## The Periodic Table – 2019 June

**1.** 0620/31/M/J/19/No.4

This question is about iodine and compounds of iodine.

**(a)** Use the kinetic particle model to describe the separation between the molecules and the type of motion of the molecules in:

- solid iodine .....

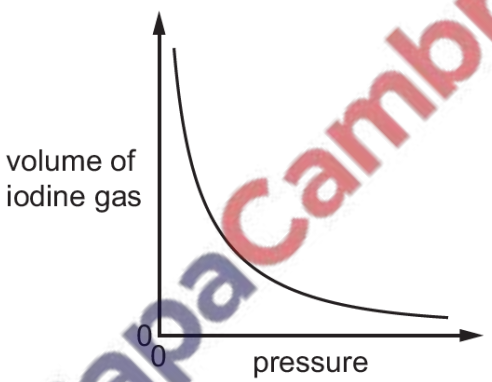
.....

- iodine gas. .....

.....

[4]

**(b)** The graph shows how the volume of iodine gas changes with pressure. The temperature is kept constant.




Describe how the volume of iodine gas changes with pressure.

.....

..... [1]

**(c)** **(i)** Complete the word equation to show the halogen and halide compound which react to form the products iodine and potassium bromide.

| | | | | | | |
|---|---|---|---|---|---|---|
| ..... | + | ..... ..... | → | iodine | + | potassium bromide |

[2]

**(ii)** Explain, in terms of the reactivity of the halogens, why aqueous iodine does **not** react with aqueous potassium chloride.

.....

..... [1]

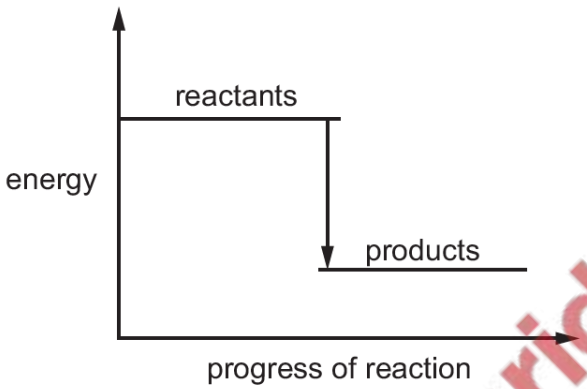
**(d)** Iodine reacts with aqueous sodium thiosulfate, $Na_2S_2O_3$.

**(i)** Balance the chemical equation for this reaction.

$$.....Na_2S_2O_3 + I_2 \rightarrow Na_2S_4O_6 + .....NaI$$

[2]

**(ii)** The energy level diagram for this reaction is shown.




Explain how this diagram shows that the reaction is exothermic.

.....

..... [1]

**(e)** Describe a test for iodide ions.

test .....

observations .....

[2]

**(f)** Molten sodium iodide is electrolysed.

Predict the product at the positive electrode.

..... [1]

[Total: 14]

**2.** 0620/32/M/J/19/No.5

This question is about bromine and compounds of bromine.

**(a)** Use the kinetic particle model to describe the arrangement **and** type of motion of the molecules in:

- liquid bromine .....

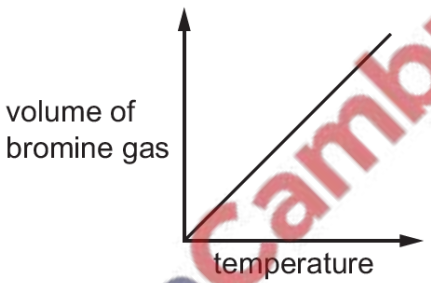
  .....

- bromine gas. .....

  .....

[4]

**(b)** The graph shows how the volume of bromine gas changes with temperature. The pressure is kept constant.




Describe how the volume of the bromine gas changes with temperature.

.....

..... [1]

**(c)** **(i)** Complete the word equation to show the halogen and halide compound which react to form the products bromine and potassium chloride.

| | | | | | | |
|---|---|---|---|---|---|---|
| ..... | + | ..... ..... | → | bromine | + | potassium chloride |

[2]

**(ii)** Explain, in terms of the reactivity of the halogens, why aqueous bromine will **not** react with aqueous potassium chloride.

