Coimisiún na Scrúduithe Stáit
State Examinations Commission

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LEAVING CERTIFICATE EXAMINATION, 2018

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CHEMISTRY – ORDINARY LEVEL

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TUESDAY, 19 JUNE – AFTERNOON 2:00 to 5:00

_____

400 MARKS

_____

Answer **eight** questions in all.

These must include at least **two** questions from **Section A**.

All questions carry equal marks (50).

_____

The information below should be used in your calculations.

Relative atomic masses (rounded):   H = 1.0, N = 14, O = 16
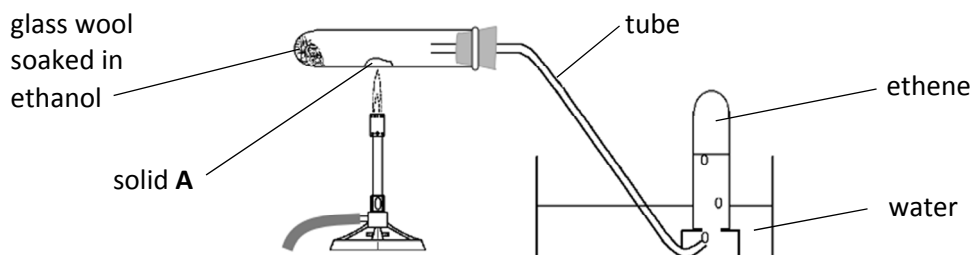
Molar volume at s.t.p. = 22.4 litres

Avogadro constant = 6.0×10^{23} mol^{-1}

The use of the *Formulae and Tables* booklet approved for use in the State Examinations is permitted. A copy may be obtained from the examination superintendent.

Section A
Answer at least <u>two</u> questions from this section. See page 1 for full instructions.

1. A student prepared and collected ethene (C_2H_4) gas using the arrangement of apparatus and chemicals shown below. A few stoppered test-tubes of the gas were kept to examine the properties of ethene.

(a) Identify the white solid **A**.   (5)

(b) (i) Describe the appearance of the gas collected.

(ii) Explain why the first few test-tubes of gas collected are *not* then used.   (9)

(c) There is a risk of suck-back while carrying out this experiment.
   (i) What is suck-back?
   (ii) Why is suck-back hazardous?
   (iii) What precaution should be taken to avoid suck-back?   (12)

(d) In a test for unsaturation a few drops of a coloured solution were added to a test-tube of ethene gas. The test-tube was re-stoppered and shaken.
   (i) Identify a reagent used to test ethene for unsaturation.
   (ii) What colour change is a positive result in this test using the reagent you identified?   (9)

(e) A combustion test was carried out on another test-tube of ethene.
   (i) How was the combustion test carried out?
   (ii) Describe the flame observed.
   (iii) Copy, complete and balance the following equation for the complete combustion of ethene in oxygen:
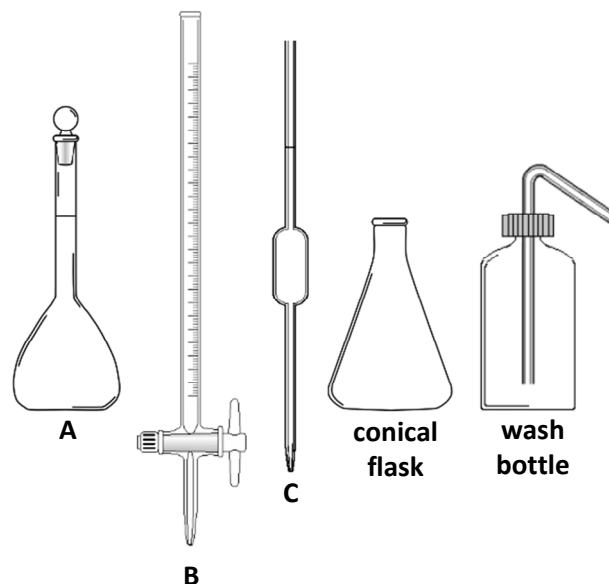
$$C_2H_4 \ + \ 3O_2 \ \rightarrow \ \text{_____} \ + \ \text{_____}$$ (15)

2. A 0.05 M solution of sodium carbonate (**Na₂CO₃**) was prepared and then used to find the concentration of a hydrochloric acid (**HCl**) solution by titration. Some pieces of apparatus used in the experiment are shown below. For each titration 25.0 cm³ of the sodium carbonate solution were measured into a conical flask and the table shows the volumes of hydrochloric acid solution added.

