2.2 Atoms, Elements and Compounds: 2-hour Pack

Calculator allowed · about 120 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Classify each of these elements as a metal or a non-metal: potassium, phosphorus, silver, neon, iron, bromine.

(3)

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2 When 12 g of carbon is completely burned in oxygen, 44 g of carbon dioxide gas is produced. Calculate the mass of oxygen that must have reacted with the carbon, using the idea of conservation of mass.

(3)

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3 Dry air is a mixture of gases. The table shows the approximate percentage by volume of four of the gases in dry air. The remainder is made up of other gases.

Gas	Percentage by volume (%)
nitrogen (N_2)	78
oxygen (O_2)	21
argon (Ar)	0.9
carbon dioxide (CO_2)	0.04

(a) Calculate the percentage of dry air made up of 'other gases'. **(2)**

.....

(b) Classify nitrogen (N_2), argon (Ar) and carbon dioxide (CO_2) as an element or a compound. **(3)**

(c) State why 'air' itself is described as a mixture rather than a compound. **(1)**

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4 Iron filings and powdered sulfur are mixed together and then heated strongly. They react to form the compound iron sulfide.

(a) Write a word equation for this reaction. **(2)**

(b) The symbol equation for this reaction is Fe + S -> FeS. State whether this equation needs balancing, and explain your reasoning. **(2)**

5 Rock salt is a naturally occurring mixture of salt (sodium chloride) and insoluble rocky material (mostly sand and grit). A technician wants to obtain pure, dry salt crystals from 40 g of rock salt.

(a) Below are four steps from the method, listed in the wrong order. 1: Filter the mixture to remove the insoluble rock. 2: Crush the rock salt into small pieces using a pestle and mortar. 3: Gently evaporate the filtrate until dry salt crystals remain. 4: Add water and stir well to dissolve the salt. Write the four steps in the correct order. **(4)**

(b) Explain why the rock salt is crushed before adding water. **(1)**

(c) The technician recovers 34.2 g of dry salt crystals from the 40 g of rock salt. Calculate the percentage of the original 40 g mass that was recovered as salt crystals. **(2)**

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6 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 (NH_3)
- ☐ 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

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7 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)**

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8 Metals and non-metals have different physical properties.

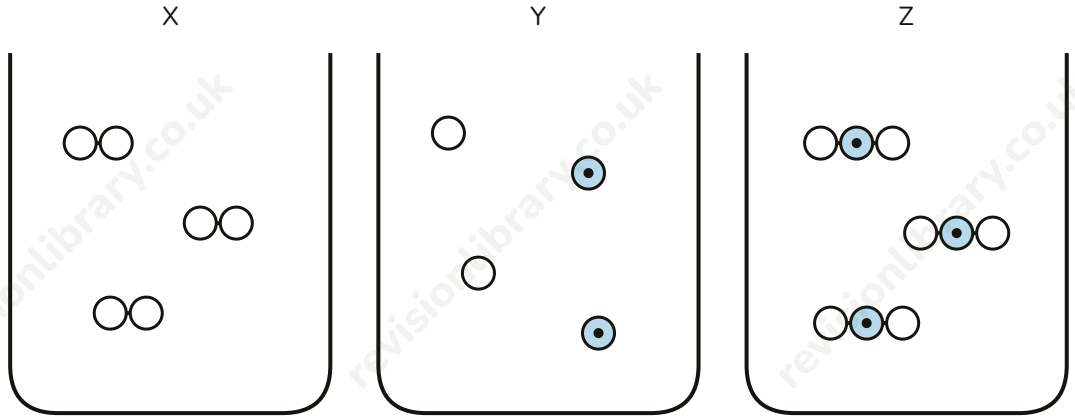
(a) State two physical properties that most metals share. **(2)**

(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)**

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9 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.



Counts and positions are schematic.

(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)**

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10 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)**

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11 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 two reasons why calcium carbonate is suitable for use in building materials such as cement. **(2)**

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12 During crystallisation, a hot evaporating basin of concentrated salt solution is heated gently over a water bath. State one safety precaution for this step and give a reason.