.....

..... [1]

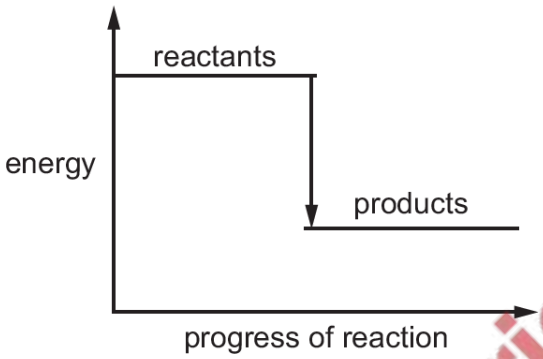
**(d)** Bromine reacts with hydrogen sulfide, $H_2S$.

**(i)** Complete the chemical equation for this reaction.

$$\ldots\ldots + H_2S \rightarrow \ldots\ldots HBr + S$$

[2]

**(ii)** The energy level diagram for this reaction is shown.




Explain how this diagram shows that the reaction is exothermic.

.....

..... [1]

**(e)** Describe a test for bromide ions.

test .....

observations .....

[2]

[Total: 13]

**3.** 0620/33/M/J/19/No.4

This question is about chlorine and compounds of chlorine.

**(a)** Use the kinetic particle model to describe the arrangement **and** type of motion of the molecules in:

- solid chlorine .....

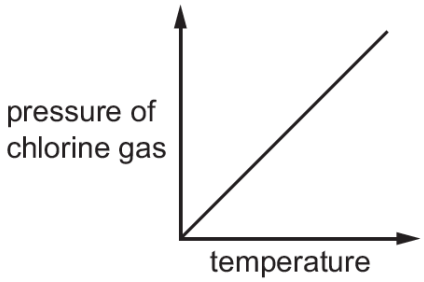
.....

- chlorine gas. .....

.....

[4]

**(b)** The graph shows how the pressure of chlorine gas changes when temperature increases. The volume is kept constant.




Describe how the pressure of the chlorine gas changes with temperature.

.....

..... [1]

**(c)** **(i)** Complete the word equation to show the halogen and halide compound which react to form the products iodine and sodium chloride.

| | | | | | | |
|---|---|---|---|---|---|---|
| ..... | + | ..... ..... | → | iodine | + | sodium chloride |

[2]

**(ii)** Explain, in terms of the reactivity of the halogens, why aqueous bromine will **not** react with aqueous sodium chloride.

.....

..... [1]

**(d)** Chlorine reacts with warm turpentine, $C_{10}H_{16}$.

Balance the chemical equation for this reaction.

$$C_{10}H_{16} + 8Cl_2 \rightarrow .....C + .....HCl$$

[2]

[Total: 10]

**4.** 0620/33/M/J/19/No.8

This question is about Group IV elements and their compounds.

**(a)** Lead compounds are pollutants in the air.

**(i)** State **one** source of lead compounds in the air.

..... [1]

**(ii)** State **one** adverse effect of lead compounds on health.

..... [1]

**(b)** The table shows how easy it is to reduce four metal oxides with carbon.

| metal oxide | ease of reduction with carbon |
|---|---|
| bismuth(III) oxide | reduced by carbon only above 250 °C |
| chromium(III) oxide | reduced by carbon only above 1200 °C |
| lead(II) oxide | reduced by carbon only above 440 °C |
| zinc oxide | reduced by carbon only above 990 °C |

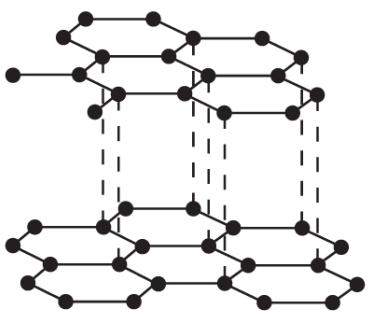
Use the information in the table to put the four metals in order of their reactivity.
Put the least reactive metal first.

least reactive → most reactive

| | | | |
|---|---|---|---|
| | | | |

[2]

**(c)** Part of the structure of graphite is shown.



Use the information from the diagram to explain why graphite is used as a lubricant.

