



Give the marks for the points in the marking scheme; an answer in other words that says the same is right.

1 Key words

1. hydrochloric
2. upward
3. lime water
4. dry ice
5. calcium hydroxide
6. lime tower
7. greenhouse gases
8. acid rain

K • 4

Each carries 0.5 mark.

2 Label the diagram

1. thistle funnel
2. Woulfe's bottle
3. dilute hydrochloric acid

4. marble or limestone (CaCO_3)
5. delivery tube
6. gas jar

K • 3

Each carries 0.5 mark.

3 Multiple choice

- i. d. 2 : 1

K • 1

The equation needs $2\text{NH}_4\text{Cl}$ for every $\text{Ca}(\text{OH})_2$; 2 : 1.

- ii. d. calcium carbonate

U • 1

For a short time: insoluble calcium carbonate, which makes the lime water milky. Calcium bicarbonate forms only when the gas is passed for a long time.

- iii. b. lime and carbon dioxide

U • 1

In a lime kiln, the burning coal heats the limestone, which breaks up into lime (quicklime, calcium oxide) and carbon dioxide: $\text{CaCO}_3 \xrightarrow{\text{heat}} \text{CaO} + \text{CO}_2$. (The coal itself also makes CO_2 as it burns.)

- iv. b. because it is lighter than air, so it rises into the jar and pushes the air down and out

U • 1

Ammonia (17) is much lighter than air (about 29), so it rises, like smoke in a chimney, and fills an upside-down jar from the top. Its solubility explains why it isn't collected over water, not why the jar is upside down.

- v. b. on a clear night, the infrared from the ground escapes to space; clouds would have absorbed it and sent part of it back down

A • 1

Clouds are made of water, a strong greenhouse substance. They work as a blanket: they absorb infrared from the ground and send part of it back. Without them, the ground loses its heat straight to space, and you get frost in the morning.

4 Very short answers

- a. MARKING SCHEME

K • 1

✓ Ammonia (NH_3).

- b. MARKING SCHEME

K • 1

✓ $\text{Ca}(\text{OH})_2 + \text{CO}_2 \rightarrow \text{CaCO}_3 + \text{H}_2\text{O}$ (balanced).



- c. MARKING SCHEME U · 1
- ✓ The CO₂ dissolved under high pressure escapes as bubbles when the pressure drops.

5 Short answers

- a. MARKING SCHEME U · 2
- ✓ Carbon dioxide (molecular mass 44) is about 1.5 times heavier than air (about 29).
 - ✓ So it sinks to the bottom of an upright jar and pushes the air out at the top, instead of escaping through the open mouth.
- b. MARKING SCHEME U · 2
- ✓ Ammonia dissolves less in warm water, so in a warm bottle the gas comes out of the solution and builds up pressure under the lid.
 - ✓ Cooling makes the gas dissolve again and lowers the pressure, so the gas and solution don't spurt out when it is opened.
- c. MARKING SCHEME U · 2
- ✓ Concentrated sulphuric acid reacts with ammonia, a base (making ammonium sulphate).
 - ✓ Quicklime is a base, so it absorbs only the water and doesn't react with ammonia.
- d. MARKING SCHEME K · 2
- ✓ Any one effect, e.g. it eats away buildings and statues of marble or limestone, and corrodes metals.
 - ✓ Any second effect, e.g. it makes the soil or lakes acidic, harming crops, forests and fish.

6 Long answer

ANSWER

A · 4

- Ammonia: $2\text{NH}_4\text{Cl} + \text{Ca}(\text{OH})_2 \rightarrow \text{CaCl}_2 + 2\text{H}_2\text{O} + 2\text{NH}_3$ (on heating).
- The reaction makes water; the slope lets it run towards the mouth, instead of back onto the hot bottom of the tube, which would crack.
- Ammonia (17) is lighter than air (about 29), so it rises into the upside-down jar and pushes the air down and out; it can't be collected over water because it is extremely soluble in water.
- Damp red litmus paper held at the mouth of the jar turns blue (or a glass rod dipped in concentrated hydrochloric acid gives dense white fumes).

MARKING SCHEME

- ✓ i. Ammonia, with $2\text{NH}_4\text{Cl} + \text{Ca}(\text{OH})_2 \rightarrow \text{CaCl}_2 + 2\text{H}_2\text{O} + 2\text{NH}_3$.
- ✓ ii. So the water formed runs towards the mouth and can't flow back onto the hot glass and crack it.
- ✓ iii. It is lighter than air, and it is very soluble in water.
- ✓ iv. Damp red litmus turns blue at the mouth of the jar (or white fumes with a rod dipped in concentrated HCl).



7 Numerical problem

ANSWER

A · 4

- $\text{CO}_2 = 12 + 2 \times 16 = 44$. $\text{NH}_3 = 14 + 3 \times 1 = 17$.
- Carbon dioxide (44) is heavier than air (29): it is collected in an upright gas jar, by the upward displacement of air. Ammonia (17) is lighter than air: it is collected in a gas jar held upside down, by the downward displacement of air.

MARKING SCHEME

- ✓ $\text{CO}_2 = 12 + 2 \times 16 = 44$.
- ✓ $\text{NH}_3 = 14 + 3 \times 1 = 17$.
- ✓ CO_2 is heavier than air ($44 > 29$), so it is collected in an upright jar by the upward displacement of air.
- ✓ NH_3 is lighter than air ($17 < 29$), so it is collected in an upside-down jar by the downward displacement of air.

8 Think

ANSWER

HA · 2

Carbon dioxide. Water and rotting leaves at the bottom give it off, and being about 1.5 times heavier than air, with no wind to stir it, it lies at the bottom like an invisible pool. In large amounts (about 10% in the air) it makes a person unconscious within minutes.

MARKING SCHEME

- ✓ Carbon dioxide, given off by rotting leaves and water at the bottom.
- ✓ It is heavier than air, so with no wind it settles at the bottom of the well and pushes out the oxygen.

9 Activity: Inside and outside a plastic box (Activity 16.2)

(not marked)

WHAT STUDENTS SHOULD FIND

The air inside the box gets several degrees warmer than outside, often 10 °C or more on a sunny day. Sunlight passes into the box and warms the air and the bottom of the box; the box stops the warm air from mixing with the cooler air outside, and the plastic holds back some of the infrared. This is the artificial greenhouse effect; a car parked in the sun heats up the same way.

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	12	10	9	2	33

