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**SPECA**

GCSE Combined Science (AQA Trilogy) · Physics

# Atomic Structure (Physics) · Mark Scheme

*For use with the Tiered Worksheet. Marking points are indicative, not exhaustive: award equivalent correct answers.*

## Section A: Foundation (Q1 to 15)

1) Nucleus contains protons (positive) and neutrons (no charge) (1); electrons (negative) surround/orbit the nucleus (1); the nucleus's radius is less than 1/10,000 of the atom's radius (1); the nucleus holds almost all of the atom's mass (1) [4]

2) Protons = 11 (1); neutrons = 23 − 11 = 12 (1); electrons = 11 (1) [3]

3) Atoms of the same element with different numbers of neutrons (1) [1]

4) It loses one (or more) outer electron(s) (1), leaving more protons than electrons, giving it an overall positive charge (1) [2]

5) Plum pudding model: a ball of positive charge with (negative) electrons embedded throughout it (1 mark, max 2 for full description including even spread); most alpha particles passed straight through the gold foil, but a small number were deflected or bounced straight back (1); this showed most of the atom is empty space, with a small, dense, positively charged nucleus concentrating the atom's mass and charge, the nuclear model (1) [4]

6) Nuclear model; Bohr's model of electrons at fixed distances; discovery of the proton; discovery of the neutron (1 mark for correct first and last, 1 mark for fully correct order) [2]

7) Activity: the rate at which a source of unstable nuclei decays (1), measured in becquerel, Bq (1); count-rate: the number of decays recorded (e.g. by a Geiger-Müller tube) per second (1) [3]

8) Alpha particle = two protons and two neutrons (equivalent to a helium nucleus) (1 mark, allow 1 for either part named); during beta decay, a neutron in the nucleus converts into a proton, and a high-speed electron is ejected from the nucleus (1 mark for conversion, 1 mark for electron ejected) [3]

9) Alpha is the most ionising (1); gamma travels the furthest through air (1) [2]

10) Mass number = 226 − 4 = 222 (1); atomic number = 88 − 2 = 86 (1) [2]

11) Mass number = 14 (unchanged) (1); atomic number = 6 + 1 = 7 (1) [2]

12) Count-rate falls from 960 to 480 in 20 minutes (one halving) (1); half-life = 20 minutes (1) [2]

13) Contamination: the unwanted presence of radioactive material on or in another material (1); irradiation: exposing an object to nuclear radiation without that object itself becoming radioactive (1); contamination means the material itself is present and continues emitting radiation, irradiation does not (1) [3]

14) The equipment is exposed to radiation from the source but never contains any radioactive material itself (1); once the exposure stops, no radioactive material remains on/in the equipment, so it is not a source of radiation itself (1) [2]

15) So other scientists can check, repeat, and scrutinise the methods and conclusions before they are widely accepted (1); this reduces the risk of incorrect claims about a real health risk being acted on or ignored (1) [2]

## Section B: Higher (Q16 to 20)

16) 12 hours ÷ 4 hours = 3 half-lives (1); fraction remaining = $(1/2)^3$ = 1/8 (1) [2]


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17) 8 days ÷ 2 days = 4 half-lives (1); 800 → 400 → 200 → 100 → 50 (1); activity after 8 days = 50 Bq (1) [3]

18) 20 minutes ÷ 5 minutes = 4 half-lives (1); 1200 → 600 → 300 → 150 → 75 (1); 75 nuclei remain (1) [3]

19) $(1/2)^5 = 1/32$ (1); ratio = 1 : 32 (1) [2]

20) You cannot lose more than 100% of a sample, so adding thirds/halves together is invalid: each half-life must be applied to what remains, not the original amount, each time (1); correct fraction remaining = 1/2 → 1/4 → 1/8, so 1/8 of the original sample remains (1) [2]

**Total: 37 marks (Section A) + 12 marks (Section B) = 49 marks**

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