Rough titration	First accurate titration	Second accurate titration
23.2 cm³	22.7 cm³	22.6 cm³

(*a*) Name the pieces of apparatus **A**, **B** and **C**. (11)

(*b*) Which piece of apparatus, **A**, **B** or **C**, was used:

(*i*) in making up the 0.05 M solution of **Na₂CO₃**,

(*ii*) to measure 25.0 cm³ of the **Na₂CO₃** solution,

(*iii*) to measure the hydrochloric acid in each titration? (9)

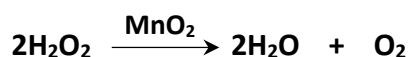
A   conical flask   wash bottle

C

B

(*c*) The wash bottle was used to rinse **A**, **B**, **C** and the conical flask with deionised water. Identify one of these pieces of apparatus that was rinsed again with a second liquid. (3)

(*d*) The 0.05 M **Na₂CO₃** solution is a <u>standard solution</u>. Explain the underlined term. (6)

(*e*) (*i*) Name a suitable indicator for use in the titrations.

(*ii*) What colour change was observed at the end point? (9)

(*f*) The equation for the titration reaction is:

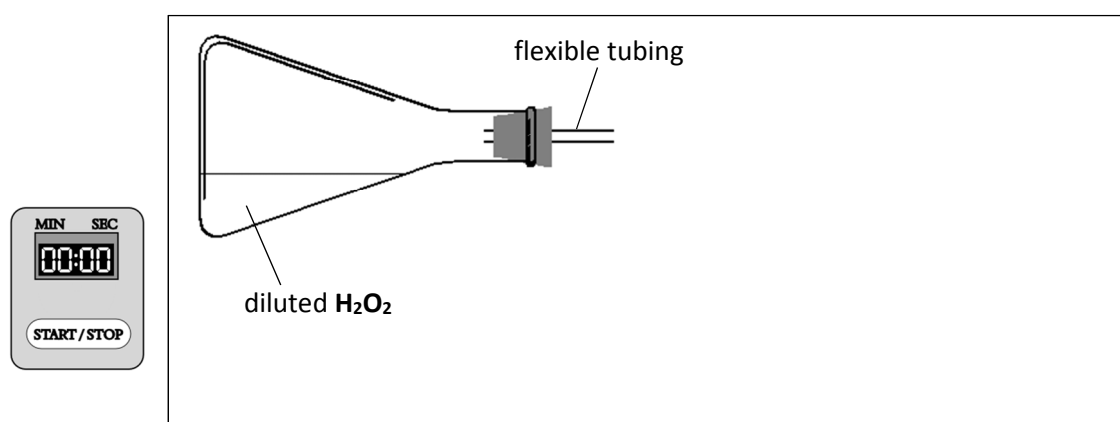$$2HCl \ + \ Na_2CO_3 \ \rightarrow \ 2NaCl \ + \ H_2O \ + \ CO_2$$

Using figures from the table above, calculate, in moles per litre, the concentration of the **HCl** solution that was titrated against 25.0 cm³ portions of the 0.05 M **Na₂CO₃** solution. (12)

3. A student investigated the rate of decomposition of a hydrogen peroxide (H_2O_2) solution using manganese dioxide (MnO_2) as a catalyst. The equation for the reaction is:

$$2H_2O_2 \xrightarrow{MnO_2} 2H_2O + O_2$$

(a) The student measured out 5 cm³ of hydrogen peroxide solution **A**, diluted it to 25 cm³ with deionised water and then transferred the diluted solution into a conical flask.

Name a suitable piece of apparatus to measure out 5 cm³ of hydrogen peroxide solution **A**. (6)

(b) Describe the appearance of the **MnO_2** catalyst. (6)

(c) Copy into your answerbook the diagram of the arrangement of apparatus shown in the box below.

Complete your diagram and label it to show:
(i)   the location of the catalyst just before the reaction is started,
(ii) how the oxygen gas can be collected and its volume measured at intervals over several minutes. (9)

(d) The data obtained are given in the table.

