2.13 The Periodic Table: Groups and Trends: 1-hour Pack

AQA 8464 · Calculator allowed · about 60 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 This question is about the layout of the modern periodic table. Complete each sentence.

(a) The horizontal rows of the periodic table are called _____. **(1)**

(b) The vertical columns of the periodic table are called _____. **(1)**

(c) Elements in the same group have the same number of _____. **(1)**

(d) Approximately what proportion of all the elements in the periodic table are metals? **(1)**

(Total for Question 1 is 4 marks)

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2 The halogens (Group 7) become less reactive as you go down the group.

(a) State how the reactivity of the halogens changes down Group 7. **(1)**

(b) Explain this trend in terms of atomic size and the distance of the outer shell from the nucleus. **(2)**

(Total for Question 2 is 3 marks)

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3 Freya carries out the required practical investigating the rate of a reaction, using the reaction between small pieces of Group 1 metals and water. She measures the volume of hydrogen gas produced over time using a gas syringe, in order to compare the reactivity of lithium and potassium.

Table 3

Time (s)	0	10	20	30	40
Volume of gas from lithium (cm3)	0	6	11	15	18
Volume of gas from potassium (cm3)	0	18	30	38	42

(a) Identify one hazard in this practical and state a control measure Freya should use to reduce the risk. **(2)**

(b) State two variables that should be kept the same for this to be a fair test. **(2)**

(c) Using Table 3, calculate the mean rate of gas production for potassium between 0 and 20 seconds. **(2)**

.....

(d) Using Table 3, explain how the results support the trend that reactivity increases down Group 1. **(1)**

(Total for Question 3 is 7 marks)

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4 John Newlands arranged the known elements in order of atomic weight in 1864.

(a) Describe the pattern Newlands identified in his 'Law of Octaves'. **(1)**

(b) Give two reasons why other scientists did not accept Newlands' table. **(2)**

(Total for Question 4 is 3 marks)

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5 Table 5 shows the results when solutions of three unknown halogens, X, Y and Z, are each added to potassium chloride, potassium bromide and potassium iodide solutions (R = reaction/colour change seen, NR = no reaction).

Halogen added	+ KCl(aq)	+ KBr(aq)	+ KI(aq)
X	NR	R	R
Y	NR	NR	R
Z	NR	NR	NR

(a) Use the results in Table 5 to place X, Y and Z in order of reactivity, most reactive first. **(1)**

(b) Explain your answer to (a), using the results in Table 5. **(2)**

(c) Suggest which real halogen X could be, giving a reason for your answer. **(1)**

(Total for Question 5 is 4 marks)

6 Compare and explain the trends in reactivity down Group 1 (the alkali metals) and down Group 7 (the halogens).

(Total for Question 6 is 6 marks)

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7 Tellurium (Te) has a relative atomic mass of 127.6 and an atomic number of 52. Iodine (I) has a relative atomic mass of 126.9 and an atomic number of 53.

(a) Explain why iodine is placed after tellurium in the modern periodic table, even though iodine has a lower relative atomic mass. **(2)**

(b) State one advantage of arranging the periodic table by atomic number rather than atomic mass. **(1)**

(Total for Question 7 is 3 marks)

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8 Potassium reacts vigorously when a small piece is added to water.

(a) Balance the symbol equation for this reaction: ___K(s) + ___H2O(l) -> ___KOH(aq) + ___H2(g) **(2)**

(b) State three observations you would expect to make when potassium reacts with water. **(3)**

(Total for Question 8 is 5 marks)

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9 Aaliyah carries out flame tests as part of the required practical 'Identification of ions by chemical and flame tests', to help identify the metal in four unlabelled compounds, W, X, Y and Z.

(a) Describe how Aaliyah should carry out a flame test on one of the samples. **(3)**

(b) Explain why the wire loop is first dipped in dilute hydrochloric acid and held in the flame until it produces no colour, before each new sample is tested. **(2)**

(c) Table 2 shows known flame colours: lithium = crimson/red, sodium = yellow/orange, potassium = lilac. Aaliyah observes that sample W gives a lilac flame and sample X gives a yellow/orange flame. Identify the metal present in sample W and in sample X. **(2)**

(Total for Question 9 is 7 marks)

10 A student titrates a solution of hydrochloric acid with sodium hydroxide. The student records mean titre 25.40 cm^3 and uses 0.100 mol/dm3 NaOH. Calculate the number of moles of NaOH used in the titre. (1 dm3 = 1000 cm^3).

