K7E Atoms, Elements and Compounds: Depth and Practice

AQA AQA KS3 Science - Chemistry · Calculator allowed · about 85 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Quickfire: circle the correct letter for each question.

(a) Which chemical symbol represents the element potassium? **(1)**

- [ ] A) P
- [ ] B) Po
- [ ] C) K
- [ ] D) Pt

(b) Which chemical symbol represents the element iron? **(1)**

- [ ] A) I
- [ ] B) Ir
- [ ] C) In
- [ ] D) Fe

(c) Which of these substances is an element? **(1)**

- [ ] A) copper (Cu)
- [ ] B) ammonia (NH3)
- [ ] C) sea water
- [ ] D) limestone (calcium carbonate)

(d) The mass number of an atom tells you the total number of: **(1)**

- [ ] A) protons only
- [ ] B) electrons only
- [ ] C) protons and neutrons added together
- [ ] D) protons and electrons added together

2 Atomic number = number of protons. Mass number = number of protons + neutrons. Use this to complete the table for the following elements.

(a) Lithium has atomic number 3 and mass number 7. State the number of protons and electrons, and calculate the number of neutrons. **(2)**

.....

(b) Aluminium has atomic number 13 and mass number 27. State the number of protons and electrons, and calculate the number of neutrons. **(2)**

.....

(c) Bromine has atomic number 35 and mass number 80. State the number of protons and electrons, and calculate the number of neutrons. **(2)**

.....

---

3 The periodic table arranges elements into groups (columns) and periods (rows).

(a) Using the periodic table, identify the group number and the period number of potassium. **(2)**

(b) Using the periodic table, identify the group number and the period number of argon. **(2)**

4 A chemical formula shows how many atoms of each element are present in a substance.

(a) State the number of atoms of each element in one molecule of ammonia, NH_3. **(2)**

(b) State the number of atoms of each element in one molecule of sulfuric acid, H_2SO_4. **(2)**

(c) State the number of atoms of each element in one molecule of glucose, $C_6H_{12}O_6$. **(3)**

---

5 The relative formula mass (Mr) is found by adding the relative atomic masses (Ar) of every atom shown in the formula. Use these Ar values: H = 1, C = 12, N = 14, O = 16, S = 32.

(a) Calculate the relative formula mass (Mr) of ammonia, NH_3. **(2)**

.....

(b) Calculate the relative formula mass (Mr) of sulfuric acid, H_2SO_4. **(3)**

.....

(c) Calculate the relative formula mass (Mr) of glucose, $C_6H_{12}O_6$. **(3)**

.....

6 Balance the following symbol equations by writing the correct numbers in front of each formula where needed.

(a) Balance: Zn + HCl -> ZnCl2 + H2 **(2)**

(b) Balance: K + Cl2 -> KCl **(2)**

(c) Balance: Zn + S -> ZnS **(2)**

---

7 Classify each change below as a physical change or a chemical change.

(a) Melting a bar of chocolate. **(1)**

(b) Burning a birthday candle. **(1)**

(c) A nail slowly rusting outdoors. **(1)**

(d) Dissolving sugar in a cup of tea. **(1)**

(e) Bread turning brown and crisp when toasted. **(1)**

(f) Crushing an ice cube into smaller pieces. **(1)**

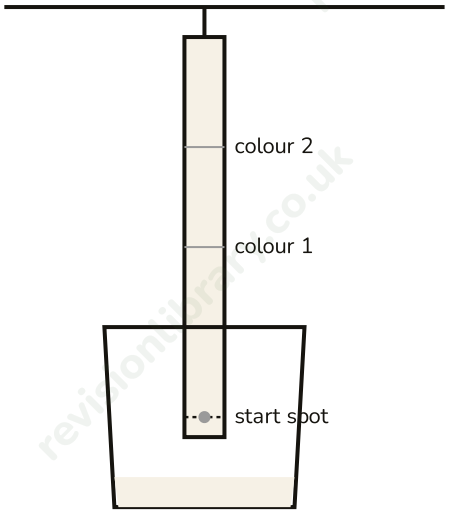
8 A single small crystal of purple potassium permanganate is dropped into a tall measuring cylinder of cold, still water. Over the next hour, a purple colour slowly spreads out from the crystal until the whole cylinder of water is a pale, even purple colour, with no stirring.

(a) Name the process by which the purple colour spreads through the water. **(1)**

(b) Explain, in terms of particles, why the purple colour spreads even though the water is not stirred. **(2)**

(c) Predict and explain how using warm water instead of cold water would change how quickly the purple colour spreads. **(1)**

9 A student wants to find out whether a green sports drink contains a single food colouring or a mixture of colourings. She spots a small drop of the drink near the bottom of a strip of chromatography paper, dips the bottom edge into water (below the spot) and leaves the water to soak up the paper.



