Definition

It is defined as gases which are manufactured packed and intended for giving to a patient for diagnosis, therapy and to produce anaesthesia. It is considered as drugs and their use without medical practitioner is unsafe.

Three types

- Therapeutic
- Laboratory
- Anaesthesia

Medicinal gases

- oxygen
- carbondioxide
- Nitrogen
- Helium
- Nitrous oxide
- Nitrous oxide N2O Laughing gas

OXYGEN

Oxygen

Air (21% O_2 /79% N_2)Grey body with black & white shoulder quartering

Medical air is used:

- In anaesthesia as a carrier gas for volatile anaesthetic agents
- For drug delivery through nebulisation.
- In ventilators and incubators to provide uncontaminated and controlled air flows

Within the hospital environment oxygen is usually found in 3 main areas

- Critical care areas
- Operating theatres
- Most wards, A&E & treatment therapy areas

Introduction

- It is important for all living cells.
- It is necessary for normal oxidative metabolism for the production of useful energy.
- oxygen is combined with haemoglobin converted into oxy haemoglobin which dissociate and release oxygen to the cell.
- Requirement of oxygen in body is classified into

- **Anoxic**
- Inadequate supply of oxygen to the tissue
- **Anaemic**
- Inadequate amount of haemoglobin to supply the oxygen to the tissue. this is due to hemorrhage, carbon monoxide poisoning etc.
- carbon monoxide has more binding affinity towards haemoglobin, only oxygen administration is not effective for this condition. A carbondioxide oxygen mixture [hyperbaric oxygen] is used for this condition.

- **Stagnant**
- It occurs due to the inadequate general circulation or retardation of local circulation. Oxygen is not used in this case whereas cardiotonic drugs are used to speed up the circulation.
- **Histotic**
- It occurs due to interferences of tissue cell oxidation or uncoupling of oxidative phosphorylation or cyanide poisoning.

Preparation

- **Fractionation of liquid air**
- It is prepared by fractional distillation of liquid air. First of all the air is purified by removing moisture, carbon di oxide and dust. then it is compressed into liquid air. The liquid air is fractioned by distillation to get oxygen which is then filled under pressure in metallic cylinder. Nitrogen is more volatile and evaporated first leaving the oxygen.
- Argon in air is difficult to separate because its boiling point only 3C higher than that of oxygen.

- **Electrolysis of water**
- In this method, a direct current is passed through 1- 25 % potassium hydroxide and NaOH solution which contain electrodes due to electrolysis of the alkaline solution. Oxygen gets liberated at anode and hydrogen at cathode. The liberated oxygen is then filled under pressure in metallic cylinder

Assay

- The apparatus used in this assay is similar to that of the assay of nitrous oxide. but here the tube B is connected to a gas pipette containing two bulbs of suitable size. The absorbing gas used here is ammonium chloride and ammonium hydroxide and follow the all procedures similar to that of nitrous oxide. Measure the residual gas volume which is present in the burette. It should not be more than 1 % v/v.

use of oxygen

- It is used as inhalant in anaesthesia post operative condition, burns and wounds.
- Osmotic condition, gaseous poisoning and artificial respiration.
- It is mixed with 5-7% CO2 which is used for stimulating respiratory centre.
- The mixture of oxygen and helium 21:79 is used for patients with severe lung damage.
- labelling
- The shoulder of cylinder should be painted white and the remainder should be painted black . The cylinder should carry a label stating oxygen . along with this, oxygen or the symbol O2 should be stenciled in paint on the shoulder of the cylinder.