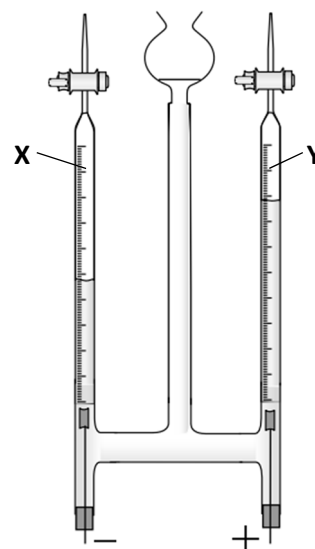| Time (minutes)	0	1	2	3	4	5	6	7	8
Volume **O_2** (cm³)	0	20	31	36.5	39	40	40	40	40

(i)   Plot a graph (on graph paper) of volume of **O_2** (*y*-axis) *versus* time. (15)
(ii) Why does the rate of this reaction slow down as the minutes go by? (3)
(iii) Use your graph to find the volume of gas collected in the first 2.5 minutes. (6)
(iv) On the same sheet of graph paper sketch the curve that you would expect to plot if the experiment were repeated using 2.5 cm³ of hydrogen peroxide solution **A** diluted to 25 cm³. (5)

Section B

See page 1 for instructions regarding the number of questions to be answered.

4.   Answer **eight** of the following (*a*), (*b*), (*c*), etc.   (50)

(*a*)   Give one difference between Mendeleev's
         periodic table of the elements
         and the modern periodic table.

(*b*)   Give the symbol of a metallic element used as a catalyst
         in the catalytic converter of a car.

(*c*)   The electrolysis of water, acidified with a few drops of
         sulfuric acid, was carried out in an apparatus like that
         shown. Inert (platinum) electrodes were used.
         Identify gas **X** and gas **Y**.

(*d*)   Write a balanced equation for the reaction that occurs
         when hydrogen gas reacts with chlorine gas
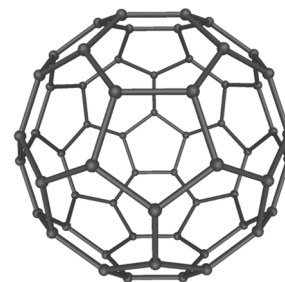   producing hydrogen chloride.

(*e*)   Calculate the pH of 0.15 M sulfuric acid (**H$_2$SO$_4$**) correct to one decimal place.

(*f*)   An equation for the combustion of methanol in oxygen is:

$$2CH_3OH \ + \ 3O_2 \quad \rightarrow \quad 2CO_2 \ + \ 4H_2O \qquad \Delta H = -1451 \ kJ$$

Is this reaction *exothermic* or *endothermic*?

Give a reason for your answer.

(*g*)   The molecular formula of glucose is **C$_6$H$_{12}$O$_6$**.
         Write the empirical formula for glucose.

(*h*)   What happens during the *primary* stage of sewage treatment?

(*i*)   A 500 cm^3 sample of swimming pool water contained 0.11 g of dissolved solids.
         Express this concentration in parts per million (p.p.m. *or* mg per litre).

(*j*)   Identify the process defined as 'emission of an electron by an unstable nucleus'.

(*k*)   Answer part **A** *or* part **B**.

A   Name the soccer-ball shaped molecule
         made up of 60 carbon atoms that was
         discovered in 1985.

or

B   Why are industrial reaction vessels
         often made of steel?

5. (*a*) Argon (**Ar**) is a gaseous unreactive element that exists as single atoms.
Why is this element unreactive? (5)

(*b*) Fluorine and oxygen are gaseous elements that exist as the diatomic molecules
F_2 and O_2.
Draw dot and cross diagrams to show the covalent bonding in F_2 *and* in O_2. (12)

(*c*) Define *electronegativity*. (6)

(*d*) The table gives the melting points and boiling points of water and of three simple
pure substances **A**, **B** and **C**.