(Total for Question 10 is 3 marks)

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Mark scheme · 2.13 The Periodic Table: Groups and Trends: 1-hour Pack

Question 1

(a) periods **B1**

(a) Answer: Periods

(b) groups **B1**

(b) Answer: Groups

(c) electrons in their outer shell (outer electrons) oe **B1**

(c) Answer: Electrons in their outer shell

(d) the majority / more than three-quarters (accept any reasonable estimate over half) oe **B1**

(d) Answer: The majority of elements (more than about three-quarters) are metals

Question 2

(a) reactivity decreases down the group **B1**

(a) Answer: Reactivity decreases down Group 7

(b) atoms get larger down the group (more electron shells), so the outer shell, where an extra electron would be gained, is further from the nucleus and more shielded (oe) **M1**

(b) this means there is a weaker force of attraction for the incoming electron, so it is harder to gain an electron, making the halogen less reactive (oe) **A1**

(b) Answer: Atoms get larger down the group, so the outer shell is further from the nucleus and more shielded; the weaker attraction for an incoming electron means it is harder to gain, so reactivity decreases

Question 3

(a) hazard: hydrogen gas produced is flammable, and/or the potassium may ignite or spit (oe) **M1**

(a) control measure: keep naked flames away from the apparatus, and/or use a safety screen and only a small piece of metal (oe) **A1**

(a) Answer: Hazard: flammable hydrogen gas (and potassium may ignite/spit). Control: keep flames away, use a safety screen and only a small piece of metal

(b) the volume of water used each time **B1**

(b) the size/mass (surface area) of the piece of metal used each time **B1**

(b) Answer: Any two of: volume of water, size/mass of the metal piece, temperature of the water

(c) correct substitution: rate = volume / time = 30 / 20 **M1**

(c) 1.5 cm^3/s (allow cm3 s^{-1}) cao **A1**

(c) Answer: 1.5 cm^3/s

(d) potassium produces gas faster than lithium (a greater volume of gas in the same amount of time / steeper initial rate), showing potassium reacts more quickly/vigorously, which supports potassium being more reactive than lithium (oe) **B1**

(d) Answer: Potassium produces gas much faster than lithium (e.g. 30 cm^3 vs 11 cm^3 at 20 s), showing it reacts more vigorously, supporting the trend that reactivity increases down Group 1

Question 4

(a) every eighth element had similar properties to the first (oe) **B1**

(a) Answer: Every eighth element in his table had similar properties

(b) one correct reason, from: the pattern only worked for the first few rows / broke down after calcium (oe); some groups contained elements with very different properties, e.g. iron placed in the same group as oxygen and sulfur (oe); no gaps were left for elements that had not yet been discovered (oe) **B1**

(b) a second, different correct reason from the same list (any two of the three reasons for full marks; do not credit the same reason twice) **B1**

(b) Answer: Any two of: the pattern broke down after the first twenty or so elements; some groups mixed together elements with very different properties (e.g. metals and non-metals); no gaps were left for undiscovered elements

Question 5

(a) X, then Y, then Z (most to least reactive) cao **B1**

(a) Answer: X > Y > Z

(b) X displaces halide ions from both potassium bromide and potassium iodide, so X must be more reactive than the halogens already combined in both of these salts; Y only displaces from potassium iodide, so Y is less reactive than X but more reactive than Z (any valid comparison) oe **M1**

(b) none of X, Y or Z reacts with potassium chloride, showing that none of them is more reactive than the halogen already in that salt, i.e. all three are the same as or less reactive than that halogen (oe) **A1**

(b) Answer: X displaces halide ions from both KBr and KI, showing it is the most reactive; Y only displaces from KI, so is next most reactive; Z displaces neither, so is least reactive. None displaces from KCl, showing none is more reactive than the halogen already present in it

(c) chlorine, because it is the most reactive of the three unknowns and, like X, chlorine is known to displace both bromide and iodide ions from solution (oe, allow ecf for a reasoned alternative consistent with the data) **B1**