NITROUS OXIDE

Nitrous Oxide (N2O) All Blue

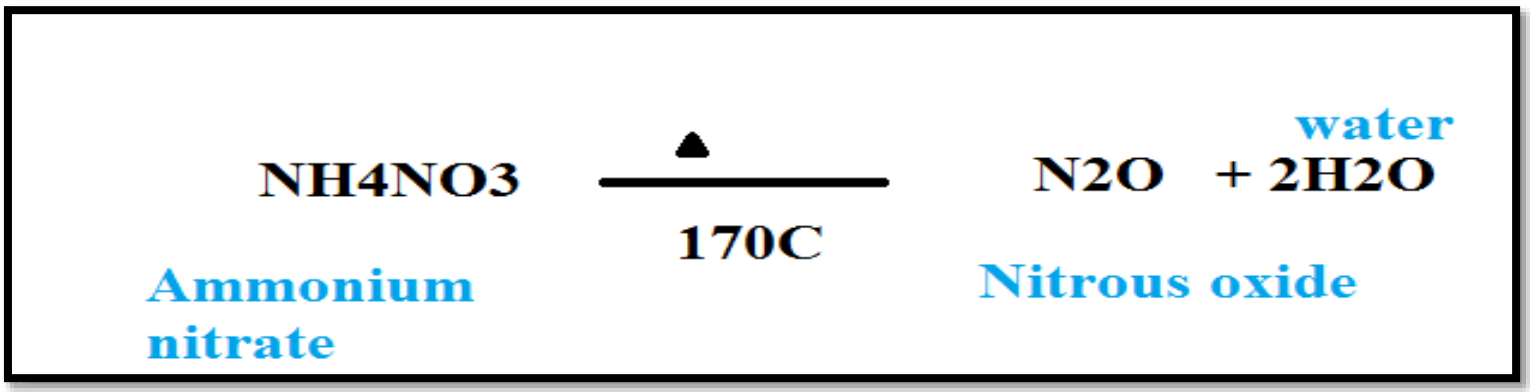
Nitrous Oxide is used:

- As an inhalation anaesthetic as part of a balanced maintenance of a General Anaesthetic.

Only medical personnel trained in the appropriate techniques should administer nitrous oxide

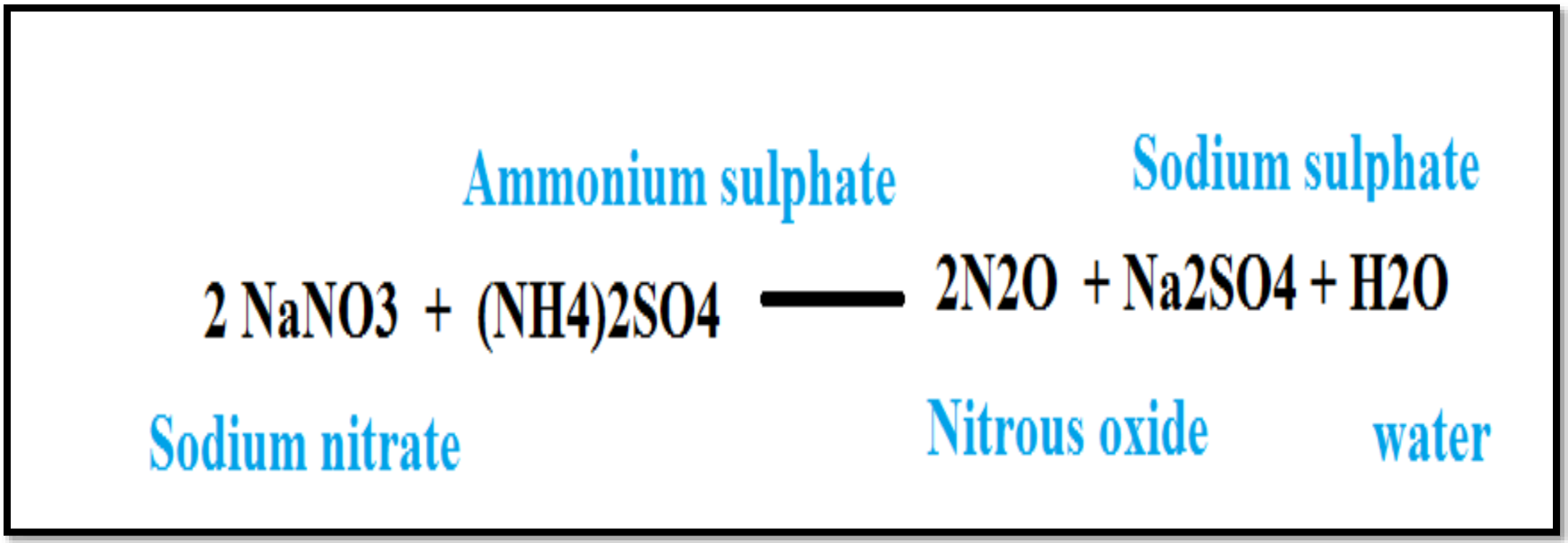
Nitrous oxide N2O Laughing gas

- **Lab preparation**
- Thermal decomposition of ammonium nitrate is explosive if temperature is allowed to rise too high. The gas obtained is purified by washing with sodium dichromate, sodium hydroxide and water finally, it is filled in cylinder under pressure at 100 atmosphere pressure



From ammonium sulphate

2 molecules of sodium nitrate is treated with ammonium sulphate to produce 2 molecules of nitrous oxide with sodium sulphate and water.



