hence, even a small mass particle can exhibit wave nature. Electrons (small mass, not negligible velocity) show wave motion.
Correct condition: Small/negligible mass.
Answer: (c) Its mass is negligible

26. Bohr proposed that electrons are present in quantised orbits and do not exist in-between. Transitions between these levels occur as sudden jumps, not gradual

flow. This reflects the concept of quantisation of energy.
Answer: (a) The quantisation concept

27. (c) When $c = \nu \times \lambda$ than $\lambda = \frac{c}{\nu} = \frac{3\times10^8}{2\times10^6} = 1.5 \times 10^2 m$

28. (b) According to quantum theory of radiation, a hot body emits radiant energy not continuously but discontinuously in the form of small packets of energy called quanta or photons.

29. (c) $13.6/n^2$ eV

Explanation:
According to Bohr's model of the hydrogen atom, the energy of an electron in the n^{th} orbit is given by:

$E = -\frac{13.6}{n^2} eV$ Here, 13.6 eV is the energy of the electron in the ground state (n = 1).

The negative sign indicates that the electron is bound to the nucleus.

As n increases, the magnitude of energy decreases, meaning the electron is less tightly bound.

So, the correct formula is $\frac{13.6}{n^2} eV$ (option c).

30. (a) $p = \frac{h}{\lambda} = \frac{6.6\times10^{-34}}{2.2\times10^{-11}} = 3 \times 10^{-23} kgms^{-1}$

31. The Bohr radius formula is:
$r = (n^2h^2) / (4\pi^2 me^2 Z)$
where n = orbit number, h = Planck's constant, m = electron mass, e = electron

charge, Z = atomic number.
Answer: (b) $r=(n^2h^2)/(4\pi^2me^2Z)$

32, The energy expression is:
$E_n = -(2\pi^2me^4Z^2)/(n^2h^2)$
This is derived from electrostatic potential energy and centripetal force balance.
Answer: (c) $E_n = -(2\pi^2me^4Z^2)/(n^2h^2)$

33. Sommerfeld extended Bohr's model by allowing elliptical orbits instead of only circular ones. This explained fine structure in spectra.
Answer: (d) Sommerfeld

34. (b) (a) Bohr's radius= $\frac{n^2h^2}{4\pi^2me^2z}$. Which is a positive quantity.

(a) & (b) positive quantity AND Discrete values

n=1,2,3,…n = 1, 2, 3, …n=1,2,3,… (principal quantum number),

h = Planck's constant,

ε_0 = permittivity of free space,

m = mass of electron,

e = charge of electron,

Z = atomic number.

Since n can only take discrete integer values, the radius of Bohr's orbit can also take only discrete values.

The radius is always positive (distance cannot be negative).

It cannot be fractional (like 1.5 orbit does not exist) because n must be an integer.

35. Bohr applied Planck's quantum theory to explain hydrogen atom structure. Planck introduced quantum theory, but Bohr was the first to apply it to atomic structure.
Answer: (b) Bohr

36. The 1s orbital is the lowest energy level. An electron transition involving 1s generally involves moving to higher orbitals (absorption) or falling back (release). Thus, both absorption or release can occur.
Answer: (c) Both release or absorption of energy

37. According to Bohr model, as n increases (moving away from nucleus), the energy becomes less negative, i.e., it increases.
Answer: (c) Increases

38. Rutherford found that most α-particles passed through while few were deflected sharply. This proved that the positive charge of the atom is concentrated in a small dense nucleus.

Answer: (c) The positive charge of the atom is concentrated in a very small space

39. According to de Broglie relation: λ = h / (mv). As velocity increases, momentum increases, and λ decreases.

Answer: (c) Decreases with increase in speed of e^-

40. (a) Gold used by Rutherford in scatting experiment.

41. (c) $\Delta E = E_3 - E_2 = 13.6\left[\frac{1}{(2)^2} - \frac{1}{(3)^2}\right] = 1.9eV$

42. (d) $R = R_0(= 1.4 \times 10^{-13} cm) \times A^{1/3}$