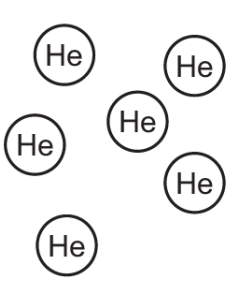
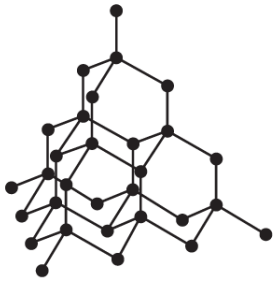
Atoms, Elements and Compounds – 2019 June

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

The diagrams show part of the structures of five substances, **A**, **B**, **C**, **D** and **E**.



A



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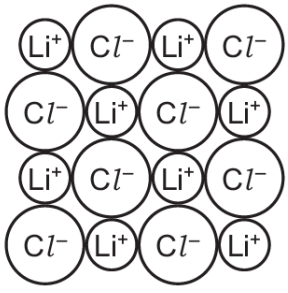
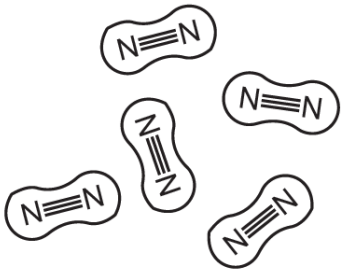
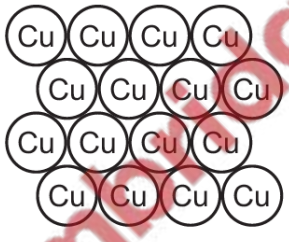


C



D



E

(a) Answer the following questions about these structures.
Each structure may be used once, more than once or not at all.

(i) Which **two** of these structures, **A**, **B**, **C**, **D** or **E**, are covalently bonded?

..... and .....
[2]

(ii) Which **one** of these structures, **A**, **B**, **C**, **D** or **E**, is a diatomic molecule?

..... [1]

(iii) Which **one** of these structures, **A**, **B**, **C**, **D** or **E**, is a compound?

..... [1]

(iv) Which **one** of these structures, **A**, **B**, **C**, **D** or **E**, is very soluble in water?

..... [1]

(v) Which **one** of these structures, **A**, **B**, **C**, **D** or **E**, is used in cutting tools?

..... [1]

(vi) Which **one** of these structures, **A**, **B**, **C**, **D** or **E**, is used in electrical wiring?

..... [1]

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(b) Substance **B** is an element.

What is meant by the term *element*?

.....

..... [1]

[Total: 8]

2. 0620/31/M/J/19/No.3

(a) The table shows the percentage by mass of the elements on Earth and in the Universe.

element	percentage by mass on Earth	percentage by mass in the Universe
helium	0.0	21.0
hydrogen	0.1	76.0
iron	35.0	1.0
magnesium	14.0	0.1
oxygen	29.0	0.8
silicon	14.0	0.1
sulfur	2.9	0.1
other elements		0.9
total	100.0	100.0

Answer these questions using only the information in the table.

(i) Deduce the percentage by mass of other elements present on Earth.

..... % [1]

(ii) Which non-metallic element is present on Earth in the greatest percentage by mass?

..... [1]

(iii) Give **two** major differences in the percentage by mass of the elements on Earth and in the Universe.

1 .....

.....

2 .....

.....

[2]

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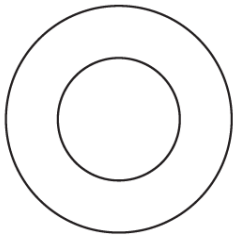
(b) Complete the diagram to show the electron arrangement in an oxygen atom.



[1]

(c) Helium, neon and argon are noble gases.

(i) Explain, in terms of the electronic structure, why neon is unreactive.

.....

..... [1]

(ii) State **one** use of argon.

..... [1]

[Total: 7]

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3. 0620/31/M/J/19/No.6

This question is about copper and copper compounds.

(a) Describe how you could prepare a pure sample of crystals of hydrated copper(II) sulfate using dilute sulfuric acid and an excess of copper(II) oxide.

.....

.....

.....

.....

..... [3]

(b) Anhydrous copper(II) sulfate is used to test for water.

$$\underset{\text{anhydrous copper(II) sulfate}}{CuSO_4} + 5H_2O \rightleftharpoons \underset{\text{hydrated copper(II) sulfate}}{CuSO_4.5H_2O}$$

(i) What is meant by the symbol $\rightleftharpoons$?