.....

..... [1]

**(d)** When carbon burns in a limited supply of air, a poisonous gas is formed.

Name this gas.

..... [1]

**(e)** When carbon is completely burned in air, carbon dioxide is formed.
Carbon dioxide forms a slightly acidic solution in water.

Which **one** of these pH values is the pH of a slightly acidic solution?
Draw a circle around the correct answer.

pH 6 pH 7 pH 8 pH 10

[1]

**(f)** Carbon dioxide is a greenhouse gas.

**(i)** Name **one** other major greenhouse gas.

..... [1]

**(ii)** State **one** effect that greenhouse gases have on the environment.

..... [1]

[Total: 9]

**5.** 0620/42/M/J/19/No.3

This question is about phosphorus and compounds of phosphorus.

**(a)** Phosphorus has the formula $P_4$. Some properties of $P_4$ are shown.

| | |
|---|---|
| melting point / °C | 45 |
| boiling point / °C | 280 |
| electrical conductivity | non-conductor |
| solubility in water | insoluble |

**(i)** Name the type of bonding that exists between the atoms in a $P_4$ molecule.

..... [1]

**(ii)** Explain, in terms of attractive forces between particles, why $P_4$ has a low melting point.

.....

..... [1]

**(iii)** Explain why phosphorus is a non-conductor of electricity.

.....

..... [1]

**(b)** Phosphorus, $P_4$, reacts with air to produce phosphorus(V) oxide, $P_4O_{10}$.

**(i)** Write a chemical equation for this reaction.

..... [2]

**(ii)** What type of chemical reaction is this?

..... [1]

**(c)** Phosphorus(V) oxide, $P_4O_{10}$, is an acidic oxide.

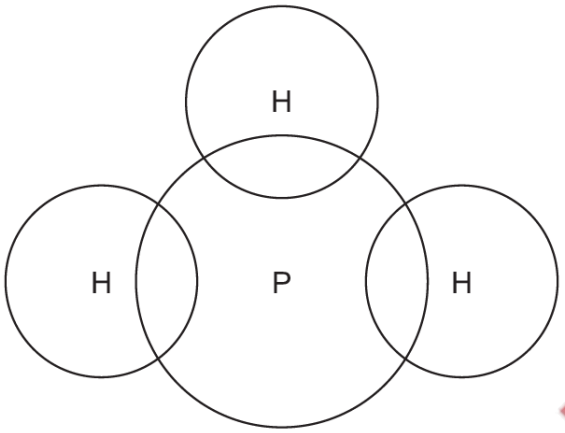
Phosphorus(V) oxide, $P_4O_{10}$, reacts with aqueous sodium hydroxide to form a salt containing the phosphate ion, $PO_4^{3-}$. Water is the only other product.

Write a chemical equation for the reaction between phosphorus(V) oxide and aqueous sodium hydroxide.

..... [2]

**(d)** Phosphine has the formula $PH_3$.

Complete the dot-and-cross diagram to show the electron arrangement in a molecule of phosphine. Show outer shell electrons only.




[2]

**(e)** Phosphine, $PH_3$, has a similar chemical structure to ammonia, $NH_3$.

Ammonia acts as a base when it reacts with sulfuric acid.

**(i)** What is meant by the term *base*?

.....

[1]

**(ii)** Write a chemical equation for the reaction between ammonia and sulfuric acid.

.....

[2]

[Total: 13]

**6.** 0620/42/M/J/19/No.6

The halogens are the elements in Group VII of the Periodic Table.

**(a)** Predict the physical state and colour of astatine at room temperature and pressure.

physical state .....

colour .....

[2]

**(b)** When chlorine reacts with aqueous potassium bromide a displacement reaction occurs.

**(i)** Describe the colour change of the solution.

from ..... to .....