Assay

- It is assayed by gasometric method. A special type of apparatus is used.
- The apparatus consist of gas burette with 100 ml capacity is connected with two capillaries A and B at upper end through a two way tap .
- The capillary A is used to pass the gas into the apparatus, the other one B is connected to a vertical capillary arm to form a four way junction.
- The right arm of the junction is attached to a mercury manometer. Tap D is connected to the air. The lower portion of the gas burette is attached to a one way tap which is connected to a mercury reservoir through a rubber tube.the upper part of the gas burette is calibrated from 0-5 ml and the lower part of the burette is calibrated from 99.5 to 100 ml both in difference of 0.1 ml.

Method

- Tightly close the three taps immerse the condenser slightly above the upper of the condenser in liquid nitrogen.
- Create a partial vacuum in the apparatus by adjusting the mobile reservoir. Maintain this pressure upto 10 minutes to make the apparatus is gas tight.
- Open the two way tube A, Completely fill the burette and tube A with mercury close the two way tube.
- Then connect a rubber tube trough a pressure relieving device to the exit valve of the gas to be analysed and pass the gas through the rubber tube for one minute connect the rubber tube to the end of A tube immediately open the two way tap to A.

Method

- By lowering the mercury reservoir to allow the specified volume of gas to enter the burette.
- Disconnect the rubber tube and allow removing the gas from the burette by slowly raising the mercury reservoir above the capillary tube.
- pass the required volume of gas to be analysed to enter the burette by lowering the mercury reservoir slightly above tube A.
- Then lower the liquid nitrogen to the middle of the condenser and allow the mercury to rise in the burette slightly above tube A.

Method

- Slowly open the burette tap to connect the condenser and allow the mercury to rise in the burette until it reaches the tap.
- Close the tap, increase the level of the liquid nitrogen so as to immerse the condenser. note the pressure and remains constant for 2 minutes.
- Move the mercury reservoir to down position, open the burette tap to connect with the condenser. Adjust the mercury reservoir until the manometer reading is similar to that of the initial pressure, close the burette tap and maintain the pressure is equal to atmospheric pressure. The volume of gas in ml indicates the volume of gas used.
- similarly take 10 determinations, remove the liquid nitrogen and dry the condenser.

Uses

- In General anesthesia for producing analgesic and anesthetic effect.
- A mixture of 1: 1 ratio with oxygen is used for the relief of pain in child birth and heart attack. Myocardial infarction.
- Calming the excited psyciatry patients.
- To induce anaesthesia.
- Non toxic in nature frequently used in dental practice.
- Quickly absorbed by inhalation, better analgesic and weak anesthetic.
- **labelling**
- The cylinder is painted with blue color with the name nitrous oxide and the symbol N2O or the name should be stenciled in paint on the shoulder of the cylinder.

Entonox (50% N2O / 50% O2)Blue with Blue & White Quartering

Entonox can be used for short term relief for procedures involving pain.