..... [1]

(ii) How can hydrated copper(II) sulfate be changed into anhydrous copper(II) sulfate?

..... [1]

(c) Complete the table to calculate the relative formula mass of anhydrous copper(II) sulfate, $CuSO_4$.
Use your Periodic Table to help you.

type of atom	number of atoms	relative atomic mass	
copper	1	64	1 × 64 = 64
sulfur			
oxygen			

relative formula mass = ...
[2]

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(d) Complete the table to show the number of electrons, protons and neutrons in the sulfur atom and copper ion shown.

	number of electrons	number of neutrons	number of protons
$^{34}_{16}S$			
$^{63}_{29}Cu^{2+}$			29

[4]

(e) Alloys of copper are used to make coins.

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

.....

..... [1]

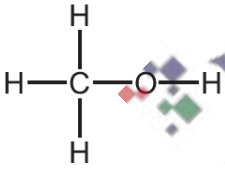
(ii) Suggest why an alloy of copper is used to make coins instead of using pure copper.

..... [1]

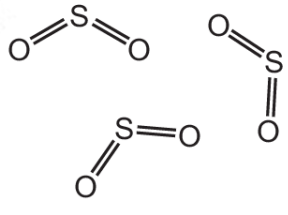
[Total: 13]

4. 0620/32/M/J/19/No.1

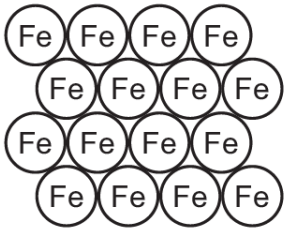
The diagrams show part of the structures of five substances, **A**, **B**, **C**, **D** and **E**.



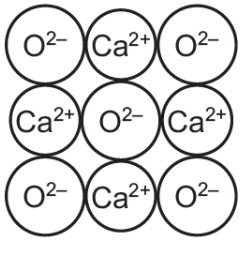
A



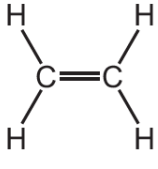
B



C



D



E

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(a) Answer the following questions about these structures.
Each structure may be used once, more than once or not at all.

State which **one** of these structures, **A**, **B**, **C**, **D** or **E**:

(i) is an alcohol

..... [1]

(ii) is an ionic compound

..... [1]

(iii) conducts electricity when solid

..... [1]

(iv) contributes to acid rain

..... [1]

(v) reacts with an acid to form a salt and water.

..... [1]

(b) Substance **E** is a compound.

What is meant by the term *compound*?

.....

..... [1]

[Total: 6]

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5. 0620/32/M/J/19/No.6

This question is about cobalt and compounds of cobalt.

(a) Describe how you could prepare a pure sample of crystals of hydrated cobalt(II) sulfate using dilute sulfuric acid and an excess of cobalt(II) carbonate.

.....

.....

.....

.....

..... [3]

(b) Complete the table to calculate the relative formula mass of anhydrous cobalt(II) sulfate, $CoSO_4$.
Use your Periodic Table to help you.

type of atom	number of atoms	relative atomic mass	
cobalt			
sulfur	1	32	1 × 32 = 32
oxygen			

relative formula mass = ...
[2]

(c) Complete the table to show the number of electrons, protons and neutrons in the oxygen atom and cobalt ion shown.

	number of electrons	number of neutrons	number of protons
$^{17}_{8}O$			
$^{59}_{27}Co^{2+}$			27

[4]

(d) Anhydrous cobalt(II) chloride is used to test for water.

State the colour change when water is added to anhydrous cobalt(II) chloride.

from ..... to .....
[2]

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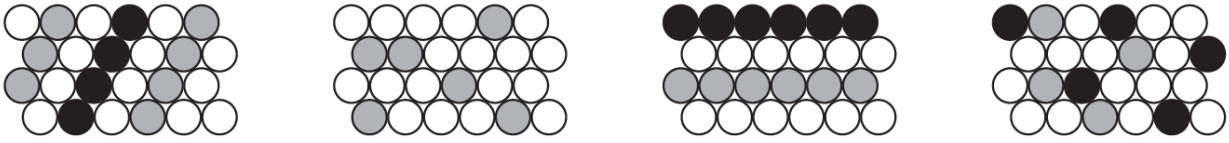
(e) An alloy of cobalt, chromium and molybdenum is used to make cutlery.