Substance	Melting point (°C)	Boiling point (°C)	Electronegativity difference between atoms in constituent bonds
A	−210	−196	0
B	−114	−85	0.96
water	0	100	
C	730	1380	

Use the properties given in the table to identify which substance, **A**, **B**, **C** or water, is
most likely to:
(*i*) have ionic bonding,
(*ii*) be gaseous and have polar covalent bonding,
(*iii*) have pure covalent bonding.
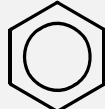Explain your reasoning in each case. (21)

(*e*) What is the shape of a water molecule? (6)

6. (*a*) What general term is used for compounds, like those shown in the table, that contain only carbon and hydrogen atoms? (5)

(*b*) Give the IUPAC names for **A**, **C** and **D**. (9)

(*c*) To which homologous series:

   (*i*) do both **A** and **B** belong,

   (*ii*) does **D** belong? (6)

(*d*) (*i*) Which compound in the table is aromatic?

   (*ii*) Write the molecular formula of this compound.

   (*iii*) Why is this compound *not* in common use? (12)

A	H—C—H with H above and H below (carbon with 4 H)
B	H—C—C—H with H above and below each C
C	H—C—C=C with H on carbons
D	H—C≡C—H
E	(benzene ring)

(*e*) Which compound in the table, when burned in oxygen, produces a very high temperature flame used for cutting and welding metal? (6)

(*f*) Which compound in the table is produced by anaerobic bacteria decomposing animal waste?

Why is the concentration of this compound in the atmosphere a cause for concern? (12)
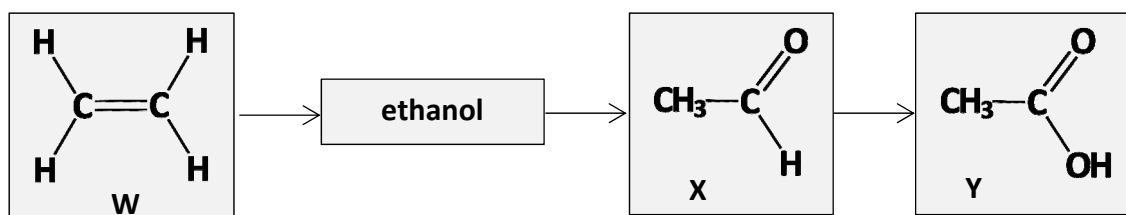

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7. (*a*) (*i*) What is hard water?

   (*ii*) What type of water hardness can be removed by boiling?

   Name, or give the formula, of a substance that causes this type of water hardness.

   (*iii*) Identify a problem caused by hard water.

   (*iv*) Give an advantage of hard water. (24)

(*b*) Consider the following chemicals and materials used in the purification of a drinking water supply.

   $Al_2(SO_4)_3$ **sand and gravel**   **chlorine**   **NaF**   **lime (CaO)**

   (*i*) What term is used to describe the use of $Al_2(SO_4)_3$ causing suspended particles in the water to clump together?

   (*ii*) Give the purpose of sand and gravel in water purification.

   (*iii*) What is the purpose of adding chlorine to the water supply?

   (*iv*) Why is **NaF** added to the water?

   (*v*) Under what circumstance would lime (**CaO**) be added to the water supply? (26)

8. Study the reaction scheme below and answer the questions that follow.

(a) Name the compounds **W**, **X** and **Y**. (15)

(b) Draw the structure of an ethanol molecule. (6)

(c) In which one of the molecules, **W**, ethanol, **X** or **Y**, are all the carbon atoms in planar geometry? (6)

(d) Classify as an addition, as a substitution or as an oxidation reaction:
(i) the conversion of **W** to ethanol,
(ii) the conversion of **X** to **Y**. (9)

(e) Describe what is observed when **X** reacts with Fehling's reagent. (9)

(f) Give a common use for **Y** in the food industry. (5)

9. (a) Define (i) oxidation, (ii) reduction, in terms of electron transfer. (12)

(b) Potassium metal reacts violently with chlorine gas to form a white salt, potassium chloride, according to the following balanced equation.

$$2K + Cl_2 \rightarrow 2KCl$$

(i) Which element is oxidised?
(ii) Which substance is the oxidising reagent? (12)

(c) (i) Describe a procedure for carrying out a flame test on the white salt.
(ii) What flame colour confirms the presence of potassium in this salt? (15)

(d) A little of the **KCl** salt is dissolved in water in a test-tube and a few drops of silver nitrate (**AgNO₃**) solution are added to confirm the presence of the chloride ion.
What is observed in the test-tube? (6)

(e) Give a reason why potassium metal reacts more violently than sodium metal with chlorine gas. (5)

10. Answer any **two** of the parts (*a*), (*b*) and (*c*). (2 × 25)

(*a*) An acid is defined as a substance that produces __1__ ions in aqueous solution and a base as a substance that produces __2__ ions in aqueous solution. An acid and a base react together to produce a __3__ and __4__ in a process called __5__. Indigestion remedies are often bases that react with excess __6__ in the stomach. The base __7__ is used in many oven cleaners and drain cleaners to dissolve grease.