Common areas who use Entonox are

- Midwifery
- A&E

CARBON DI OXIDE

Carbon Dioxide (CO_2) All grey green

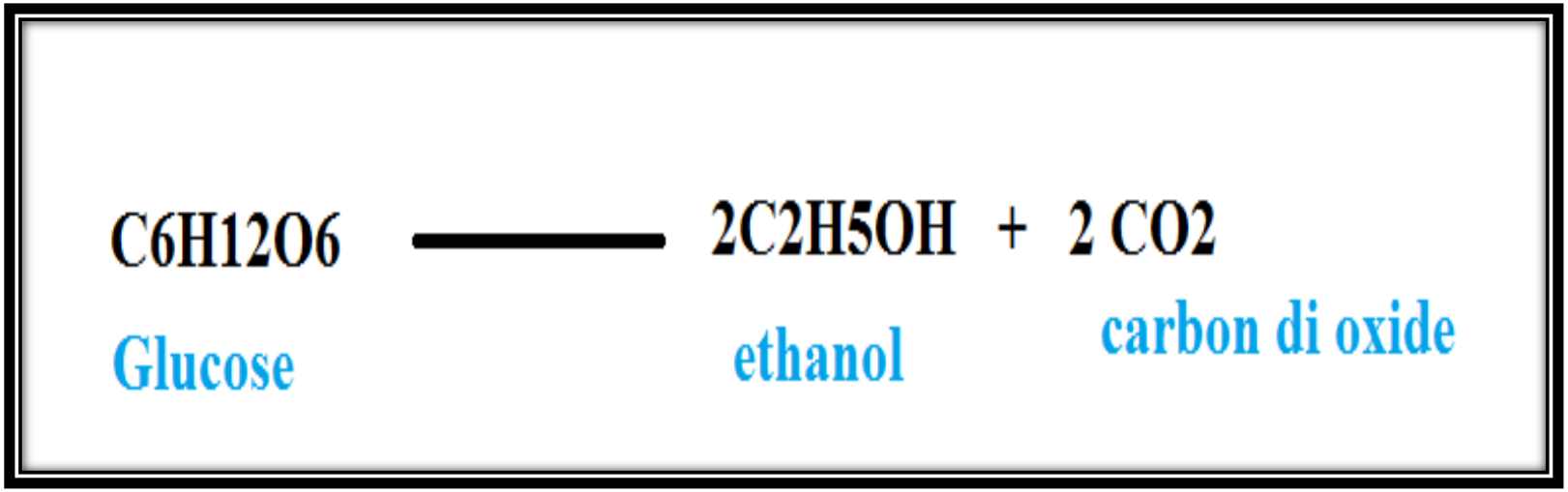
Carbon dioxide is insufflated into the abdominal cavity to distend it to allow investigation & treatment of intra abdominal disease and for laparoscopic surgery.

Carbon dioxide should only be given under the direct supervision of a clinician.

- Air contains 0.03% v/v of CO_2
- Sources Volcanoes
- Dead bodies decay
- Respiration
- Combustion
- Fermentation

Preparation

- **By Fermentation process**
- Fermentation of a sugar produces alcohol and CO2 as a byproduct.



Commercial

Co2 from fuel gas which is passed under pressure over potassium carbonate, which yields potassium bicarbonate and CO2 is liberated. Then it should be compressed into a metallic cylinder.

carbon di oxide

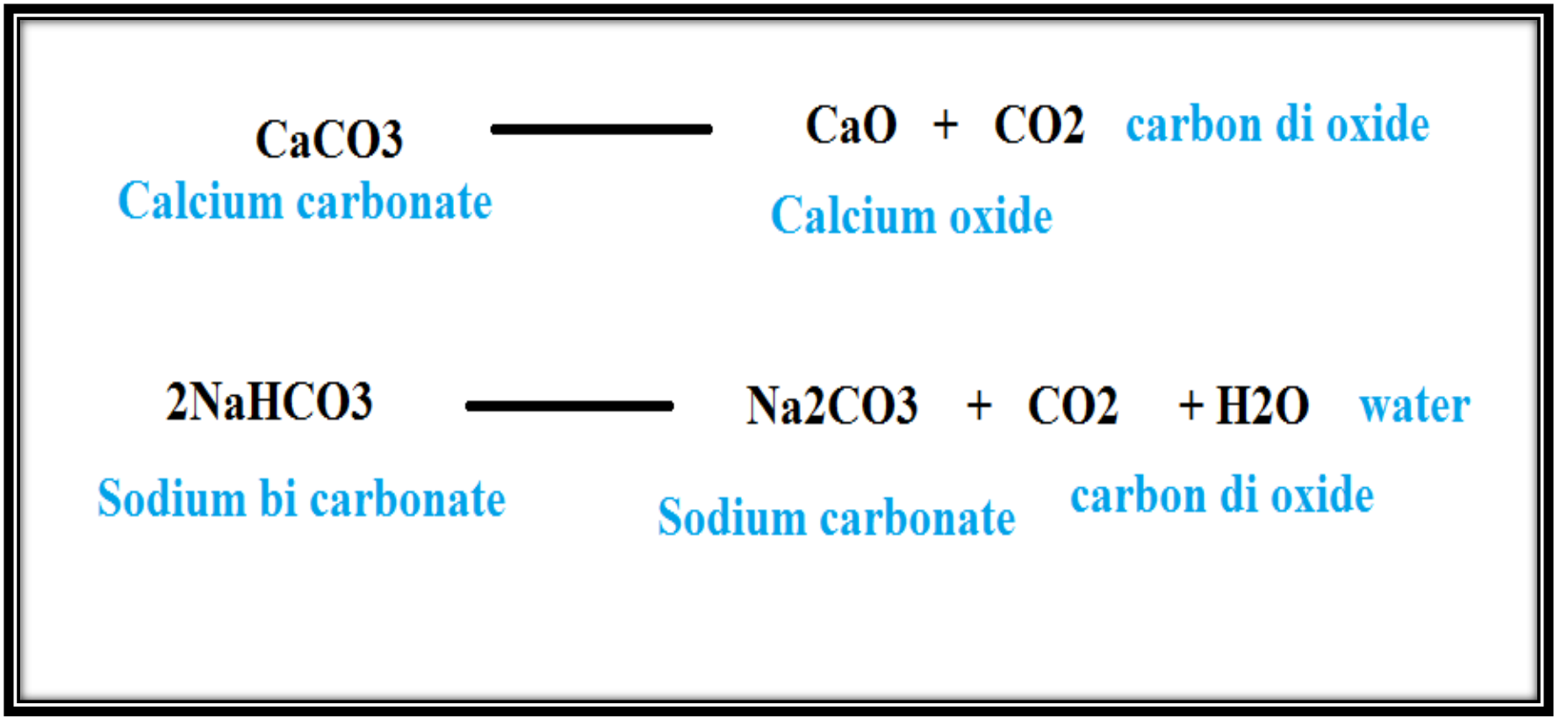
$$K_2CO_3 + CO_2 + H_2O \longrightarrow KHCO_3$$