(i) Which **one** of the following diagrams best represents the structure of the alloy?
Draw a circle around the correct answer.



A **B** **C** **D**

[1]

(ii) Which **one** of these substances is also used to make cutlery?
Tick **one** box.

mercury	☐
sodium	☐
stainless steel	☐
graphite	☐

[1]

[Total: 13]

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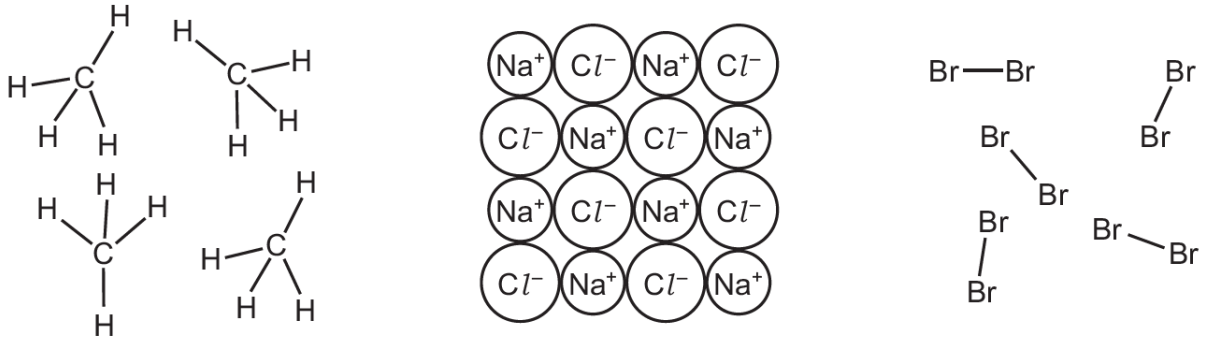
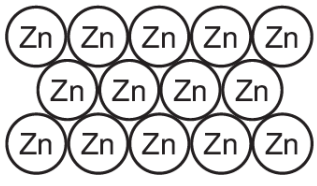
6. 0620/33/M/J/19/No.1

The diagram shows part of the structures of five substances, **A**, **B**, **C**, **D** and **E**.





D

E

(a) Answer the following questions about these structures.
Each structure may be used once, more than once or not at all.

(i) Which **two** of these structures, **A**, **B**, **C**, **D** or **E**, are compounds?

..... and .....

[2]

(ii) Which **one** of these structures, **A**, **B**, **C**, **D** or **E**, is monatomic?

..... [1]

(iii) Which **one** of these structures, **A**, **B**, **C**, **D** or **E**, conducts electricity when solid?

..... [1]

(iv) Which **one** of these structures, **A**, **B**, **C**, **D** or **E**, is the main constituent of natural gas?

..... [1]

(v) Which **one** of these structures, **A**, **B**, **C**, **D** or **E**, is a solid which is soluble in water?

..... [1]

(vi) Which **one** of these structures, **A**, **B**, **C**, **D** or **E**, is a hydrocarbon?

..... [1]

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(b) Substance **E** is present in air.
Air is a mixture of different gases.

Describe **two** characteristics of a mixture.

1 .....

.....

2 .....

.....

[2]

[Total: 9]

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7. 0620/33/M/J/19/No.6

This question is about zinc and compounds of zinc.

(a) Describe how you could prepare a pure sample of crystals of hydrated zinc sulfate using dilute sulfuric acid and an excess of zinc.

.....

.....

.....

.....

..... [3]

(b) The equation shows the effect of heat on anhydrous zinc sulfate.

$$ZnSO_4 \xrightarrow{\text{heat}} ZnO + SO_3$$

(i) What type of chemical reaction is this?
Tick **one** box.

addition	☐
decomposition	☐
displacement	☐
oxidation	☐

[1]

(ii) When 12.60 g of anhydrous zinc sulfate is heated, the mass of zinc oxide formed is 6.34 g.

Calculate the mass of zinc oxide formed when 63.0 g of anhydrous zinc sulfate is heated.

mass of zinc oxide = ... g [1]

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(c) Complete the table to calculate the relative formula mass of anhydrous zinc sulfate, $ZnSO_4$. Use your Periodic Table to help you.

type of atom	number of atoms	relative atomic mass	
zinc	1	65	1 × 65 = 65
sulfur			
oxygen			

relative formula mass = ...