(2)

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13 Atomic number = number of protons. Mass number = number of protons + neutrons. Use this to work out the particle numbers 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)**

.....

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14 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)**

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15 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)**

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

(a) Balance: $Zn + HCl \rightarrow ZnCl_2 + H_2$ **(2)**

(b) Balance: $K + Cl_2 \rightarrow KCl$ **(2)**

(c) Balance: $Zn + S \rightarrow ZnS$ **(2)**

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17 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)**

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18 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)**

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Mark scheme · 2.2 Atoms, Elements and Compounds: 2-hour Pack

Question 1

potassium = metal AND silver = metal both correct **B1**

iron = metal AND phosphorus = non-metal both correct **B1**

neon = non-metal AND bromine = non-metal both correct **B1**

Answer: **Potassium: metal. Phosphorus: non-metal. Silver: metal. Neon: non-metal. Iron: metal. Bromine: non-metal.**

Question 2

no atoms are created or destroyed in a chemical reaction, so total mass of reactants = total mass of products, oe **B1**

mass of oxygen = 44 - 12 **M1**

= 32 g cao **A1**

Answer: **32 g**

Question 3

(a) 78 + 21 + 0.9 + 0.04 = 99.94 **M1**

(a) 100 - 99.94 = 0.06% cao **A1**

(a) Answer: **0.06%**

(b) nitrogen = element **B1**

(b) argon = element **B1**

(b) carbon dioxide = compound **B1**

(b) Answer: **Nitrogen: element. Argon: element. Carbon dioxide: compound.**

(c) the gases are not chemically combined/bonded together and can be present in variable proportions, oe **B1**

(c) Answer: **The gases in air are not chemically combined and their proportions can vary.**

Question 4

(a) iron + sulfur -> **B1**

(a) -> iron sulfide **B1**

(a) Answer: **iron + sulfur -> iron sulfide**

(b) no, it does not need balancing (it is already balanced) **B1**

(b) there is 1 iron atom and 1 sulfur atom on each side of the equation, oe **B1**

(b) Answer: **No, it is already balanced: 1 iron atom and 1 sulfur atom appear on each side.**

Question 5

(a) step 2 first (crush the rock salt) **B1**

(a) step 4 second (add water and stir) **B1**

(a) step 1 third (filter) **B1**

(a) step 3 fourth (evaporate) ft consistent logical order **B1**

(a) Answer: **2, 4, 1, 3**

(b) crushing increases the surface area of the rock salt, so it dissolves more quickly/completely, oe **B1**

(b) Answer: **Crushing increases the surface area of the rock salt, so the salt dissolves more quickly and completely.**

(c) 34.2 / 40 **M1**

(c) x 100 = 85.5% cao **A1**

(c) Answer: **85.5%**

Question 6

(a) C (K) cao **B1**

(a) Answer: **C) K**

(b) D (Fe) cao **B1**

(b) Answer: **D) Fe**

(c) A (copper) cao **B1**

(c) Answer: **A) copper (Cu)**

(d) C cao **B1**

(d) Answer: **C) protons and neutrons added together**

Question 7

(a) the iron and carbon are not chemically joined (bonded) together, oe **B1**

(a) the proportions can be varied and each substance keeps its own individual properties, oe **B1**

(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) 850 x 0.02 (or 850 x 2/100) **M1**

(b) = 17 kg cao **A1**

(b) Answer: **17 kg**

Question 8

(a) any one from: good conductor of electricity/heat, shiny (lustrous), malleable, ductile, high melting/boiling point, high density, sonorous, strong or hard **B1**

(a) any second correct property from the list above **B1**

(a) Answer: **Any two of: good electrical/thermal conductor, shiny, malleable, ductile, high melting/boiling point, high density, sonorous, strong or hard.**

(b) any one from: poor conductor of electricity/heat (insulator), dull appearance, brittle when solid, low melting/boiling point, low density **B1**

(b) any second correct property from the list above **B1**

(b) Answer: **Any two of: poor electrical/thermal conductor, dull, brittle when solid, low melting/boiling point, low density.**

(c) potassium = metal AND tin = metal both correct **B1**

(c) magnesium = metal AND silicon = non-metal (accept metalloid or semi-metal for silicon) both correct **B1**