Potassium carbonate — fuel — water — Potassium bi carbonate

$$2KHCO_3 \longrightarrow K_2CO_3 + CO_2 + H_2O$$

Potassium bi carbonate — Potassium carbonate — Carbon di oxide — water

From carbonates of heavy metals or bicarbonates of alkali metal



Assay

- It is assayed by gasometry. The absorbing gas used is potassium hydroxide solution 50 %. The decreased gas volume is measured at standard temperature and pressure. Not more than 1 ml of gas is remaining in the tube if 100ml of sample is used. Remaining all is similar to oxygen.

Use of CO2

- The mixture of 95: 5 [ratio of CO2: O2] is used in the treatment of carbon monoxide poisoning for increasing the ventilator exchange rate and dissociation rate of co from haemoglobin
- Carbonated vehicles are useful for masking the unpleasant taste of saline.
- Inhalation of CO2 as been used for relaxation.
- Detoxification of heroin addicts
- Dry ice as temperature of 80C is used to remove warts.
- 6% carbon di oxide is toxic.
- **labelling**
- The shoulder of the cylinder should be painted grey and having the name and symbol of CO2 stenciled with paint on it.

Heliox(21%O_2 /79%He), Brown with white quartering

Heliox is a mixture of helium and oxygen and is often used in emergency situations where upper or lower airways are partially obstructed, but may also be used within an intensive care setting for those patients receiving both invasive and non invasive ventilation.

Heliox should be administered via appropriate equipment calibrated for the gas mixture.

Helium

- It contains NLT 99% by volume of He
- It is the second highest element in the periodic table. It is used as a diluent in oxygen administered during mucosal plug obstructions, laryngeal edema etc. which produces turbulent air flow. The density of this mixture is one third of the density of air since the diffusion of gas through the small orifice, by this way it penetrates the restricted respiratory passages with greater facility than air.
- Due to less density than air, it changes or pitches or sounds uttered by the vocal cords to be increased leads to unintelligible speech like Donald duck sound.

Preparation & Use

- Helium is obtained from either natural gas or fractional distillation of liquid air which is intended for medicinal gas.
- **Use**
- Helium - oxygen mixture are easier to breathe by patients with severe lung damage or with obstructions in upper respiratory tract.
- Helium breathing may also influence vocal pattern and vocal pitch.

Storage

- It should be stored and supplied in brown colored metal cylinder under compression in 98 %v/v purity. Mixtures of oxygen and helium in the ratio of 20-21 % and 79-80% v/v re also supplied in cylinders which are painted black on the body and white and brown batches on the shoulders and neck.

NITROGEN

- It is important constituent of animal and plant tissues; largely present as amino acid asproteins
- It is used as diluent for pure oxygen
- It is used as pharmaceutical aid to remove air by this way it is used as an antioxidant.
- The increased concentration of nitrogen in blood leads to narcosis.
- It is obtained by fractional distillation of liquid air

- Assay
- It is assayed by gasometry
- Use
- It is used as diluent for oxygen before administration
- It is also used to remove tumors.
- Storage
- It should be stored and supplied in metal cylinders painted grey with black on the neck and shoulders and the name or symbol is stenciled on the body of the cylinder.

