2.2 Atoms, Elements and Compounds: Test Pack

Calculator allowed · about 65 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Quickfire: circle the correct letter for each question.

(a) Which subatomic particle has no overall electric charge? **(1)**

- ☐ A) Proton
- ☐ B) Neutron
- ☐ C) Electron
- ☐ D) Nucleus

(b) Which of these substances is a compound? **(1)**

- ☐ A) Oxygen gas (O_2)
- ☐ B) Iron (Fe)
- ☐ C) Carbon dioxide (CO_2)
- ☐ D) Air

(c) The atomic number of an atom tells you the number of... **(1)**

- ☐ A) neutrons
- ☐ B) protons
- ☐ C) protons and neutrons added together
- ☐ D) electron shells

(d) Which chemical symbol represents the element sodium? **(1)**

- ☐ A) S
- ☐ B) So
- ☐ C) Na
- ☐ D) N

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2 A mixture contains salt, sand and iron filings, all mixed together as dry solids. Describe, step by step, how you could separate this mixture into three pure, dry substances. In your answer, explain which physical property is used to separate the substances at each stage.

(6)

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3 All atoms are made up of smaller subatomic particles.

(a) Name the three subatomic particles found inside an atom. **(3)**

(b) State where the protons and neutrons are located within an atom. **(1)**

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4 The periodic table arranges all known elements into groups (vertical columns) and periods (horizontal rows).

(a) State what elements in the same group of the periodic table have in common, and state what the period number of an element tells you about its atoms. **(2)**

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

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5 State the number of atoms of each element present in the following formulas.

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

(b) State the number of atoms of each element in one formula unit of ammonium sulfate, $(NH_4)_2SO_4$. **(2)**

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6 Balance each symbol equation below by writing the correct numbers in front of the formulas where needed.

(a) Balance: $Ca + O_2 \rightarrow CaO$ **(2)**

(b) Balance: $H_2 + Cl_2 \rightarrow HCl$ **(2)**

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7 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)**

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8 Define each of these three terms.

(a) Element **(1)**

(b) Compound **(1)**

(c) Mixture **(1)**

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9 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)

10 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.

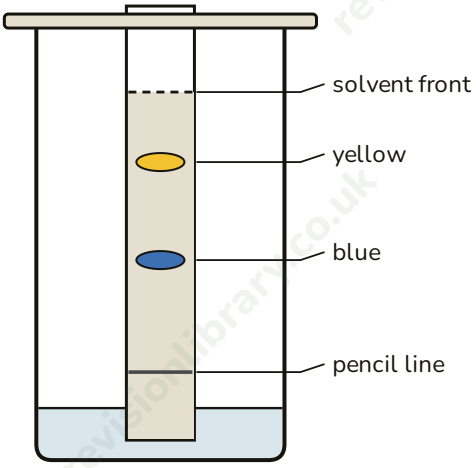
(a) Calculate the relative formula mass (Mr) of ammonia, NH_3. **(2)**

(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)**

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11 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)**

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Mark scheme · 2.2 Atoms, Elements and Compounds: Test Pack

Question 1

(a) B (neutron) cao **B1**

(a) Answer: **B) Neutron**

(b) C (carbon dioxide) cao **B1**

(b) Answer: **C) Carbon dioxide (CO_2)**

(c) B (protons) cao **B1**

(c) Answer: **B) protons**

(d) C (Na) cao **B1**

(d) Answer: **C) Na**

Question 2

Level 1 Simple, isolated statements about separating the mixture, e.g. use a magnet and/or filter it, with little or no reference to the physical properties involved. Steps may be incomplete or in the wrong order. **1-2**

Level 2 A logically ordered description covering most of the separation stages, with some reference to physical properties (e.g. magnetism, solubility), but explanations may be incomplete or one stage may be missing or unclear. **3-4**

Level 3 A clear, logical, fully ordered description of all three separation stages (removing iron, separating sand from salt solution, recovering dry salt) with correct scientific explanation of the physical property used at each stage. **5-6**

Indicative content:

- Use a magnet to attract and remove the iron filings from the dry mixture, because iron is magnetic and sand and salt are not (magnetism).
- Add water to the remaining sand and salt mixture and stir; the salt dissolves in the water because it is soluble, but the sand does not dissolve because it is insoluble.
- Filter the mixture; the insoluble sand 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.
- Allow or gently dry the sand collected on the filter paper to obtain pure, dry sand.
- Gently evaporate the filtrate (salt solution), for example using an evaporating basin, until all the water has evaporated and dry salt crystals remain.
- Correct overall order: magnet first, then dissolve and filter, then evaporate.
- May mention heating gently towards the end of evaporation to avoid spitting or decomposing the salt.

