The Nuclear atom

Mark Scheme 3

Level	IGCSE
Subject	Physics
ExamBoard	CIE
Topic	Atomic Physics
Sub-Topic	The nuclear atom
Paper Type	(Extended) Theory Paper
Booklet	Mark Scheme 3

Time Allowed: **66 minutes**

Score: **/55**

Percentage: **/100**

1 **(a)** electromagnetic (waves / radiation / rays / spectrum)   B1
        OR (high energy) photons

   (b) α and β deflected in opposite directions   B1

        any 1 from: B1
        • β deflected more (than α)
        • deflections perpendicular to field direction and to paths of particle
        • paths (of particles) are curves / circular / arcs

   (c) curved path   B1

        (deflected/attracted) towards positively charged plate   B1
        OR in opposite direction to field

   (d) (i) α-particle OR helium <u>nucleus</u> OR 2 protons + 2 neutrons   B1

        (ii) A = 210 Z = 84   B1

                                                                              [Total: 7]

2 **(a)** 2 protons and 2 neutrons OR helium <u>nucleus</u>   B1

   (b) α in direction of field OR α towards negative (plate)
        OR β in opposite direction to field OR β towards positive (plate)
        OR α and β deflected in opposite directions   C1

        α in direction of field OR α towards negative (plate)
        AND
        β in opposite direction to field OR β towards positive (plate)   A1

   (c) not deflected   B1

   (d) versions owtte of same element owtte   B1

        (isotopes of same element have) same proton number/number of protons/atomic
        number/Z   B1

        (isotopes of same element have) different nucleon numbers/ number of
        neutrons/mass number/A   B1

3 **a ( )** γ : none / zero / 0 / neutral AND
2 cm (or more) of lead / thick lead / 50 cm (or more) of concrete   B1

β: particle / electron AND
any named metal / glass / concrete OR 1 m of air   B1

α: particle / helium nucleus / 2 protons + 2 neutrons / $_2^4$He / $_2^4$α AND
positive OR + OR +2   B1

(b) **(i)** 38

(ii) 90

(iii) 52

(iv) 38   B3

(c) 36 hours = 3 half-lives
OR halving in steps from 4800 to 600 seen   C1

half-life = 12 hours OR 3 half-lives OR 2 / 3 of 36   C1

(further time to reduce to 150 Bq =) 24 (hours)   A1

[Total: 9]

4 **(a)** **(i)** alpha or α

(ii) beta or β

(iii) gamma or γ   B2

Symbols must be clear
3 correct B2
2 correct B1

(b) **(i)** repulsion   B1
α particle and (gold) nucleus / protons of (gold) nucleus have positive charges   B1

(ii) Any two of:
Nucleus is very small (compared to size of atom) OR Most of atom is empty
space

Nucleus is positive / contains protons OR Nucleus has (all) the positive charge
of the atom

Nucleus is heavy OR Nucleus has most / all of the mass of the atom   B2   **[6]**

Ignore neutrons

5 **(a)** A and C   B1

   (b) (4.2×10^{10} years   B1

   (ii) idea of decay OR changes proton/neutron/nucleon number
            OR change into another nuclide/isotope/element/type of atom
            OR emits α/β particle (ignore γ / radiation)   B1

   (iii) idea of insignificant change in activity during stated time up to 5×10^{9} years
             OR   experiment time insignificant c.f. 1.4×10^{10} years OR long half life
             OR long time to decay   B1   [4]

6 **(a) (i)**   proton   B1

      (ii)   proton and neutron   B1

   (b) number of protons = 47   B1
            number of neutrons = 60   B1

   (c) (i)   8 hrs +/– 0.25 hrs   B1

      (ii)   first point plotted is half the count-rate of a point on the curve, and 8 hours
               after that point (ecf from **(c)(i)**)   B1

               second point plotted same as above or with respect to first point plotted   B1

               possible points include:
               16 hrs,   80 counts/s
               24 hrs,   40 counts/s
               13.5 hrs, 100 counts/s
               21.5 hrs,   50 counts/s
               16.5 hrs,   75 counts/s   [7]

7	**(a)**	A doubles back, either side	B1	
		B carries on, slightly deflected	B1	
		C carries straight on	B1	[3]
	(b)	only (very) few scattered through large angles	B1	
		most pass undeviated so most of atom space	B1	
		scattering/deflection/repulsion due to concentrated mass/charge/charge/nucleus	B1	[3]

[Total: 6]

8	**(a)**	top line correct, need 24 and 0	**B1**	
		bottom line correct, need 12 and −1 (accept β or e for electron	**B1**	**2**
	(b)	particles take curved path (accept from diagram)	**B1**	
		move between the poles at right angles to lines of force	**B1**	
		move out of paper	**B1**	**3**
	(c) (i)	use detector to pick up <u>radiation</u> (from isotope at points on/in body etc.)	**B1**	
		high count where circulation good or v.v. explained	**B1**	
	(ii)	alpha particles all absorbed, none detected		
		beta particles may be largely absorbed, not penetrative enough		
		gamma rays reach detector/leave body any two	**B2**	**4**
				[9]