(a) Name this practical technique. **(1)**

(b) After the water has risen up the paper, the spot has separated into two distinct coloured bands, one blue and one yellow. State what this shows about the green colouring in the drink. **(1)**

(c) The yellow band has moved 6.0 cm from the start spot and the water (solvent) front has moved 8.0 cm. Calculate the Rf value of the yellow dye. **(2)**

.....

(d) Explain why the two dyes end up at different distances up the paper. **(1)**

10 Carbon exists as more than one isotope, including carbon-12 and carbon-14.

(a) Explain what is meant by the term isotope, using carbon-12 and carbon-14 as examples. **(3)**

(b) Calculate the number of neutrons in an atom of carbon-14. **(1)**

.....

11 Steel is an alloy made from 98% iron and 2% carbon by mass.

(a) State why steel is a mixture and not a compound. **(2)**

(b) Calculate the mass of carbon in a steel girder with a total mass of 850 kg. **(2)**

.....

12 Metals and non-metals have different physical properties.

(a) State two physical properties that most metals share. **(2)**

(b) State two physical properties that most non-metals share. **(2)**

(c) Classify the following elements as a metal or a non-metal: potassium, silicon, tin, bromine, magnesium, sulfur. **(3)**

13 Three test tubes each contain a gas, shown as small circles representing particles. Tube X contains only pairs of two identical circles joined together, all the same colour, scattered throughout. Tube Y contains a mixture of separate single circles of two different colours, not joined to each other, scattered throughout. Tube Z contains only triplets of three circles joined together, each triplet made of one circle of one colour joined to two circles of a second colour, repeated throughout with no single circles present.

(a) Identify which tube represents an element made of diatomic molecules (e.g. like oxygen gas, O_2). **(1)**

(b) Identify which tube represents a mixture of two elements. **(1)**

(c) Identify which tube represents a compound (e.g. like carbon dioxide, CO_2), and explain your answer. **(1)**

---

14 Define each of these three terms.

(a) Element **(1)**

(b) Compound **(1)**

(c) Mixture **(1)**

15 State whether each sentence about atoms and isotopes is true or false.

(a) In a neutral atom, the number of electrons always equals the number of protons. **(1)**

(b) Isotopes of the same element always have different numbers of protons. **(1)**

(c) Most of the mass of an atom is concentrated in its nucleus. **(1)**

---

16 Copper (an element) is used to make electrical wiring. Calcium carbonate (a compound) is used to make cement.

(a) Explain why copper is a suitable material for making electrical wiring. **(2)**

(b) Suggest one property that makes calcium carbonate suitable for use in building materials such as cement. **(2)**

---

17 During crystallisation, a hot evaporating basin of concentrated salt solution is heated gently over a water bath.

(2)

18 A sample of rock salt, mined from underground, is a mixture of sodium chloride crystals and insoluble grey rock (mostly sand and clay minerals). A student is given 40 g of crushed rock salt and asked to produce pure, dry, edible salt crystals from it, and to check the purity of the salt she collects. Describe, step by step, a method she could use, including how she could check that her final crystals are pure sodium chloride.

(6)

Mark scheme · K7E Atoms, Elements and Compounds: Depth and Practice

Question 1

- (a) **B1** C (K) cao
- (a) Answer: **C) K**
- (b) **B1** D (Fe) cao
- (b) Answer: **D) Fe**
- (c) **B1** A (copper) cao
- (c) Answer: **A) copper (Cu)**
- (d) **B1** C cao
- (d) Answer: **C) protons and neutrons added together**

Question 2

- (a) **B1** protons = 3, electrons = 3
- (a) **B1** neutrons = 7 - 3 = 4 cao
- (a) Answer: **Protons = 3, electrons = 3, neutrons = 4.**
- (b) **B1** protons = 13, electrons = 13
- (b) **B1** neutrons = 27 - 13 = 14 cao
- (b) Answer: **Protons = 13, electrons = 13, neutrons = 14.**
- (c) **B1** protons = 35, electrons = 35
- (c) **B1** neutrons = 80 - 35 = 45 cao
- (c) Answer: **Protons = 35, electrons = 35, neutrons = 45.**

Question 3

- (a) **B1** group 1
- (a) **B1** period 4
- (a) Answer: **Group 1, Period 4.**
- (b) **B1** group 0 (or group 8), accept either label
- (b) **B1** period 3
- (b) Answer: **Group 0 (Group 8), Period 3.**