Common Medical Gas cylinders by size

In order from left to right:

- CD (Oxygen)
- E
- F
- G

SIGNS

Oxidisation

Gases if released will Increase the levels of oxygen in the atmosphere and will support and increase the rate of combustion

Storage pressure

The stored pressure in a medical gas cylinder can be up to 300 bar, which is 150 times greater than your car tyre.

It is essential that Cylinders are stored correctly in a well ventilated area and not exposed to extremes of temperature

Temperature

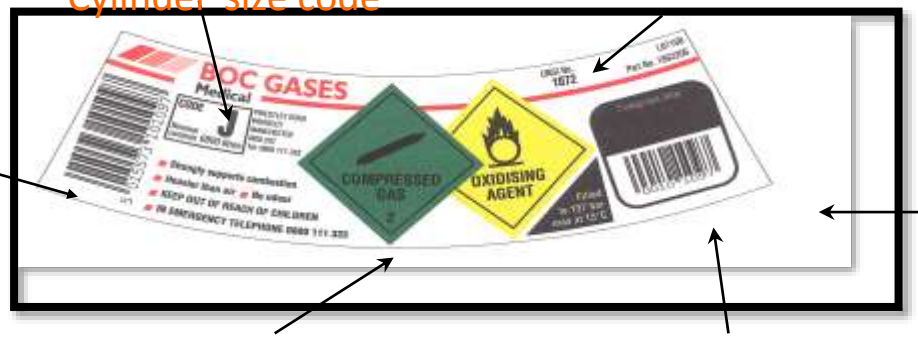
The storage temperature of certain gases can be below minus 180 degrees Celsius

Ability to asphyxiate

Gases stored in liquid form can expand up to 800 times its volume and cause oxygen deficient atmospheres.

Where to find Safety Information

Cylinder collar



Cylinder size code

UNSI number

Product & cylinder size bar code

Batch Label to be affixed here

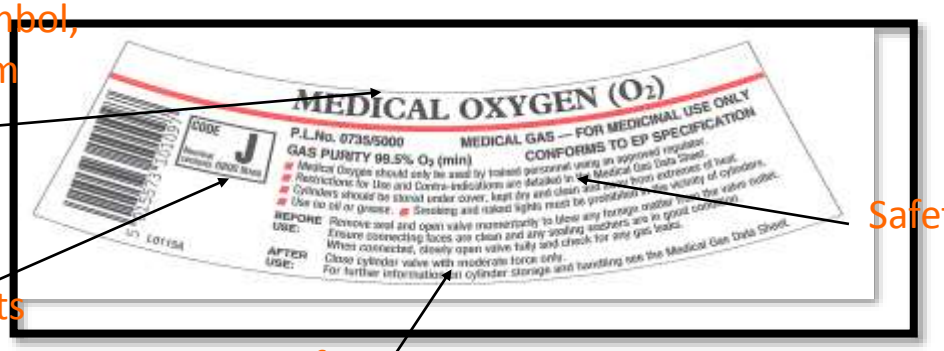
Hazard warning diamonds

Max cylinder pressure in bar

Cylinder collar labels give important safety and usage information, as well as confirming the identity of the cylinder contents. They should ALWAYS be checked before a cylinder is used and should NEVER be removed.

Cylinder collar

Name, chemical symbol, pharmaceutical form of product



Safety information

Nominal contents in Litres

Directions for use, storage and handling precautions

The contents stated on the cylinder collar should correspond with the colour of the cylinder.

It is NOT sufficient to assume that the colour coding of the cylinder accurately reflects the contents.

- The approximate consumption rate of a CD cylinder at 5L per min is 1.5hrs.
- BOC Medical gases have a 3 year shelf life and should not be used after the expiry date.
- If the gas is not being used, the cylinder valve should be closed.

Moving and Handling

Storage

- Storage is divided into two types, a MAIN store and smaller units, situated in convenient locations around the hospital and known as READY TO USE stores.
- In addition to this you will have areas on your ward where one or two cylinders will be held, ready for administration to a patient, this we would refer to as a cylinder parking area.
- Where ever medical gases are stored, they should be on their own and away from any other flammable gases or other materials.

Gas Outlet arrangement

- Medical gas outlets are always arranged in the same order from left to right and are identified by colour and the name of the gas.