(c) Answer: X could be chlorine, as chlorine is known to displace both bromide and iodide ions from solution, matching the reactivity pattern shown by X

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Question 6

Level 3 A clear, detailed and accurate comparison of both trends, correctly explaining each in terms of atomic size and electron shells, with the opposite direction of the two trends clearly identified and explained (metals lose an electron, halogens gain one). **5-6**

Level 2 The trend for at least one group is described and explained in terms of atomic size/electron shells; some comparison between the two groups is attempted but may be incomplete or only partly correct. **3-4**

Level 1 Simple statement(s) of the trend(s) (e.g. Group 1 becomes more reactive, Group 7 becomes less reactive down the group), with little or no linked explanation. **1-2**

Level 0 No relevant content. **0**

Indicative content:

- Group 1: reactivity increases down the group.
- Group 1 atoms get larger down the group (more electron shells).
- The single outer electron is further from the nucleus and more shielded, so it is held less strongly / the attraction between the nucleus and outer electron is weaker.
- This makes the outer electron easier to lose, so Group 1 metals react more readily going down the group (e.g. potassium reacts more vigorously with water than lithium).
- Group 7: reactivity decreases down the group.
- Group 7 atoms get larger down the group (more electron shells).
- The outer shell, where an extra electron would be gained, is further from the nucleus and more shielded.
- This makes it harder to attract and gain an extra electron, so Group 7 elements react less readily going down the group (e.g. chlorine can displace bromine and iodine from solution, but iodine can displace neither).
- The two trends are in opposite directions because Group 1 elements react by losing an electron, which becomes easier further from the nucleus, whereas Group 7 elements react by gaining an electron, which becomes harder further from the nucleus.

Question 7

(a) the modern periodic table is arranged in order of increasing atomic (proton) number, not atomic mass (oe) **M1**

(a) iodine has a higher atomic number than tellurium (53 compared with 52), so it is placed after tellurium despite having a slightly lower atomic mass (oe) **A1**

(a) Answer: The table is ordered by atomic number, and iodine (53) has a higher atomic number than tellurium (52), so it comes after tellurium despite its slightly lower atomic mass

(b) elements with similar properties are grouped together correctly / avoids anomalies where the mass order would separate similar elements (oe) **B1**

(b) Answer: Elements with similar chemical properties are correctly grouped together, avoiding the anomalies that atomic mass order would cause

Question 8

(a) $2K(s) + 2H_2O(l)$ -> $2KOH(aq) + ...$ (correct coefficients for K and H_2O) **M1**

(a) ... -> $2KOH(aq) + H_2(g)$, fully balanced cao **A1**

(a) Answer: $2K(s) + 2H_2O(l)$ -> $2KOH(aq) + H_2(g)$

(b) fizzing/effervescence as hydrogen gas is given off (oe) **B1**

(b) the potassium moves rapidly across the surface of the water (oe) **B1**

(b) the potassium ignites, giving a lilac flame, and/or a pop or crackling sound is heard (any one) oe **B1**

(b) Answer: Any three of: fizzing/bubbles of gas; the potassium moves/skates across the surface; a lilac flame and/or popping sound as it ignites; the solution formed turns universal indicator purple (alkaline)

Question 9

(a) dip a clean nichrome (or platinum) wire loop into the sample (as a solid, paste or solution) (oe) **M1**

(a) hold the wire in the clear/blue part of a roaring (fully open air-hole) Bunsen flame (oe) **M1**

(a) observe and record the colour of the flame produced **A1**

(a) Answer: Dip a clean wire loop in the sample, hold it in the roaring blue flame of a Bunsen burner, and observe the colour produced

(b) this cleans the wire and removes any residue left over from the previous sample (oe) **M1**

(b) so that the colour seen for the new sample is not contaminated by a previous result, keeping the identification valid/reliable (oe) **A1**

(b) Answer: It cleans off any residue from the last sample, so the flame colour observed is only due to the new sample and the result is valid

(c) W contains potassium (lilac flame) **B1**

(c) X contains sodium (yellow/orange flame) **B1**

(c) Answer: W = potassium, X = sodium

Question 10

convert volume to dm3 and substitute: n = 0.100 x (25.40/1000) **M1**

0.00254 mol cao **A1**

includes correct units mol **B1**

Answer: 0.00254 mol

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