[2]

(d) Complete the table to show the number of electrons, protons and neutrons in the sulfur atom and zinc ion shown.

	number of electrons	number of neutrons	number of protons
$^{36}_{16}S$			
$^{67}_{30}Zn^{2+}$			30

[4]

(e) An alloy contains zinc, copper and aluminium.

What is meant by the term *alloy*?

.....

..... [1]

[Total: 12]

8. 0620/41/M/J/19/No.1

This question is about the structures of atoms and ions.

(a) Define the term *proton number*.

.....

..... [2]

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(b) (i) Complete the table to show the number of protons, neutrons and electrons present in atoms of $^{24}_{12}Mg$ and $^{26}_{12}Mg$.

	number of protons	number of neutrons	number of electrons
$^{24}_{12}Mg$			
$^{26}_{12}Mg$			

[2]

(ii) What term is used to describe atoms of the same element, such as $^{24}_{12}Mg$ and $^{26}_{12}Mg$?

..... [1]

(iii) Explain why the chemical properties of $^{24}_{12}Mg$ and $^{26}_{12}Mg$ are the same.

.....

..... [2]

(c) Complete the table to identify the atoms and ions which have the following numbers of protons, neutrons and electrons.

	number of protons	number of neutrons	number of electrons
$^{23}_{11}Na^{+}$	11	12	10
	4	5	4
	17	20	18

[4]

(d) State the electronic structure of the following atom and ion.

Al .....

S^{2-} .....

[2]

[Total: 13]

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9. 0620/42/M/J/19/No.2

(a) $^{22}_{11}Na$, $^{23}_{11}Na$ and $^{24}_{11}Na$ are isotopes of sodium.

(i) Describe how these sodium isotopes are the same and how they are different in terms of the total number of protons, neutrons and electrons in each.

same .....

.....

different .....

.....

[3]

(ii) Why do all **three** isotopes have an overall charge of zero?

.....

..... [1]

(iii) Why do all **three** isotopes have the same chemical properties?

.....

..... [2]

(iv) Why do sodium ions have a charge of +1?

.....

..... [1]

(b) Carbon is an element which exists in different forms.

(i) Name **two** forms of the element carbon that have giant covalent structures.

..... and ..... [1]

(ii) Name the oxide of carbon that is a toxic gas.

..... [1]

[Total: 9]

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10. 0620/43/M/J/19/No.1

Atoms contain particles called electrons, neutrons and protons.

(a) Complete the table.

particle	where the particle is found in an atom	relative mass	relative charge
	orbiting the nucleus	$\frac{1}{1840}$	
			+1
	in the nucleus		

[3]

(b) How many electrons, neutrons and protons are there in the ion shown?

$$^{44}_{20}Ca^{2+}$$

number of electrons .....

number of neutrons .....

number of protons .....

[3]

[Total: 6]

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11. 0620/43/M/J/19/No.2

Magnesium exists as three isotopes, $^{24}_{12}Mg$, $^{25}_{12}Mg$ and $^{26}_{12}Mg$.

(a) State, in terms of the total numbers of electrons, neutrons and protons, **one** difference and **two** similarities between these magnesium isotopes.

difference .....

similarity 1 .....

similarity 2 .....

[3]

(b) All isotopes of magnesium react with dilute hydrochloric acid to make hydrogen and a salt.

(i) Why do all isotopes of magnesium react in the same way?

.....

.....

..... [2]

(ii) Write a chemical equation for the reaction between magnesium and dilute hydrochloric acid.

..... [2]

(iii) Describe a test for hydrogen.

test .....

result .....

[2]

(c) Magnesium is a metal.

Describe the structure and bonding of metals. Include a labelled diagram in your answer.

.....

.....

.....

.....

[3]

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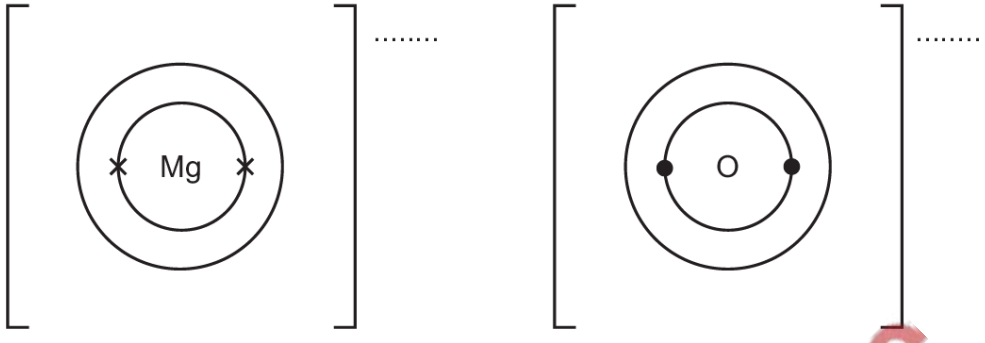
(d) Magnesium reacts with oxygen to form the ionic compound magnesium oxide.