Flow meter

- To set flow turn knob anti clockwise until ball rises to the flow rate required, watch for 2-3 seconds to ensure flow rate maintained, the ball should sit in the middle of the required rate
- When not in use the flow of gas must be turned off by turning knob clockwise and the ball falls to zero.
- Flow meters should be operated by qualified nursing/medical staff


BS5682
OXYGEN


BS5682
AIR 4 BAR


BS5682
VACUUM


OFF
-50
High
-20
-80
0
-100
kPa

CASE STUDY QUESTIONS

- A 56 year old female patient is receiving oxygen at 1.5 L/min. via a pulsed-dose oxygen delivery system attached to a reservoir cannula. As you are doing your oxygen rounds, the patient complains of severe shortness of breath and states "she is not getting enough air". What would be your first immediate response at this time?

A. Attach the patient's reservoir cannula to a thorpe tube flowmeter at 1.5 L/min.

B. Remove the cannula and verify the flow

C. Troubleshoot the equipment

D. Increase the liter flow to 2 L/min.

Answer

- Take care of the patient first!
- A Will give the patient O2 immediately (then check what else may be wrong)
- B Focusing on the equipment not the patient, does not help the pt
- C Same as b
- D May or may not help, because you do not know what is going on

A patient with a laryngeal tumor is presently receiving 80/20% helium-oxygen by a nonrebreathing mask at 5 L/min. The patient is alert, but appears agitated. Vital signs indicate a pulse of 131/min, respirations at 30/min, and a blood pressure of 140/90 mm Hg. Which of the following is the most appropriate action to take?

A. Initiate sedation.

B. Recommend changing to an F I O 2 of 1.0.

C. Increase the gas flow to the mask.

D. Administer racemic epinephrine.

Answer

- **EXPLANATIONS:**
- **(h) A. Initiating sedation could further reduce the patient's ability to provide adequate ventilation.**
- **(u) B. Increasing the F I O 2 would improve oxygenation, but would not help with carbon dioxide elimination from the lungs.**
- **(c) C. Higher flows of helium/oxygen, undiluted by air entrainment, will ensure consistent administration of the 80/20 mixture and improve ventilation past the stricture caused by the laryngeal tumor.**
- **(u) D. Administering racemic epinephrine will have no effect on the size of the laryngeal tumor.**

- The physician has requested that you administer 80% helium and 20% oxygen mixture to a patient. Which of the following equipment would you need to administer the therapy?
- I. Air/oxygen proportioner
- II. Venturi mask
- III. Oxygen analyzer
- IV. Non-rebreather mask

A.IV only

B.I and III only

C.II only

D.I, III and IV only

Answer

- 1Comes already mixed, so don’t need this
- 2Entrains air and will mess up the mixtiue
- 3No need, it’s already mixed
- 4This is all you need to provide 100% source gas. But must stay partially inflated at all times.

- A patient is receiving oxygen via a Venturi mask at an FIO2 of 0.45. The nurse is complaining that the patient keeps removing the Venturi mask from his face. You would do which of the following at this time?
- A.Tape the Venturi mask to the patient's face
- B.Restrain the patient
- C.Switch to a nasal cannula at 6 L/min.
- D.Intubate the patient orally

Answer

- Atempting, but not the best answer, would be inappropriate
- BTempting, but not good
- CThis would solve the problem (about the same FiO2 4%/L + RA = 45%)
- DMay keep them from complaining but not the best way to solve the problem

What is the approximate total flow that would be delivered from a 40% air-entrainment mask receiving 12 L/min of oxygen?

A. 12 L/min

B. 48 L/min

C. 52 L/min

D. 72 L/min

Answer

- **EXPLANATIONS:**
- **(u) A. See B for correct calculation.**
- **(c) B. A 40% air-entrainment mask entrains air at a ratio of (3)air:(1)O 2 . Let x = O 2 flow in L/min 3x = air entrained 3x + x = total flow 3(12) + 12 = total flow = 48 L/min.**
- **(u) C. See B for correct calculation.**
- **(u) D. See B for correct calculation**

A patient with chronic hypercapnia is to receive oxygen at home by nasal cannula at 2 L/min. The respiratory therapist should advise the patient to ensure the oxygen flow does not exceed 2 L/min because excessive oxygenation may

