RADLEY

Academic Scholarship 2019

Chemistry

Time allowed – 30 Minutes

Use pencil for the drawing of the graph. You do not need a calculator.

Total marks: 35

Name: ……..…….

This paper is about the element lanthanum and a group of elements called the halogens.

1 Read the following passage about the element Lanthanum. Then, answer the questions below.

Lanthanum, chemical symbol La, is element number 57 in the Periodic Table. Its name derives from the Greek verb lanthanein, meaning to lie hidden. Its melting-point is 921°C and its boiling-point is 3457°C. It is a metallic element and does not occur in Nature as the pure metal like some other metals. Instead, it occurs in the form of various ores. One of these is called Bastnasite and has the formula $LaCO_3F$. The extraction of lanthanum can involve several possible complex processes. In one of these, lanthanum chloride, $LaCl_3$, is formed and this is then heated with lithium (Li) metal. This is done in a so-called inert atmosphere. The reaction can be described by the following equation:

$$\boldsymbol{LaCl_3 + 3\,Li \rightarrow 3\,LiCl + La}$$

Lanthanum has a shiny appearance; however, when exposed to the air, even at room temperature, it readily oxidises. The metal and its compounds have a variety of uses. For example, it forms certain alloys, which are able to absorb large volumes of hydrogen gas.

a) Why do you think the metal might be named after the Greek verb *lanthanein*?

[1]

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b) At 1000℃ would lanthanum be a solid, liquid or gas? Explain your answer.

[2]

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c) Which might be the more reactive metal, lanthanum or gold? Explain your answer.

[2]

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d) Is Bastnasite a compound or a mixture? Explain your answer.

[2]

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e) How many different elements are there in the formula of Bastnasite? Now list them by name.

[3]

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f) How many atoms make up one unit of Bastnasite?

[1]

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g) What is an inert atmosphere and why is it needed for the reaction of lanthanum chloride with lithium?

[2]

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h) What might be used for this inert atmosphere? Explain your choice.

[2]

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i) Why is lithium and not copper used in this reaction?

[1]

.....

j) Suggest another metal that could be used to extract lanthanum in this way?

[1]

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k) Lanthanum chloride and lithium chloride are so-called ionic compounds as they consist of ions of opposite charges which attract each other. There is no overall charge on lanthanum chloride or lithium chloride. In lanthanum chloride, $LaCl_3$, the lanthanum is an ion with a charge of 3+ (La^{3+}). What is the charge of chlorine and lithium in LiCl? Explain your answer.

[3]

Charge on chloride: ..... Charge on Lithium: .....

.....

.....

2 At room temperature fluorine and chlorine are both gases, whereas bromine is a brown liquid and iodine a purple-black solid.

a) A few drops of bromine were placed into a test tube and the test tube was stoppered. State what you will **see** after a few hours. Explain your observation.

[2]

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b) When iodine is placed in a test tube as before, a purple vapour can be seen developing, but no liquid is formed. What do you call this process?

[1]

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c) Explain the arrangement and movement of the particles in solid iodine.

[2]

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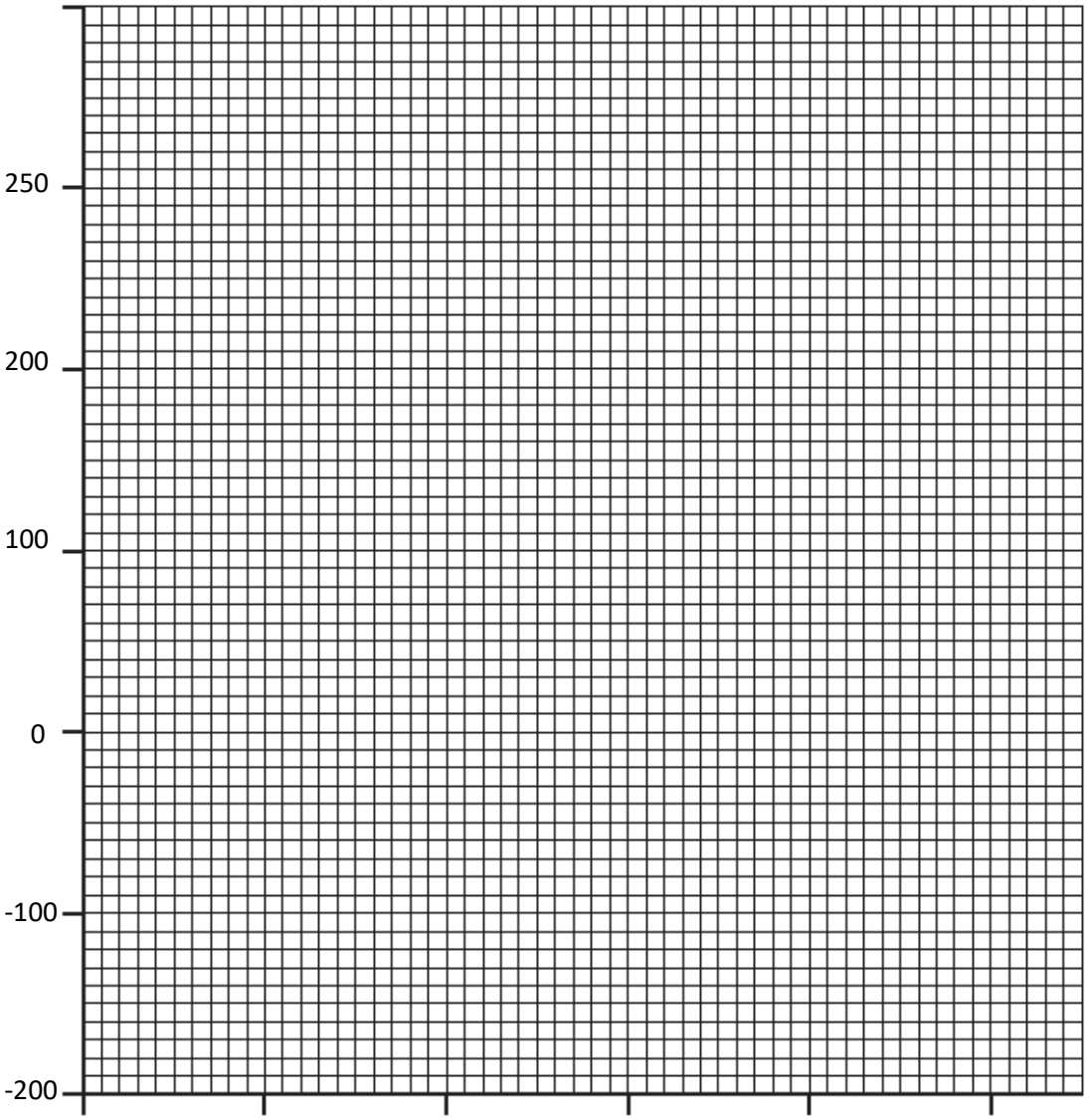
d) The following table gives the boiling point for the halogens. Plot the boiling point against the atomic number on the graph paper below. **Ensure that your graph is fully labelled.**

[4]

element	**atomic number**	**boiling point / °C**
fluorine	9	- 190
chlorine	17	-30
bromine	35	60
iodine	54	180
astatine	85	?



(i) Draw a line of best fit through your data points. [1]

(ii) Estimate the boiling point for astatine. Draw construction lines.

Boiling point of astatine: ……^{o}C. [2]

(iii) How would you separate a mixture of the four halogens fluorine, chlorine, bromine and iodine.

[3]

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End of Paper