

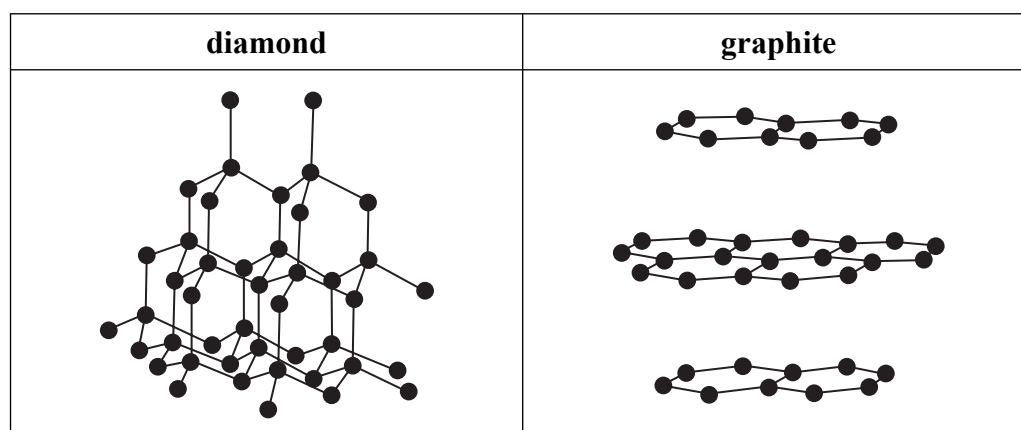




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1. The diagrams show parts of the structures of diamond and of graphite, which are two forms of the element carbon.



(a) Each bond in diamond is formed by a shared pair of electrons.

(i) What is the name of this type of bond?

..... (1)

(ii) How many of these bonds does each carbon atom in diamond form?

..... (1)

(iii) Why is a large amount of energy needed to convert solid diamond into a gas?

.....  
 ..... (1)

(b) Graphite can be used as a lubricant.

Explain, in terms of its structure, why graphite is a lubricant.

.....  
 .....  
 ..... (2)



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(c) Recently, two other forms of carbon have been discovered.  
One is Buckminsterfullerene, a type of fullerene.

(i) Name another recently discovered form of carbon.

.....  
(1)

(ii) A molecule of Buckminsterfullerene has the formula  $C_{60}$ .  
Calculate the relative formula mass of this molecule.  
(Relative atomic mass: C = 12)  
Show your working.

.....  
.....  
Answer = .....  
(1)

(d) Information on the Internet gives the formulae of three different oxides of carbon.  
They are CO, CO<sub>2</sub> and C<sub>3</sub>O<sub>2</sub>.  
An oxide of carbon was found to contain 12 g of carbon and 16 g of oxygen.  
What is the formula of this oxide of carbon?  
(Relative atomic masses: C = 12, O = 16)

.....  
(1)

(Total 8 marks)

Q1



2. In July 2009, the element with atomic number 112 was named copernicium. The element was named after Nicolaus Copernicus, a Polish astronomer.



Nicolaus Copernicus

The symbol for an atom of copernicium is Cp.

- (a) The atomic number of copernicium is 112.

- (i) How many protons are there in an atom of copernicium?

.....  
(1)

- (ii) Some atoms of copernicium have a mass number of 277.  
How many neutrons are in the nucleus of one of these atoms?

.....  
(1)

- (iii) By July 2009, four isotopes of copernicium were known.  
How do atoms of these isotopes of copernicium differ from each other?

.....  
.....  
(1)



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(b) As only a few atoms of copernicium have been made, its chemical and physical properties are unknown. However, copernicium is expected to form an ionic fluoride. This compound will contain copernicium ions,  $\text{Cp}^{2+}$ , and fluoride ions,  $\text{F}^-$ .

(i) Write the formula of copernicium fluoride.

.....  
(1)

(ii) Describe how copernicium atoms, Cp, and fluorine atoms, F, form copernicium ions,  $\text{Cp}^{2+}$ , and fluoride ions,  $\text{F}^-$ .

.....  
.....  
.....  
(2)

(Total 6 marks)

Q2

7

Turn over



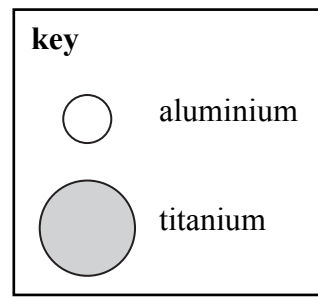
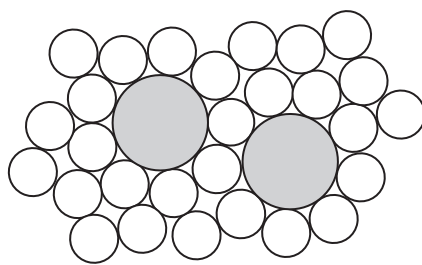
3. Titanium is a silver-grey metal.  
It is in much demand because it is strong and resistant to corrosion, and has a relatively low density.  
The melting point of titanium is 1670 °C.  
Like other metals, titanium is a good conductor of electric current.