[2]

**(ii)** Write a chemical equation for this reaction.

..... [2]

**(c)** Reactions occur when some aqueous solutions of halogens are added to aqueous solutions of halides.

Use the key to complete the table to show the results of adding halogens to halides.

key
✓ = reaction
✗ = no reaction

| | | halides | | |
|---|---|---|---|---|
| | | KC*l*(aq) | KBr(aq) | KI(aq) |
| halogens | $Cl_2$(aq) | | ✓ | |
| | $Br_2$(aq) | | | |
| | $I_2$(aq) | | | |

[2]

[Total: 8]

**7.** 0620/42/F/M/19/No.1

Period 3 of the Periodic Table is shown.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| sodium | magnesium | aluminium | silicon | phosphorus | sulfur | chlorine | argon |

Answer the following questions using only these elements.
Each element may be used once, more than once or not at all.

State which element:

**(a)** is a gas at room temperature and pressure

..... [1]

**(b)** forms a basic oxide with a formula of the form $X_2O$

..... [1]

**(c)** is made of atoms which have a full outer shell of electrons

..... [1]

**(d)** forms an oxide which causes acid rain

..... [1]

**(e)** is extracted from bauxite

..... [1]

**(f)** forms an oxide which has a macromolecular structure

..... [1]

**(g)** consists of diatomic molecules.

..... [1]

[Total: 7]

**8.** 0620/42/F/M/19/No.3

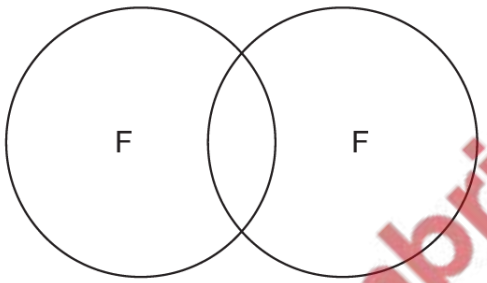
Fluorine is a Group VII element. Fluorine forms compounds with metals and non-metals.

**(a)** Predict the physical state of fluorine at room temperature and pressure.

..... [1]

**(b)** Fluorine exists as diatomic molecules.

Complete the dot-and-cross diagram to show the electron arrangement in a molecule of fluorine. Show outer shell electrons only.




[2]

**(c)** Write a chemical equation for the reaction between sodium and fluorine.

..... [2]

**(d)** Explain why chlorine does **not** react with aqueous sodium fluoride.

.....

..... [1]

**(e)** Tetrafluoromethane and lead(II) fluoride are fluorides of Group IV elements. Some properties of tetrafluoromethane and lead(II) fluoride are shown in the table.

| property | tetrafluoromethane | lead(II) fluoride |
|---|---|---|
| formula | $CF_4$ | |
| melting point / °C | –184 | 855 |
| boiling point / °C | –127 | 1290 |
| conduction of electricity when solid | non-conductor | non-conductor |
| conduction of electricity when molten | non-conductor | good conductor |

**(i)** What is the formula of lead(II) fluoride?

..... [1]

**(ii)** What type of bonding is present between the atoms in tetrafluoromethane?

..... [1]

**(iii)** What type of structure does solid lead(II) fluoride have?

..... [1]

**(iv)** Explain, in terms of attractive forces between particles, why lead(II) fluoride has a much higher melting point than tetrafluoromethane.

In your answer refer to the types of attractive forces between particles and their relative strengths.

.....

.....

.....

..... [3]

**(f)** Tetrafluoroethene is an unsaturated compound with the formula $C_2F_4$.
Tetrafluoroethene is the monomer used to make the polymer poly(tetrafluoroethene).

**(i)** What is meant by the term *unsaturated*?

.....

..... [1]

**(ii)** Describe a test to show that tetrafluoroethene is unsaturated.

test .....

observations .....
[2]

**(iii)** Draw the structure of a molecule of tetrafluoroethene. Show all of the atoms and all of the bonds.

[1]

**(iv)** Tetrafluoroethene can be polymerised to form poly(tetrafluoroethene).

Draw **one** repeat unit of poly(tetrafluoroethene). Show all of the atoms and all of the bonds.

[2]

**(v)** Deduce the empirical formula of:

tetrafluoroethene .....

poly(tetrafluoroethene). .....
[2]

[Total: 20]