C is false; the Thomson model does *not* predict discrete energy levels.
D is false; in the Thomson model the electrons are visualized as localized negative charges in a uniformly positively charged background.
E is false; in the Rutherford model the electron continually radiates energy and will fall into the nucleus.

F is correct; when distant from the nucleus the α–particle has kinetic energy $p^2/2m$; at r_{cl} the α–particle has zero kinetic energy but the electrostatic potential energy is proportional to r_{cl}^{-1}. The initial kinetic energy has been converted into electrostatic potential energy so $p^2/2m$ = constant/r_{cl} and so r_{cl} is proportional to p^{-2}.

G is false; in the Thomson model, α–particles *can* be scattered through more than 90° as a result of multiple scattering processes, but the probability is far too small to explain the experimental data.

Q7 The correct responses are D and F

$r \propto n^2$ (see equation 17 in Unit 13), therefore $r_5/r_4 = 25/16 = 1.56$

$$E_{photon} = E_5 - E_4 = -13.6\ \mathrm{eV}/5^2 - \left(-13.6\ \mathrm{eV}/4^2\right) \text{ (See Eq. 20 of Unit 13.)}$$
$$= 13.6\ \mathrm{eV}(1/16 - 1/25) = 0.31\ \mathrm{eV}$$

Q8 The correct response is F

$$E = eV = \frac{hc}{\lambda}$$

hence minimum (cut off) wavelength is given by

$$\lambda = \frac{hc}{eV} = \frac{6.63\times10^{-34}\times3\times10^{8}}{1.6\times10^{-19}\times3\times10^{4}}\ \mathrm{nm} = 4.1\times10^{-11} = 0.041\ \mathrm{nm}$$

Thus *five* characterstic peaks, at 0.043, 0.051, 0.060, 0.065 and 0.070 would be present in this spectrum.

Q9 The correct response is E

Use the Compton scattering equation (eq. 6 in Unit 14)

$$(\lambda_1 - \lambda_0) = \frac{h}{mc}(1-\cos\theta)$$

$$\lambda_1 = \lambda_0 + \frac{h}{mc}(1-\cos\theta) = 3.5\times10^{-3}\ \mathrm{nm} + \left(\frac{6.63\times10^{-34}}{9.1\times10^{-31}\times3\times10^{8}}\right)(1-0.707)\ \mathrm{m}$$
$$= 3.5\times10^{-12}\ \mathrm{m} + (2.4\times10^{-12})\times0.293\ \mathrm{m}$$
$$= 3.5\times10^{-12}\ \mathrm{m} + 0.7\times10^{-12}\ \mathrm{m} = 4.2\times10^{-12}\ \mathrm{m} = 0.0042\ \mathrm{nm}$$

Q10 The correct statements are B and E

A is incorrect; the relation $\lambda = h/p$ applies to electromagnetic radiation and to particles having mass, such as protons.

B is correct; $p_{sand} = mv = 2\times10^{-5}$ kg m s^{-1},

$$p_{photon} = \frac{h}{\lambda} = \left(\frac{6.63\times10^{-34}}{3.32\times10^{-12}}\right)\ \mathrm{kg\ m\ s^{-1}} = 2\times10^{-22}\ \mathrm{kg\ m\ s^{-1}} = 10^{-17}\ p_{sand}.$$

C is wrong; probability ∝ (amplitude)^2.

D is wrong; kinetic energy = $p^2/2m$, so halving the KE makes momentum = $p/\sqrt{2}$ and thus de Broglie wavelength = $\sqrt{2}\lambda$.
E is correct; quantum mechanics predicts the probability of a measurement having a given result.
F is wrong; blocking one slit converts the two slit pattern to a one slit pattern.
G is wrong; it is possible to observe which slit electrons pass through, but at the expense of losing the two slit interference pattern (Frame 9, Unit 14).