(i) Complete the dot-and-cross diagrams to show the electronic structures of the ions in magnesium oxide. Show the charges on the ions.



[3]

(ii) Magnesium oxide melts at 2853 °C.

Why does magnesium oxide have a high melting point?

.....

..... [1]

(iii) Explain why molten magnesium oxide can conduct electricity.

.....

.....

..... [1]

[Total: 17]

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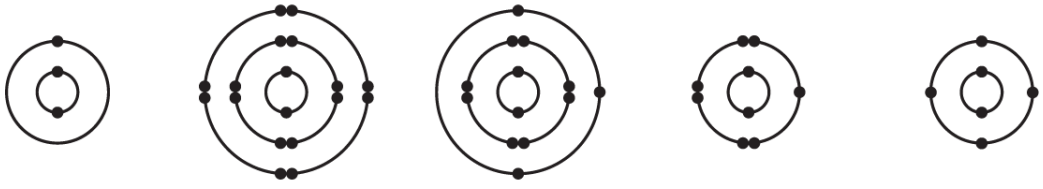
12. 0620/32/F/M/19/No.1

This question is about electronic structures.

(a) The electronic structures of five atoms, **A**, **B**, **C**, **D** and **E**, are shown.



A **B** **C** **D** **E**

Answer the following questions about these electronic structures.
Each electronic structure may be used once, more than once or not at all.

State which electronic structure, **A**, **B**, **C**, **D** or **E**, represents an atom:

(i) of an element in Group III of the Periodic Table ..... [1]

(ii) of a monatomic gas ..... [1]

(iii) of carbon ..... [1]

(iv) which has 18 protons ..... [1]

(v) which forms a stable ion with a single negative charge. ..... [1]

(b) Draw the electronic structure of a silicon atom.

[2]

[Total: 7]

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13. 0620/32/F/M/19/No.2

This question is about uranium and its compounds.

(a) (i) An isotope of uranium is represented by the symbol shown.

$$^{235}_{92}U$$

Deduce the number of electrons and neutrons in one atom of this isotope of uranium.

number of electrons .....

number of neutrons .....

[2]

(ii) State the main use of this isotope of uranium.

..... [1]

(b) Complete the sentence about isotopes using words from the list.

atoms **compound** **electrons** **element** **ions**

mixture **molecules** **neutrons** **substance**

Isotopes are ..... of the same ..... which have the same proton number but a different number of ..... .

[3]

(c) Uranium is a metal.

Give **two** physical properties which are characteristic of **all** metals.

1 .....

2 .....

[2]

(d) Uranium reacts with hydrogen to form uranium hydride, UH_3.
The reaction is reversible.

Complete the chemical equation for this reaction by:

- balancing the equation
- drawing the symbol for a reversible reaction in the box.

$$2U + \text{.....}\ H_2 \ \square\ \text{....}\ UH_3$$

[3]

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(e) A compound of uranium has the formula UO_2F_2.

Complete the table to calculate the relative formula mass of UO_2F_2.
Use your Periodic Table to help you.

	number of atoms	relative atomic mass	
uranium	1	238	1 × 238 = 238
oxygen			
fluorine			

relative formula mass = ...
[2]

[Total: 13]

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14. 0620/42/F/M/19/No.2

(a) The table gives information about some atoms or ions, **A**, **B** and **C**.

Complete the table.

	number of protons	number of electrons	electronic structure	charge
A	11	10	2,8	
B		18		0
C		10	2,8	–1

[4]

(b) (i) Carbon is an element.

Define the term *element*.

.....

..... [1]

(ii) $^{12}_{6}C$, $^{13}_{6}C$ and $^{14}_{6}C$ are isotopes of carbon.

Complete the table.

	number of protons	number of neutrons
$^{12}_{6}C$		
$^{13}_{6}C$		
$^{14}_{6}C$		

[2]

[Total: 7]

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