(a) Explain why metals are good conductors of electric current.

.....  
.....  
.....

(2)

(b) Titanium can be mixed with many other metals, such as aluminium, to make alloys.  
Explain how alloying titanium with aluminium can make aluminium stronger.



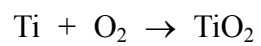
.....  
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(2)



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(c) When heated, titanium combines with oxygen to form titanium(IV) oxide,  $\text{TiO}_2$ .



Calculate the maximum mass of titanium(IV) oxide that could be produced if 9.6 g of titanium were reacted with excess oxygen.  
(Relative atomic masses: O = 16, Ti = 48)

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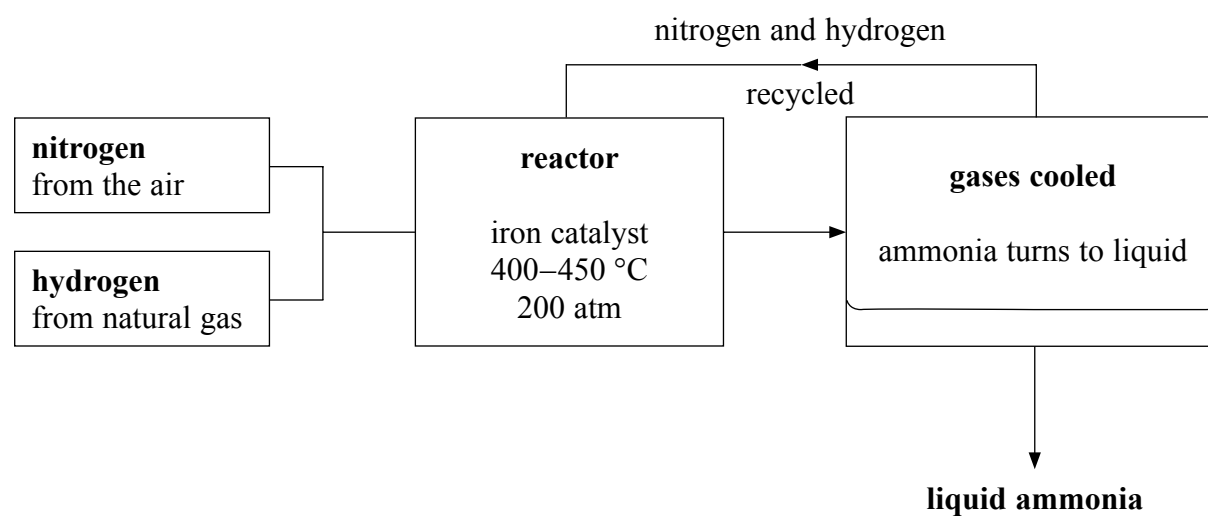
answer = ..... g  
(2)

Q3

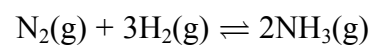
(Total 6 marks)



4. In the Haber process, nitrogen and hydrogen are reacted to form ammonia. A diagram for the process is shown below.



The equation for the reaction is



- (a) Explain the meaning of the symbol  $\rightleftharpoons$

.....  
 ..... (1)

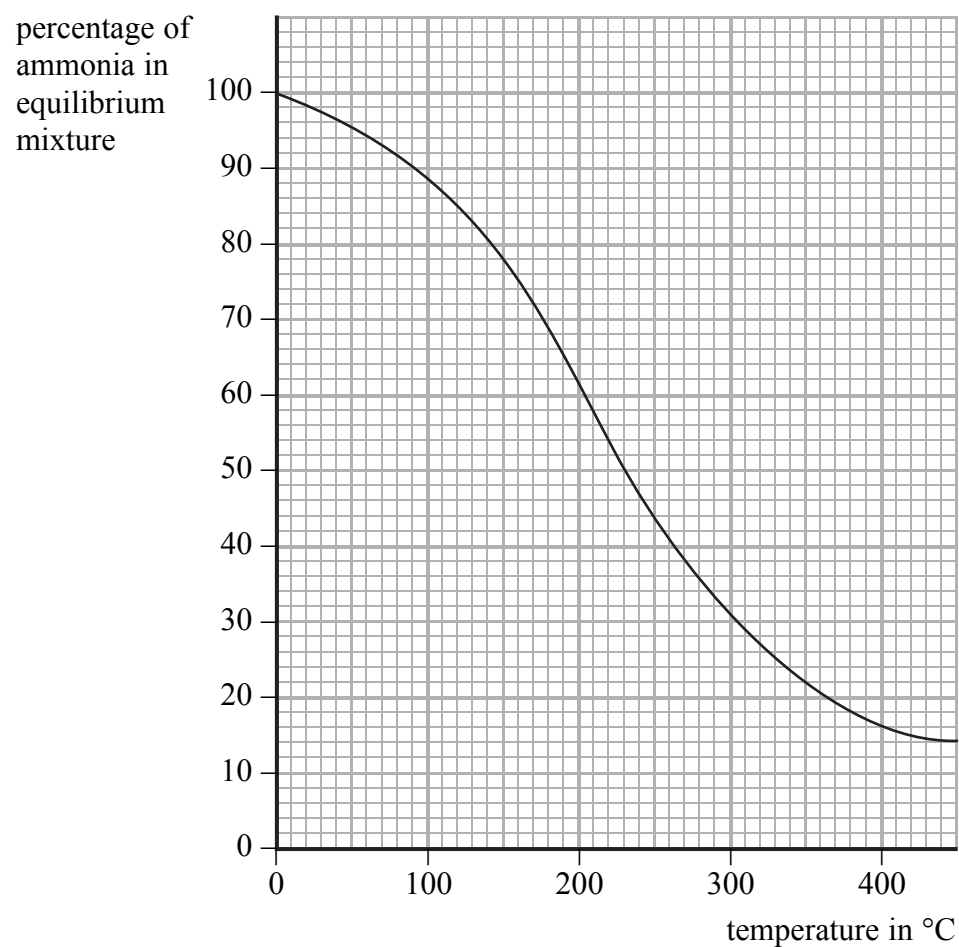
- (b) The mixture of gases leaving the reactor contains nitrogen and hydrogen. Explain why this nitrogen and hydrogen is recycled.