Question 4

- (a) **B1** 1 nitrogen atom
- (a) **B1** 3 hydrogen atoms
- (a) Answer: **1 nitrogen atom and 3 hydrogen atoms.**
- (b) **B1** 2 hydrogen atoms and 1 sulfur atom
- (b) **B1** 4 oxygen atoms
- (b) Answer: **2 hydrogen atoms, 1 sulfur atom, 4 oxygen atoms.**
- (c) **B1** 6 carbon atoms
- (c) **B1** 12 hydrogen atoms
- (c) **B1** 6 oxygen atoms
- (c) Answer: **6 carbon atoms, 12 hydrogen atoms, 6 oxygen atoms.**

Question 5

- (a) **M1** 14 + (1 x 3)
- (a) **A1** = 17 cao
- (a) Answer: **Mr(NH3) = 17**
- (b) **M1** identifies 2 H, 1 S and 4 O atoms from the formula
- (b) **M1** (1 x 2) + 32 + (16 x 4)
- (b) **A1** = 98 cao
- (b) Answer: **Mr(H2SO4) = 98**
- (c) **M1** identifies 6 C, 12 H and 6 O atoms from the formula
- (c) **M1** (12 x 6) + (1 x 12) + (16 x 6)
- (c) **A1** = 180 cao
- (c) Answer: **Mr(C6H12O6) = 180**

Question 6

- (a) **M1** 2HCl correctly placed on the left
- (a) **A1** Zn + 2HCl -> ZnCl2 + H2 fully balanced cao
- (a) Answer: **Zn + 2HCl -> ZnCl2 + H2**
- (b) **M1** 2K on the left and 2KCl on the right
- (b) **A1** 2K + Cl2 -> 2KCl fully balanced cao
- (b) Answer: **2K + Cl2 -> 2KCl**
- (c) **M1** recognises the equation is already balanced with 1 Zn and 1 S on each side
- (c) **A1** Zn + S -> ZnS (no extra numbers needed) cao
- (c) Answer: **Zn + S -> ZnS**

Question 7

- (a) **B1** physical cao
- (a) Answer: **Physical**
- (b) **B1** chemical cao
- (b) Answer: **Chemical**
- (c) **B1** chemical cao
- (c) Answer: **Chemical**
- (d) **B1** physical cao
- (d) Answer: **Physical**
- (e) **B1** chemical cao
- (e) Answer: **Chemical**
- (f) **B1** physical cao
- (f) Answer: **Physical**

Question 8

- (a) **B1** diffusion cao
- (a) Answer: **Diffusion.**
- (b) **M1** dissolved potassium permanganate particles move constantly and randomly in the water
- (b) **A1** they move from the area of high concentration near the crystal to areas of lower concentration until they are spread evenly through the water, oe
- (b) Answer: **Dissolved particles move randomly through the water, spreading from where they are concentrated (near the crystal) to where they are less concentrated, until evenly spread.**
- (c) **B1** it would spread faster, because the particles have more energy and move faster in warmer water, oe
- (c) Answer: **It would spread faster, because the particles have more kinetic energy and move faster at a higher temperature.**

Question 9

- (a) **B1** (paper) chromatography cao
- (a) Answer: **Paper chromatography.**
- (b) **B1** the green colour is a mixture of at least two different dyes (a blue dye and a yellow dye), not a single pure substance, oe
- (b) Answer: **The green colouring is a mixture of at least two different dyes, not a single pure colouring.**
- (c) **M1** Rf = distance moved by spot / distance moved by solvent = 6.0 / 8.0
- (c) **A1** = 0.75 cao
- (c) Answer: **0.75**
- (d) **B1** the two dyes have different solubilities/different attractions to the paper, so one is carried further up the paper by the water than the other, oe
- (d) Answer: **The two dyes are carried different distances because they have different solubility in water and different attraction to the paper.**

Question 10

- (a) **B1** both are atoms of carbon with the same number of protons (6), i.e. the same atomic number
- (a) **B1** they have different numbers of neutrons
- (a) **B1** this gives them different mass numbers (12 and 14), oe
- (a) Answer: **Isotopes are atoms of the same element (same number of protons) with different numbers of neutrons, so different mass numbers. Carbon-12 and carbon-14 both have 6 protons but different neutron numbers.**
- (b) **B1** 8 cao (ft candidate's own atomic number of carbon from (a) if consistent)
- (b) Answer: **8 neutrons.**

Question 11

- (a) **B1** the iron and carbon are not chemically joined (bonded) together, oe
- (a) **B1** the proportions can be varied and each substance keeps its own individual properties, oe
- (a) Answer: **Steel is a mixture because the iron and carbon are not chemically bonded together; the proportions can be varied and each substance keeps its own properties.**
- (b) **M1** 850 x 0.02 (or 850 x 2/100)
- (b) **A1** = 17 kg cao
- (b) Answer: **17 kg**