Question 3

(a) proton **B1**

(a) neutron **B1**

(a) electron (any order) **B1**

(a) Answer: **Proton, neutron, electron (any order).**

(b) in the nucleus (centre of the atom) oe **B1**

(b) Answer: **In the nucleus, at the centre of the atom.**

Question 4

(a) elements in the same group have the same number of electrons in their outer shell, giving similar chemical properties oe **B1**

(a) the period number equals the number of electron shells (energy levels) occupied by electrons oe **B1**

(a) Answer: **Same group = same number of outer-shell electrons (similar chemical properties). Period number = number of electron shells occupied.**

(b) group 7 **B1**

(b) period 3 **B1**

(b) Answer: **Group 7, Period 3.**

Question 5

(a) 6 carbon atoms **B1**

(a) 12 hydrogen atoms **B1**

(a) 6 oxygen atoms **B1**

(a) Answer: **6 carbon atoms, 12 hydrogen atoms and 6 oxygen atoms.**

(b) 2 nitrogen atoms and 8 hydrogen atoms (from the 2 NH_4 groups) **B1**

(b) 1 sulfur atom and 4 oxygen atoms **B1**

(b) Answer: **2 nitrogen atoms, 8 hydrogen atoms, 1 sulfur atom and 4 oxygen atoms.**

Question 6

(a) 2Ca and 2CaO correctly placed **M1**

(a) $2Ca + O_2$ -> 2CaO fully balanced cao **A1**

(a) Answer: **$2Ca + O_2$ -> 2CaO**

(b) 2HCl correctly placed on the right **M1**

(b) $H_2 + Cl_2$ -> 2HCl fully balanced cao **A1**

(b) Answer: **$H_2 + Cl_2$ -> 2HCl**

Question 7

(a) both are atoms of carbon with the same number of protons (6), i.e. the same atomic number **B1**

(a) they have different numbers of neutrons **B1**

(a) this gives them different mass numbers (12 and 14), oe **B1**

(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) 8 cao (ft candidate's own atomic number of carbon from (a) if consistent) **B1**

(b) Answer: **8 neutrons.**

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Question 8

(a) a substance made of only one type of atom, oe **B1**

(a) Answer: **A substance made of only one type of atom.**

(b) two or more different elements chemically joined together in fixed proportions, oe **B1**

(b) Answer: **Two or more different elements chemically joined together in fixed proportions.**

(c) two or more substances that are not chemically joined together and can be present in variable proportions, oe **B1**

(c) Answer: **Two or more substances not chemically joined together, which can be present in variable proportions.**

Question 9

Level 1 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. **1-2**

Level 2 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. **3-4**

Level 3 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). **5-6**

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°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.

Question 10

(a) 14 + (1 x 3) **M1**

(a) = 17 cao **A1**

(a) Answer: **Mr(NH_3) = 17**

(b) identifies 2 H, 1 S and 4 O atoms from the formula **M1**

(b) (1 x 2) + 32 + (16 x 4) **M1**

(b) = 98 cao **A1**

(b) Answer: **Mr(H_2SO_4) = 98**

(c) identifies 6 C, 12 H and 6 O atoms from the formula **M1**

(c) (12 x 6) + (1 x 12) + (16 x 6) **M1**

(c) = 180 cao **A1**

(c) Answer: **Mr($C_6H_{12}O_6$) = 180**

Question 11

(a) (paper) chromatography cao **B1**

(a) Answer: **Paper chromatography.**

(b) 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 **B1**

(b) Answer: **The green colouring is a mixture of at least two different dyes, not a single pure colouring.**

(c) Rf = distance moved by spot / distance moved by solvent = 6.0 / 8.0 **M1**

(c) = 0.75 cao **A1**

(c) Answer: **0.75**

(d) 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 **B1**

(d) Answer: **The two dyes are carried different distances because they have different solubility in water and different attraction to the paper.**

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