Nitrogen

Is nitrogen necessary for human life?
Nitrogen is absolutely necessary for human life because bacteria digest dead plant and animal matter, and they release ammonia. Ammonia is a form of nitrogen which is used by plants to make them grow.
When animals eat the plants, they acquire usable nitrogen compounds which are essential to their diet.
Our whole food chain is dependent upon nitrogen to survive.

Can't we get nitrogen from the air we breathe?
Nitrogen makes up 78% of the air that we breathe, but we get no benefit from breathing it. In fact, we could suffocate by breathing too much of it, not because it is poisonous, but rather because it could deprive us of the oxygen that our bodies need.

How was nitrogen used on the Hornet?
Nitrogen was used on the ship as a fire suppressant, Airplane tires, catapult pressure source, and wave guide. Fire needs oxygen to burn. Nitrogen cannot extinguish a fire, but can prevent a fire by replacing the oxygen that the fire requires.

Where can we see an example of this on the Hornet?
Go down to Third Deck, just below the Ward Room. There, you will see the ordinance transfer area which has various large lockers for temporary storage of explosive weapons. Look for the locker that says *Sidewinder Missiles.* Directly over the door to this compartment, you will see a hand-wheel. When this room is supplied with sidewinder missiles, that hand-wheel opens a valve which will flood this compartment with nitrogen. Sidewinder missiles are detonated by heat, and an accidental fire could cause a chain-reaction explosion of all the missiles in that compartment, so flooding the room with nitrogen is an important safety precaution.

Where do we get all that nitrogen?
The Hornet has two nitrogen / oxygen generating plants. These rooms are called *Cryogeneration Rooms* or *O_2N_2 Rooms.* These are fancy words, but they are easy to understand: *cryo* = ice, and *generation* = manufacturing, so *cryogeneration* simply means that they freeze air. And, O_2 is the chemical symbol for *oxygen,* and N_2 is the symbol for *nitrogen.*

How are nitrogen and oxygen extracted from the air?
Ambient air is compressed, and then cooled by a heat exchanger. The compressed air is now cold, and the chemical elements will separate by weight. The settling tank is tall and thin. The heavier elements (mostly carbon dioxide), will sink to the bottom of the tank and may be discarded. The lighter elements (oxygen and hydrogen), will rise to the top of the tank with nitrogen floating above the oxygen. The two gases, now separated, will go through heat exchangers again, which will continue to cool the gases until they turn into a liquid. Oxygen liquefies at -297^{o}F, and nitrogen liquefies at -346^{o}F. The liquid oxygen and nitrogen are then pumped to other parts of the ship where they will be stored in tanks or cylinders.

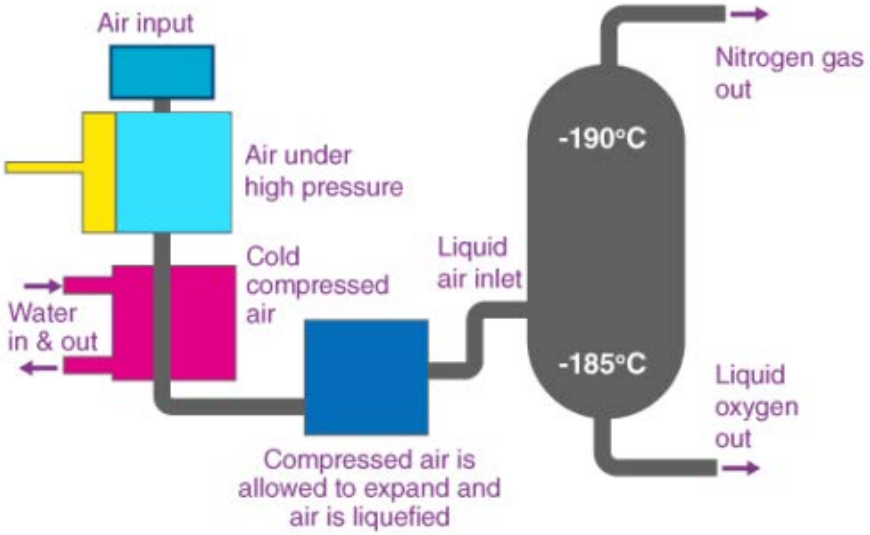

Figure 1 Separation Technic for Air

Does the liquid gas need to be refrigerated to remain a liquid?
It must be refrigerated. You cannot pressurize N2 or O_2 into a liquid. N_2 must be cooled down to about -196C/-321F and O_2 must be kept below -183°C (-297°F). If its temperature rises above this, it will turn to gas and it will over pressurize its container. Typically, you see a vent on a N_2/O_2 container that is spewing a very cold gas. It is allowed to boil off keeping the rest of the liquid cold.

To fill a 5' tall bottle with nitrogen, we had to chill the gas to -346^{o}F. We started with 230 cubic feet of warm nitrogen, and it all got squeezed into a 5' bottle. As the pressure was released, the volume of warm gas turned into 700 times its volume as a liquid. Liquid oxygen expands about 860 times the volume when turning into a gas.

