Marking Scheme – The Atomic Strucure

Question 1 (2015 - Section B - Question 5 - Part a - c)

QUESTION 5

(*a*) (*i*) GIVE: **fluorescence / glow / coloured light / shadow cast by anode (cross, object)** / deflection of beam **using magnetic (electric) field / paddle (wheel) rotated** clockwise / **paddle (wheel) pushed (moved** to) right / using a **charged electroscope** / associated **static electricity** (3)

(*ii*) NAME: **J.J. Thomson** (3)

WHAT: **electron** (3)

(*b*) NAME: Henri **Becquerel** / Marie **Curie** / Pierre **Curie** (3)

(*c*) STATE: **most** alpha-particles **undeflected (passed straight through, were deflected slightly as they passed through)** the gold foil //
some alpha-particles **deflected** //
some (a few) alpha-particles **reflected (deflected** straight **back)** along their original paths
[Marks available from a good labelled diagram.] (3 × 3)

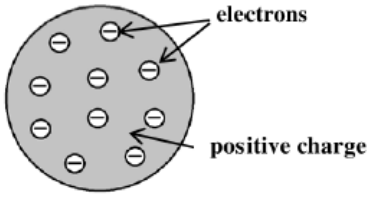
EXPLAIN: (*i*) **repulsion (deflection)** of positive alpha-particles (3)

(*ii*) **most** alpha-particles **undeflected (passed straight through, were deflected slightly as they passed through)** the gold foil /
large angles of deflection (repulsion) for many alpha-particles consistent with charge concentrated in small, dense nucleus /
a few (a small number) alpha-particles **reflected (deflected** straight **back)** showing most of mass concentrated in small, dense nucleus /
statistical analysis of angles of deflection consistent with charge and mass concentrated in small, dense nucleus (3)
[Marks for EXPLAIN (*i*) or (*ii*) cannot be given for STATE above.]

Question 2 (2014 - Section B - Question 4 - Part (b))

(*b*) DESCRIBE: mass of **positive**ly-charged material **//**
with electrons (small **negative charges)**
scattered (embedded) in it

[Correctly labelled diagram acceptable.]



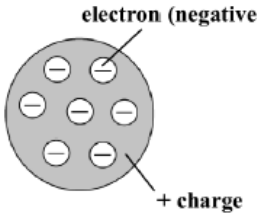
(2 × 3)

Question 3 (2012 - Section B - Question 11 - Part (a))

(a) *(i)* WHAT: **helium nuclei (-eus) / He^{2+}** / particle having **two protons and two neutrons** (4)

(ii) DESC: **sphere (ball) with positive (+) charge** spread out over it //

with **electrons embedded (scattered, dotted, placed** at random) **in it** (2 × 3)



[Marks can be got from a labelled diagram. The words "electron(s)/ negative charges" and "positive (+)" required in description or diagram. Dots(es) may be used for electrons.]

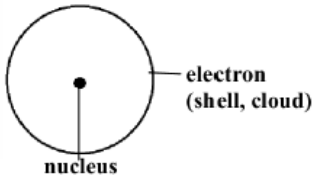
(iii) EXPL: **repelled** //

when passing **near (by) nucleus {near (by) positive (+) core (centre)}** (2 × 3)
[The two 3s could be got from a suitable diagram.]

(iv) SOME: **collided with nucleus {positive (+) core (centre)}** //

SMALL: **nucleus {positive (+) core (centre)} very small / most (almost all) of** atom's **mass** concentrated **in nucleus {positive (+) core (centre)} / most (almost all) of atom is empty space** (2 × 3)

(v) DRAW: **nucleus {central mass (core) shown and labelled with one (or more) shell(s) of electrons (or electron cloud) shown and labelled** (3)



Question 4 (2010 - Section B - Question 5)

(a) STATE: **Small // indivisible // identical** atomic mass (weight) for particular element (2 × 4)

(b) NAME: (i): **Thomson //**
(ii): **Rutherford //**
(iii): **Millikan** (3 × 3)

(c) OUTLINE: **The electron** in a hydrogen atom **occupies (restricted to) fixed energy levels (energy values, discrete energies) //**

an electron in an energy level does not radiate energy //

electron occupies lowest energy levels available / electron occupies ground state //

the electron can move (become excited) to a higher energy **level if it receives** an amount of **energy (photon** of energy) //

the photon (energy) must be exactly **equal to the energy difference between the ground state (a lower level) and a higher** energy **level (excited state) //**

the electron in an excited state (a higher level) is unstable //

the excited **electron falls back to a lower** energy **level //**

emitting the excess **energy in the form of a photon of light (h*f*) / emitting light of a definite frequency (wavelength) /** emitting light according to $E_2 - E_1 = hf$ (hν)
[Accept 'quantum' for 'photon' and 'shell' for 'level.'] ANY FOUR: (6 + 3 × 3)

(d) STATE: **Didn't work for higher elements / only worked for hydrogen / doesn't work for multi electron systems //**

Did not take wave-particle duality into account //

Did not allow for uncertainty (probability) //

Did not explain higher resolution spectra / didn't explain discovery of sublevels //

Could not account for the existence of orbitals / Zeeman effect / splitting of spectral lines (ANY 2 × 3)

(e) DEFINE: **Region (space)** around the nucleus of an atom //
where there is a 99% (high) probability of finding an electron / where electron most **likely to be found //**

or

space occupied by electron // described by solution of Schrödinger equation
(2 × 3)

DRAW: **Dumbbell drawn** (3)

STATE: **two / 2** (3)

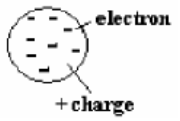
Question 5 (2009 - Section B - Question 4 - Part (a))

(a) NAME: Robert **Millikan** (3)
PARTICLE: **electron** (3)

Question 6 (2007 - Section B - Question 11 - Part (a) (i) - (ii))

QUESTION 11

(a) (i) DESCR: **positively charged sphere (ball) // electrons* embedded (scattered, dotted, placed** at random**) in it** (4 + 3)
[*The word "electron(s)" required in description or diagram.]
Marks can be got from a labelled diagram such as:
[Allow 3 marks for "plum pudding" unqualified]



(ii) STATE: *first observation*: **deflection** of alpha particles (3)
second observation: alpha particles **reflected (rebounded , bounced back, came straight back)** (3)

EXPL: *first observation*: particles **passed close to** small, **positive mass (charge)** (3)
second observation: particles **collided with small,** very **dense mass (material, nucleus, point)** (3)
[The explanations for the first and second observations must be given separately, or else it must be absolutely clear from the candidate's answer which observation is being explained.]