3.5 Atomic Structure: 30-minute Pack

AQA 8461 · Calculator allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Sodium atoms (Na) can form ions by losing one electron to become Na^+.

(a) State how many electrons a neutral sodium atom has. (Sodium atomic number = 11) **(1)**

(b) State the number of electrons in a Na^+ ion. **(1)**

(Total for Question 1 is 2 marks)

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2 Background radiation is the low-level radiation that is around us all the time.

(a) Give two natural sources of background radiation. **(2)**

(b) State one man-made (artificial) source of background radiation. **(1)**

(c) Explain, in terms of atoms, why some rocks (such as granite) emit background radiation. **(1)**

(Total for Question 2 is 4 marks)

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3 An atom of sodium can be written as Na-23, with atomic number 11.

(a) Define what is meant by 'atomic number'. **(1)**

(b) Define what is meant by 'mass number'. **(1)**

(c) Calculate the number of neutrons in an atom of Na-23. **(2)**

(d) Explain what is meant by the term 'isotope', using two isotopes of an element other than sodium as an example. **(2)**

(Total for Question 3 is 6 marks)

4 When an unstable nucleus emits α radiation its atomic number and mass number change.

(a) A nucleus has atomic number 92 and mass number 238. Calculate the atomic number after it emits one α particle. **(1)**

(b) Calculate the mass number after emission of one α particle. **(1)**

(Total for Question 4 is 2 marks)

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5 An atom of element X has 17 protons and 20 neutrons.

(a) State the atomic number of element X. **(1)**

(b) Write the nuclide notation for this atom, in the form A X, where A is the mass number and X is the element symbol. Use X as the element symbol. **(1)**

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(Total for Question 5 is 2 marks)

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6 A radiographer stands behind a lead screen while a patient has an X-ray taken.

(a) Explain the difference between radioactive contamination and irradiation. **(2)**

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(b) Explain why standing behind the lead screen reduces the radiographer's exposure to X-rays. **(2)**

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(c) State one other precaution taken by hospital workers who regularly handle radioactive sources, to reduce their risk of contamination. **(1)**

(Total for Question 6 is 5 marks)

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7 The activity of a radioactive source halves every half-life. Show that, after 3 half-lives have passed, the activity of a source has fallen to approximately 12.5% of its initial value.

(Total for Question 7 is 3 marks)

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Mark scheme · 3.5 Atomic Structure: 30-minute Pack

Question 1

(a) 11 electrons cao **B1**

(a) Answer: 11 electrons

(b) 10 electrons (lost one electron) cao **B1**

(b) Answer: 10 electrons

Question 2

(a) any one valid natural source, e.g. radon gas (from rocks/ground), cosmic rays (from space), rocks and soil (e.g. granite), food and drink **B1**

(a) any second different valid natural source from the list above **B1**

(a) Answer: Any two of: radon gas, cosmic rays, rocks/soil, food and drink.

(b) any valid man-made source, e.g. medical X-rays/scans, nuclear industry/power stations, fallout from nuclear weapons testing **B1**

(b) Answer: Medical X-rays or scans (or the nuclear industry).

(c) they contain small amounts of naturally occurring radioactive/unstable isotopes, which decay and emit radiation, oe **B1**

(c) Answer: They contain naturally occurring unstable (radioactive) isotopes that decay and emit radiation.

Question 3

(a) the number of protons in the nucleus of an atom, oe **B1**

(a) Answer: The number of protons in the nucleus of an atom.

(b) the total number of protons and neutrons in the nucleus of an atom, oe **B1**

(b) Answer: The total number of protons and neutrons in the nucleus of an atom.

(c) correct method: neutrons = mass number - atomic number, i.e. 23 - 11 **M1**

(c) 12 neutrons, cao **A1**

(c) Answer: 12 neutrons

(d) isotopes are atoms of the same element (same number of protons/same atomic number) with different numbers of neutrons (different mass numbers), oe **B1**

(d) correct named example of two isotopes of the same element, e.g. carbon-12 and carbon-14, oe **B1**

(d) Answer: Isotopes are atoms of the same element with the same number of protons but different numbers of neutrons, e.g. carbon-12 and carbon-14.

Question 4

(a) 92 - 2 = 90 **B1**

(a) Answer: 90

(b) 238 - 4 = 234 **B1**

(b) Answer: 234

Question 5

(a) 17 (number of protons cao) **B1**

(a) Answer: 17

(b) 37 X (mass number = 17 + 20 = 37) cao **B1**

(b) Answer: 37 X

Question 6

(a) contamination is the unwanted presence of radioactive material (particles) on or inside an object or person, which continues to expose it/them to radiation until removed, oe **B1**

(a) irradiation is being exposed to radiation from a source without being in contact with it, and exposure stops once the person moves away from (or the source is removed from) the radiation, oe **B1**

(a) Answer: Contamination is unwanted radioactive material on or in an object/person, which keeps exposing it. Irradiation is exposure to radiation from a source without contact, which stops when the source is removed or the person moves away.

(b) lead is a dense material that strongly absorbs (ionising) X-ray/γ-type radiation, oe **B1**

(b) so most of the radiation is absorbed by the screen and does not reach the radiographer, reducing their dose, oe **B1**

(b) Answer: Lead strongly absorbs X-rays, so the screen blocks most of the radiation from reaching the radiographer, reducing their exposure.

(c) any valid precaution, e.g. wearing gloves and protective clothing, using remote handling tools/tongs, washing hands thoroughly after handling, storing sources in sealed/shielded containers **B1**

(c) Answer: Wearing gloves and protective clothing, or using tongs/remote handling tools.

Question 7

recognises the activity halves each half-life: after 1 half-life, activity = 50% of initial **M1**

after 2 half-lives, activity = 50% of 50% = 25% of initial **M1**

after 3 half-lives, activity = 50% of 25% = 12.5% of initial, cso (answer given in question, full working must be shown) **A1**

Answer: 12.5% of the initial activity (shown).

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