A. dry secretions.

B. cause oxygen toxicity.

C. trigger retinopathy.

D. depress breathing.

Answer

- **EXPLANATIONS:**
- **(u) A. Exposure to high levels of oxygen is not known to dry secretions.**
- **(u) B. The incidence of oxygen toxicity is increased when a patient has extended exposure to F I O 2 levels = 0.60. It is very unlikely that a nasal cannula is able to deliver an F I O 2 = 0.60.**
- **(u) C. Retinopathy of prematurity is a complication of elevated PaO 2 levels and has the highest incidence in neonates weighing < 1 kg.**
- **(c) D. Patients with chronic hypercapnia breathe in response to hypoxic stimulation of aortic and carotid receptors. Excessive supplemental oxygen may suppress the hypoxic ventilatory drive and result in hypoventilation.**

A patient is receiving oxygen by a nonrebreathing mask. The reservoir bag collapses during inspiration. The respiratory therapist should

A. increase the oxygen liter flow by 5 L/min.

B. adjust the flow until the reservoir bag remains partially inflated at end-inspiration.

C. remove leaflet valves from exhalation ports.

D. remove the one-way valve between the reservoir bag and the mask.

Answer

- **EXPLANATIONS:**
- **(a) A. Increasing the flow may solve the problem; however, further assessment is required since 5 L/min may still not be sufficient.**
- **(c) B. The flow should be increased to ensure adequate volume in the reservoir bag throughout each breath.**
- **(h) C. Removing the leaflet valves will decrease the concentration of oxygen due to air dilution and may inappropriately lower the F I O 2 .**
- **(h) D. Removing the one-way valve changes the mask to a partial rebreathing mask and may inappropriately lower the F I O 2 .**

A respiratory therapist has initiated oxygen therapy with a nasal cannula. In addition to a signature and credentials, which of the following is the best example of appropriate documentation?

A. nasal cannula placed on patient, HR=96, SpO 2 =92%, RR=22

B. 12/6/03, 2 L/min oxygen placed on patient at 0830

C. 0830, nasal cannula at 2 L/min, temp=101, HR=96, RR=22, BP=150/80

D. 12/6/03, 0830, nasal cannula started at 2 L/min, SpO 2 =92%, RR=22, HR=96

Answer

- **EXPLANATIONS:**
- **(u) A. See D for explanation.**
- **(u) B. See D for explanation.**
- **(u) C. See D for explanation.**
- **(c) D. This includes all appropriate information: date, time, mode, liter flow, and the patient's response to therapy.**

An air-entrainment mask will deliver an F I O 2 higher than intended if

A. the flow is set too high.

B. nebulized water is being added through the air-entrainment ports.

C. corrugated tubing was added between the air-entrainment adapter and mask.

D. the air-entrainment ports have been blocked.

Answer

- **EXPLANATIONS:**
- **(u) A. If the flow is set higher than recommended, it will entrain more room air and still maintain the same F I O 2 . It will not deliver a higher F I O 2 than intended.**
- **(u) B. Adding nebulized water through the air-entrainment ports is not routinely performed. The F I O 2 will not increase.**
- **(u) C. Adding tubing between the air-entrainment adapter and the mask will not cause the mask to entrain less room air and deliver a higher F I O 2 than expected.**
- **(c) D. If the air-entrainment ports have been blocked, room air cannot be entrained and the patient will receive a higher F I O 2 than expected.**

You are working with an intubated patient who is mechanically ventilated. The O2 analyzer is a galvanic fuel-cell type. Every time the patient's airway pressure fluctuates during a mechanical breath, the O2 percentage goes up and then down. This could be caused by:

A. Plugged capillary line
B. Dry analyzer chamber
C. Variable pressure against analyzer probe
D. Exhausted supply of chemical reactant

Pressure sensitive,
Use a polarographic analyzer

Which of the following oxygen administration devices is capable of meeting and/or exceeding a patient's inspiratory flow?

A. air-entrainment mask

B. nasal cannula

C. nonrebreathing mask

D. reservoir cannula

Answer

- **EXPLANATIONS:**
- **(c) A. The entrainment of room air can result in total flow equal to, or exceeding, patient peak inspiratory flow and tidal volume.**
- **(u) B. A nasal cannula is generally not used at flows greater than 6 L/min. Average patient peak inspiratory flow is 35 L/min; therefore, tidal volume requirements cannot be met by nasal cannula flow alone.**
- **(u) C. A non rebreathing mask may deliver a high flow, but it cannot be determined if total flow is adequate to meet the patient's needs.**
- **(u) D. A reservoir cannula cannot deliver a flow high enough to meet a patient's inspiratory needs.**