The following words and formulae are omitted from the passage above.

    OH^-   **neutralisation**   **water**   **H^+**

        HCl   **salt**   **NaOH**

Write in your answerbook the omitted word or formula corresponding to each of the numbers (**1** to **7**). (25)

(*b*) Define (*i*) atomic number, (*ii*) mass number, (*iii*) isotopes.

Refer to the periodic table of the elements on page 79 of the *Formulae and Tables* booklet and answer the following questions.

(*iv*) What is the atomic number of chlorine?

(*v*) How many electrons occupy each of the main energy levels (shells) in a chlorine atom?

(*vi*) What is the relative atomic mass of chlorine?

(*vii*) Why is the relative atomic mass of chlorine *not* a whole number? (25)

(*c*) The gas dinitrogen oxide (**N_2O**) can be used as an anaesthetic. It can be made by decomposing ammonium nitrate (**NH_4NO_3**) using heat according to the following balanced equation.

$$NH_4NO_3 \rightarrow N_2O + 2H_2O$$

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(*i*) Copy and complete in your answerbook the following statement.

'One mole of **N_2O** has a mass of …………… grams, contains ……………… **N_2O** molecules and occupies a volume of ……….. litres at s.t.p.'

(*ii*) What is the mass in grams of one mole of ammonium nitrate (**NH_4NO_3**)?

(*iii*) When 16 g of **NH_4NO_3** react according to the equation above, how many moles of water are formed?

What volume does the **N_2O** gas produced occupy at s.t.p.? (25)

11. Answer any **two** of the parts (*a*), (*b*) and (*c*). (2 × 25)

(*a*) Matter is composed of tiny particles which may be atoms, molecules or ions.
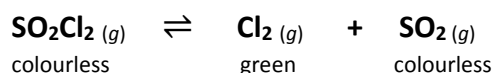Name the three states of matter.

What is the difference:
(*i*) between an atom and an ion,
(*ii*) between an atom and a molecule? (11)

Diffusion is evidence for the movement of tiny particles in a liquid or in a gas.
Give an example of diffusion.

Supply the missing words in the following statement of Boyle's law:
'The **1** of a certain mass of gas is inversely proportional to its **2** at
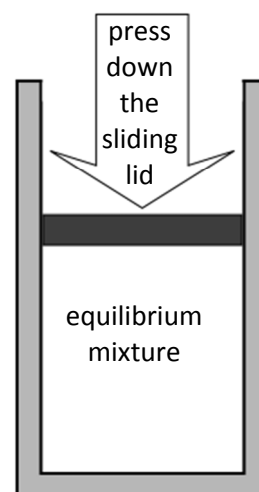constant **3** .' (14)

(*b*) Sulfuryl chloride (**SO_2Cl_2**) decomposes when heated to form equal volumes
of chlorine (**Cl_2**) gas and sulfur dioxide (**SO_2**) gas. When some **SO_2Cl_2** vapour was
heated in a closed container at a certain temperature a <u>chemical equilibrium</u>
was reached according to the following balanced equation.

$$SO_2Cl_2\,_{(g)} \rightleftharpoons Cl_2\,_{(g)} + SO_2\,_{(g)}$$
colourless   green   colourless

(*i*) Explain the underlined term.
(*ii*) Write the equilibrium constant (**K_c**)
expression for this reaction. (13)

According to Le Châtelier's principle, changing certain
factors causes stress to a system in equilibrium.

(*iii*) Predict the effect on the colour of this equilibrium
mixture of increasing the pressure by compressing
the gases as shown.