.....  
 ..... (1)



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(c) The graph shows the percentage of ammonia in equilibrium mixtures at different temperatures and at a pressure of 400 atm.



(i) Write down the temperature needed to produce 20% of ammonia in the equilibrium mixture at a pressure of 400 atm.

temperature ..... °C  
(1)

(ii) What happens to the percentage of ammonia in the equilibrium mixtures as the temperature decreases?

.....  
.....

(1)

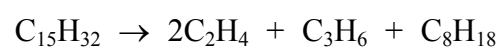
Q4

(Total 4 marks)



5. In the petroleum industry, fractions are obtained by the fractional distillation of crude oil. Ethene is formed when some of these fractions are cracked.

One possible reaction in the cracking process is



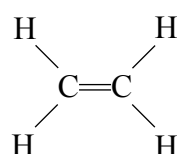
- (a) Two of the products shown are ethene and octane,  $\text{C}_8\text{H}_{18}$ .  
Give the name of the other product of this reaction.

..... (1)

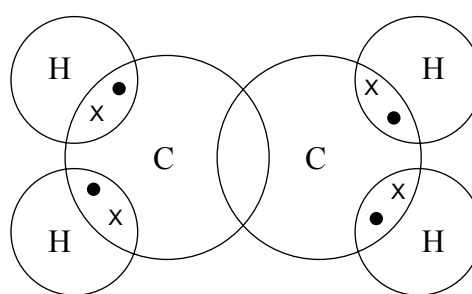
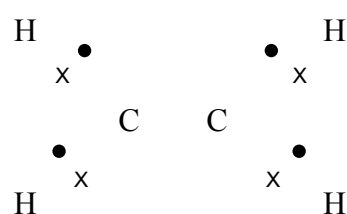
- (b) Some fractions containing large molecules are cracked.  
Explain why it is useful to crack these fractions.

.....  
 .....  
 .....  
 ..... (2)

- (c) The structure of an ethene molecule can be shown as



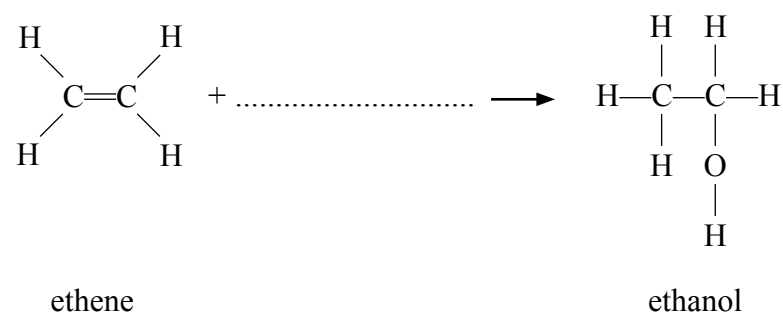
Complete **either** of the two dot and cross diagrams below to show the electrons in the bonds between the carbon atoms in an ethene molecule.



(1)



(d) Some of the ethene, C<sub>2</sub>H<sub>4</sub>, is converted into ethanol, C<sub>2</sub>H<sub>5</sub>OH.



(i) Give the name of the substance that reacts with ethene to form ethanol in this reaction.

.....  
(1)

(ii) In one factory, 1.00 tonne of ethene produces 1.48 tonnes of ethanol. Calculations from the equation show that 1.00 tonne of ethene should produce 1.64 tonnes of ethanol. Calculate the percentage yield of this reaction.

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.....  
.....

answer = ..... %  
(1)

(Total 6 marks)

Q5

**TOTAL FOR PAPER: 30 MARKS**

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