Why are there 5-foot nitrogen bottles in the tire shop on the Hangar Deck?
Nitrogen is always used to fill aviation tires. One reason is because our air compressors can only reach 250 psi air pressure, and many of our planes require over 300 psi for reliability and efficiency. The nitrogen bottles contain over 2,000 psi. Another reason is that ambient air contains water vapor, which can rust and corrode steel-belted tires. You also don't want any water in your tires which can freeze when the plane reaches high altitudes. Landing a plane with frozen tires can be very hazardous. One more reason is because nitrogen has large molecules which do not leak air pressure, and ambient air contains some smaller molecules which can leak out and require constant refilling.

Where can we find the larger storage tanks of nitrogen?
Some large nitrogen tanks can be found on Fourth Deck, just forward of the Sidewinder Assembly room. After the missiles are assembled, they are tested to make sure that the tailfins can track infrared light. The missiles are then fused and ready to explode, so the compartments they are stored in can be flooded with nitrogen if needed.

Why are there nitrogen tanks in the passageway near the Port Catapult room?
When the Hornet was remodeled in 1953, the new catapult was designed to use compressed air (4,000psi) to suddenly flood a tank of hydraulic oil to supply the energy to launch aircraft. All Essex-class carriers used the same system. On May 26, 1954, the USS Bennington (CV20), made a tragic discovery: air containing oxygen + sudden high pressure + petroleum oil = huge explosion. The resulting explosion and fire caused 103 deaths and 200 serious injuries. To avoid this happening again, all Essex carriers used nitrogen in their pressure tanks instead of ambient air.

Why don't they use nitrogen to launch airplanes today?
Following the 1954 disaster on the USS Bennington, nitrogen was used to replace oxygen as a stopgap measure to prevent explosions on the other Essex carriers. In 1955 the USS Midway was totally rebuilt with a new style of catapult.

What engineering changes had to be made to launch aircraft by steam power?
The remodeled Midway has 12 boilers, compared to Hornet's 8. Her two evaporator plants produce 280,000 gallons of fresh water per day, compared to Hornet's 100,000 gallons. Many other engineering adjustments had to be made to convert from hydraulic to the steam powered catapult.

Oxygen

What percentage of our atmosphere is oxygen?
Oxygen is the most common element in the world. In fact, 47% the world's mass is oxygen, but it comprises only 21% of our atmosphere. The vast majority of Earth's oxygen is in the form of water.

How is it possible for two gases (oxygen + hydrogen) to become a liquid?
Water is a liquid made up of a hydrogen molecule bonded with two oxygen molecules to form a compound which is held together by electrostatic force. Hydrogen has a slightly positive electron, and oxygen has a slightly negative electron, so it is easy for them to bond chemically. All it takes is a spark of electricity, (like a lightning bolt), to start the chemical reaction. The result is a compound which is a heavier liquid than the two gas molecules separately. On earth at one atmosphere of pressure, 14.7psia, H_2O will be liquid between 0C/32F and 100C/212F. Above 212F it becomes a gas.

When nitrogen and oxygen were distilled on the Hornet, what was the oxygen used for?
On a flight mission, it was essential for pilots to carry a supply of oxygen for flying at high altitudes, and also for doing high g-force maneuvers.

What in the world is an OBA locker?
An Oxygen Breathing Apparatus locker is a handy thing to have around whenever the air suddenly becomes contaminated by smoke, chemical fumes, or poisonous gas. The locker contains a supply of facemasks which can provide you with oxygen-rich pressurized clean air. The chemical reaction for an oxygen breathing apparatus is: $4KO_2$ (s) + $2CO_2$ (g) → $2K_2CO_3$ (s) + $3O_2$ (g), where potassium superoxide (KO_2) reacts with carbon dioxide (CO_2) from exhaled breath to produce oxygen (O_2) and absorb the carbon dioxide simultaneously.

Air scrubbers are also popular on submarines. When you breathe, you inhale 21% oxygen, and you exhale 16% oxygen + 5% carbon dioxide. The air scrubber will filter out the carbon dioxide, and replace it with 5% oxygen. In this way, you can breathe the same air again and again.

Who else on the ship uses oxygen?
In Sick Bay, oxygen has many uses. The easiest one to see is in the Quarantine Room. You have two bunks with metal hoops over them. This is used for burn victims. A tent is set up over the patient to keep anything from touching the wound. Oxygen is released under the tent to promote healing. Antiseptics are also applied to avoid infection.

Is it used anywhere else?
The engineering department has many uses for oxygen. Combined with acetylene as a fuel, oxygen is used for welding, cutting and brazing hard metals.

Is liquid oxygen flammable?
Liquid oxygen is not flammable, but when it is near any flammable substance, even a small spark could trigger an instantaneous and violent combustion. It is extremely dangerous to store or handle.

Carbon Dioxide

Since nitrogen and oxygen can be distilled from the atmosphere, why can't carbon dioxide?
Less than ½% of our atmosphere contains carbon dioxide, so it is not practical to manufacture it by distillation. All carbon dioxide used on the Hornet was obtained from private industry. It is a common bi-product during production of ammonia, alcohol, and fertilizers.

Where do we see CO_2 tanks on the Hornet?
There are red CO_2 fire extinguishers near all electrical or combustible areas on the ship.

Are there areas where large amounts of CO_2 could flood an entire room?
All engine rooms, fuel storage areas, and fuel filter rooms could be flooded with CO_2 in an emergency. The easiest one for visitors to see is the HEAF filter room (purple tank) on Third Deck, port side, between the classrooms. All red nozzles are identified as CO_2 outlets.