(*iv*) Give another way to change the colour of this equilibrium
mixture – other than by changing its pressure. (12)

press
down
the
sliding
lid

equilibrium
mixture

(*c*) Answer part **A** *or* part **B**.

A

How do most metals compare to most plastics in terms of (*i*) hardness, (*ii*) lustre?

Copper is used as a building material for roofing, plumbing and wiring. The plastic
poly(chloroethene), or PVC, is used for plumbing and in electrical cable.

What property of the plastic PVC makes it suitable for use in electrical cable? (15)

Give an advantage of using PVC for plumbing in place of copper pipes.

What metallic property allows copper to be:
(*iii*) hammered or rolled into sheets for use in roofing,
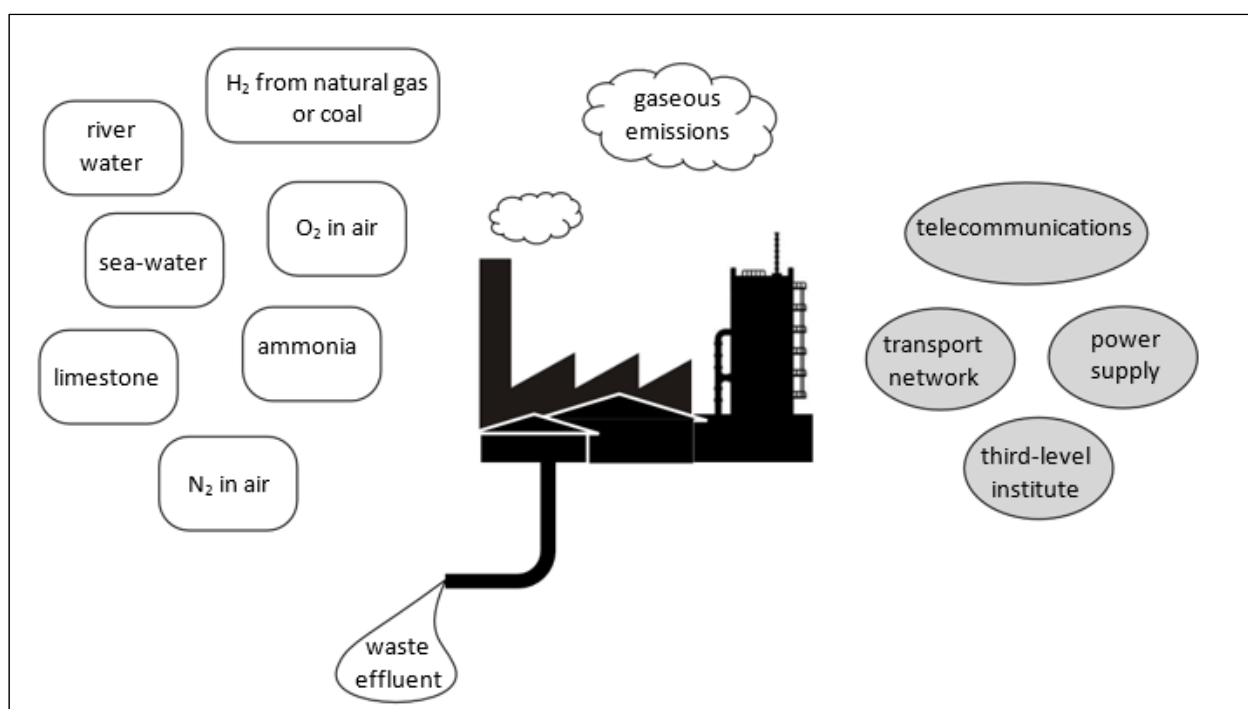(*iv*) drawn into long strands for use in wiring? (10)

or

B

Answer the questions below about any **one** of these three case studies:

industrial production of **ammonia**,

industrial production of **nitric acid**,

industrial production of **magnesium oxide**.

(*i*)   State the formula of the main product of the industry you studied.   (3)

(*ii*)   What is the major use of this product?   (6)

(*iii*)   Select, from the left of the scheme below, two feedstock materials for the industry you studied.   (6)

(*iv*)   Select an infrastructural feature from the right of the scheme below and explain how it is essential in the industry you studied.   (6)

(*v*)   How does the industry you studied deal with *either* emissions *or* waste effluent?   (4)

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