(c) bromine = non-metal AND sulfur = non-metal both correct **B1**

(c) Answer: **Potassium: metal. Silicon: non-metal (a metalloid or semi-metal is also accepted). Tin: metal. Bromine: non-metal. Magnesium: metal. Sulfur: non-metal.**

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Question 9

(a) Tube X **B1**

(a) Answer: **Tube X.**

(b) Tube Y **B1**

(b) Answer: **Tube Y.**

(c) Tube Z, because it contains two different elements chemically joined together in a fixed ratio (repeated throughout), oe **B1**

(c) Answer: **Tube Z, because two different types of atom are joined together in a fixed ratio throughout.**

Question 10

(a) true cao **B1**

(a) Answer: **True**

(b) false cao **B1**

(b) Answer: **False**

(c) true cao **B1**

(c) Answer: **True**

Question 11

(a) copper is a good conductor of electricity **B1**

(a) copper is also ductile, so it can be drawn out into long thin wires, oe **B1**

(a) Answer: **Copper is a good electrical conductor and is ductile, so it can be drawn into long thin wires.**

(b) it is a hard, strong solid, oe **B1**

(b) it is abundant and cheap to obtain (mined as limestone) and does not dissolve easily in rainwater, oe **B1**

(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 12

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 **B1**

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 13

(a) protons = 3, electrons = 3 **B1**

(a) neutrons = 7 - 3 = 4 cao **B1**

(a) Answer: **Protons = 3, electrons = 3, neutrons = 4.**

(b) protons = 13, electrons = 13 **B1**

(b) neutrons = 27 - 13 = 14 cao **B1**

(b) Answer: **Protons = 13, electrons = 13, neutrons = 14.**

(c) protons = 35, electrons = 35 **B1**

(c) neutrons = 80 - 35 = 45 cao **B1**

(c) Answer: **Protons = 35, electrons = 35, neutrons = 45.**

Question 14

(a) group 1 **B1**

(a) period 4 **B1**

(a) Answer: **Group 1, Period 4.**

(b) group 0 (or group 8), accept either label **B1**

(b) period 3 **B1**

(b) Answer: **Group 0 (Group 8), Period 3.**

Question 15

(a) 1 nitrogen atom **B1**

(a) 3 hydrogen atoms **B1**

(a) Answer: **1 nitrogen atom and 3 hydrogen atoms.**

(b) 2 hydrogen atoms and 1 sulfur atom **B1**

(b) 4 oxygen atoms **B1**

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

(c) 6 carbon atoms **B1**

(c) 12 hydrogen atoms **B1**

(c) 6 oxygen atoms **B1**

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

Question 16

(a) 2HCl correctly placed on the left **M1**

(a) Zn + 2HCl -> $ZnCl_2$ + H_2 fully balanced cao **A1**

(a) Answer: **Zn + 2HCl -> $ZnCl_2$ + H_2**

(b) 2K on the left and 2KCl on the right **M1**

(b) 2K + Cl_2 -> 2KCl fully balanced cao **A1**

(b) Answer: **2K + Cl_2 -> 2KCl**

(c) recognises the equation is already balanced with 1 Zn and 1 S on each side **M1**

(c) Zn + S -> ZnS (no extra numbers needed) cao **A1**

(c) Answer: **Zn + S -> ZnS**

Question 17

(a) physical cao **B1**

(a) Answer: **Physical**

(b) chemical cao **B1**

(b) Answer: **Chemical**

(c) chemical cao **B1**

(c) Answer: **Chemical**

(d) physical cao **B1**

(d) Answer: **Physical**

(e) chemical cao **B1**

(e) Answer: **Chemical**

(f) physical cao **B1**

(f) Answer: **Physical**

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Question 18

(a) diffusion cao **B1**

(a) Answer: **Diffusion.**

(b) dissolved potassium permanganate particles move constantly and randomly in the water **M1**

(b) 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 **A1**

(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) it would spread faster, because the particles have more energy and move faster in warmer water, oe **B1**

(c) Answer: **It would spread faster, because the particles have more kinetic energy and move faster at a higher temperature.**

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