Question 12

- (a) **B1** any one from: good conductor of electricity/heat, shiny (lustrous), malleable, ductile, high melting/boiling point, high density, sonorous
- (a) **B1** any second correct property from the list above
- (a) Answer: **Any two of: good electrical/thermal conductor, shiny, malleable, ductile, high melting/boiling point, high density, sonorous.**
- (b) **B1** any one from: poor conductor of electricity/heat (insulator), dull appearance, brittle when solid, low melting/boiling point, low density
- (b) **B1** any second correct property from the list above
- (b) Answer: **Any two of: poor electrical/thermal conductor, dull, brittle when solid, low melting/boiling point, low density.**
- (c) **B1** potassium = metal AND tin = metal both correct
- (c) **B1** magnesium = metal AND silicon = non-metal both correct
- (c) **B1** bromine = non-metal AND sulfur = non-metal both correct
- (c) Answer: **Potassium: metal. Silicon: non-metal. Tin: metal. Bromine: non-metal. Magnesium: metal. Sulfur: non-metal.**

Question 13

- (a) **B1** Tube X
- (a) Answer: **Tube X.**
- (b) **B1** Tube Y
- (b) Answer: **Tube Y.**
- (c) **B1** Tube Z, because it contains two different elements chemically joined together in a fixed ratio (repeated throughout), oe
- (c) Answer: **Tube Z, because two different types of atom are joined together in a fixed ratio throughout.**

Question 14

- (a) **B1** a substance made of only one type of atom, oe
- (a) Answer: **A substance made of only one type of atom.**
- (b) **B1** two or more different elements chemically joined together in fixed proportions, oe
- (b) Answer: **Two or more different elements chemically joined together in fixed proportions.**
- (c) **B1** two or more substances that are not chemically joined together and can be present in variable proportions, oe
- (c) Answer: **Two or more substances not chemically joined together, which can be present in variable proportions.**

Question 15

- (a) **B1** true cao
- (a) Answer: **True**
- (b) **B1** false cao
- (b) Answer: **False**
- (c) **B1** true cao
- (c) Answer: **True**

Question 16

- (a) **B1** copper is a good conductor of electricity
- (a) **B1** copper is also ductile, so it can be drawn out into long thin wires, oe
- (a) Answer: **Copper is a good electrical conductor and is ductile, so it can be drawn into long thin wires.**
- (b) **B1** it is a hard, strong solid, oe
- (b) **B1** it is abundant and cheap to obtain (mined as limestone) and does not dissolve easily in rainwater, oe
- (b) Answer: **Calcium carbonate (limestone) is a hard, strong, insoluble solid that is abundant and cheap to obtain, making it well suited to building materials.**

Question 17

- **B1** one safety precaution, e.g. use tongs or a cloth to move the hot evaporating basin, do not touch it with bare hands, or wear safety goggles
- **B1** a reason linked to the hazard, e.g. the basin and its contents are very hot and could cause burns, or hot solution could splash/spit, oe
- Answer: **Use tongs (or a heatproof cloth) to move the hot evaporating basin, because it and the solution inside are hot enough to cause burns.**

Question 18

- **Level 1** (1-2): Simple, isolated statements, e.g. dissolve it and filter it, with little or no reference to the correct order, the physical properties involved, or any purity check.
- **Level 2** (3-4): A logically ordered description covering most stages (dissolving, filtering, evaporating/crystallising) with some reference to physical properties, but the method or the purity check may be incomplete or unclear.
- **Level 3** (5-6): A clear, fully ordered description of crushing, dissolving, filtering, and evaporating to crystallise, with correct scientific explanation of the physical property used at each stage, and a valid purity check (e.g. comparing melting point to the known melting point of pure sodium chloride, or noting that pure crystals melt sharply at one temperature rather than over a range).
- **Indicative content:**
  - Crush the rock salt into small pieces to increase its surface area, then add it to warm water and stir to dissolve the soluble salt, leaving the insoluble rock undissolved.
  - Filter the mixture; the insoluble rock is retained on the filter paper because its particles are too large to pass through the tiny pores, while the salt solution passes through as the filtrate.
  - Gently heat (evaporate) the filtrate, for example in an evaporating basin, to remove some of the water and concentrate the solution.
  - Stop heating before the solution is completely dry and leave it to cool and crystallise slowly, which produces larger, purer salt crystals than evaporating fully.
  - Filter or pick out the crystals and pat them dry, for example between sheets of filter paper.
  - To check purity, measure the melting point of the dried crystals: pure sodium chloride melts sharply at one fixed temperature (801 degrees C), whereas an impure sample would melt over a range of temperatures, often at a lower temperature.
  - Correct overall order: crush, dissolve, filter, evaporate/crystallise, dry, then test melting point.