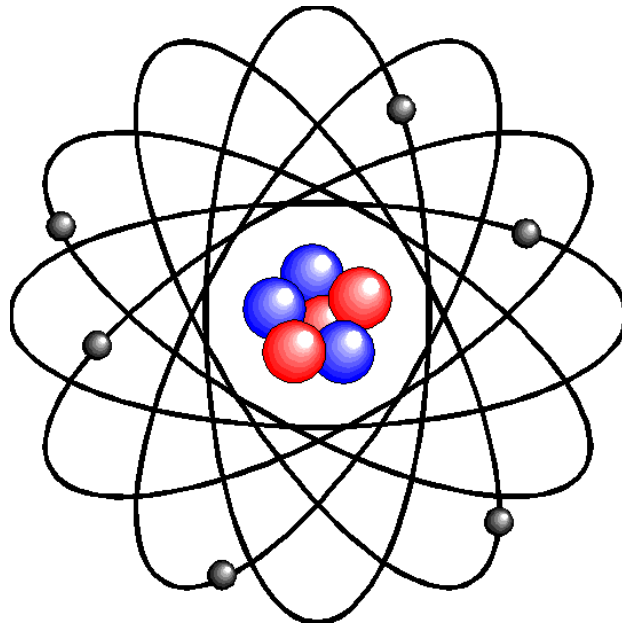



Radiation Safety: Oxygen-15 gas



START

Learning Tips

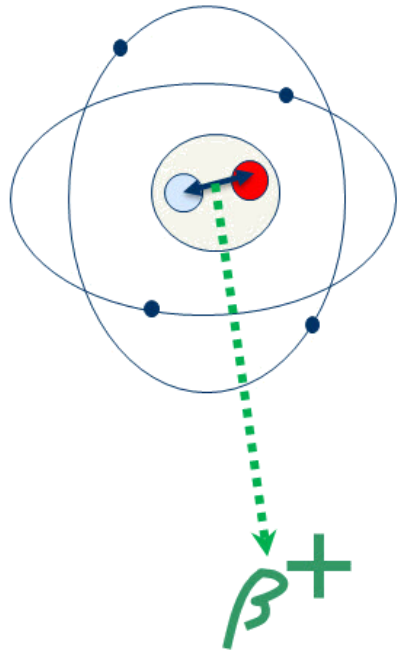
1. Click the **Next** and **Previous** arrows below  to navigate [the module](#).
2. Check out the **FAQ** tab to help answer any questions you may have.
3. This module will take you approximately 25 minutes to complete.
4. Contact the Radiation Safety Officer for any inquiries or feedback regarding any radiation safety training module.

Radiation Safety: Oxygen-15 gas

- Prerequisite learning on LearningEdge:
 - Basic Level Isotope Safety
 - Radiation Safety for Isotope Handler's
- All staff (PIs, students, animal health technicians, PET/MRI technologists etc.) involved with O-15 gas experiments must complete this online module and go through the O-15 gas SOP with the RSO
- Staff will be approved by the RSO for work with O-15 gas after these two criteria have been met

Review: Protons and Positron Radiation

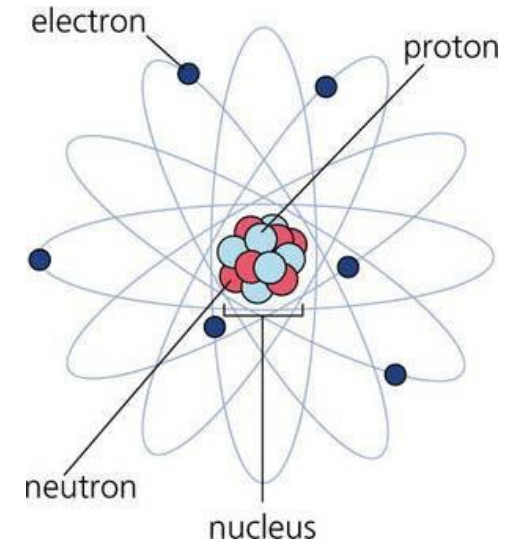
- During radioactive decay, positron emission (beta decay) occurs when a proton inside the nucleus of O-15 is converted into a neutron resulting in the emission of a positron (green) particle
 - A positron is an electron with a unit-positive charge



- Common Isotope Used and its Specific Energy

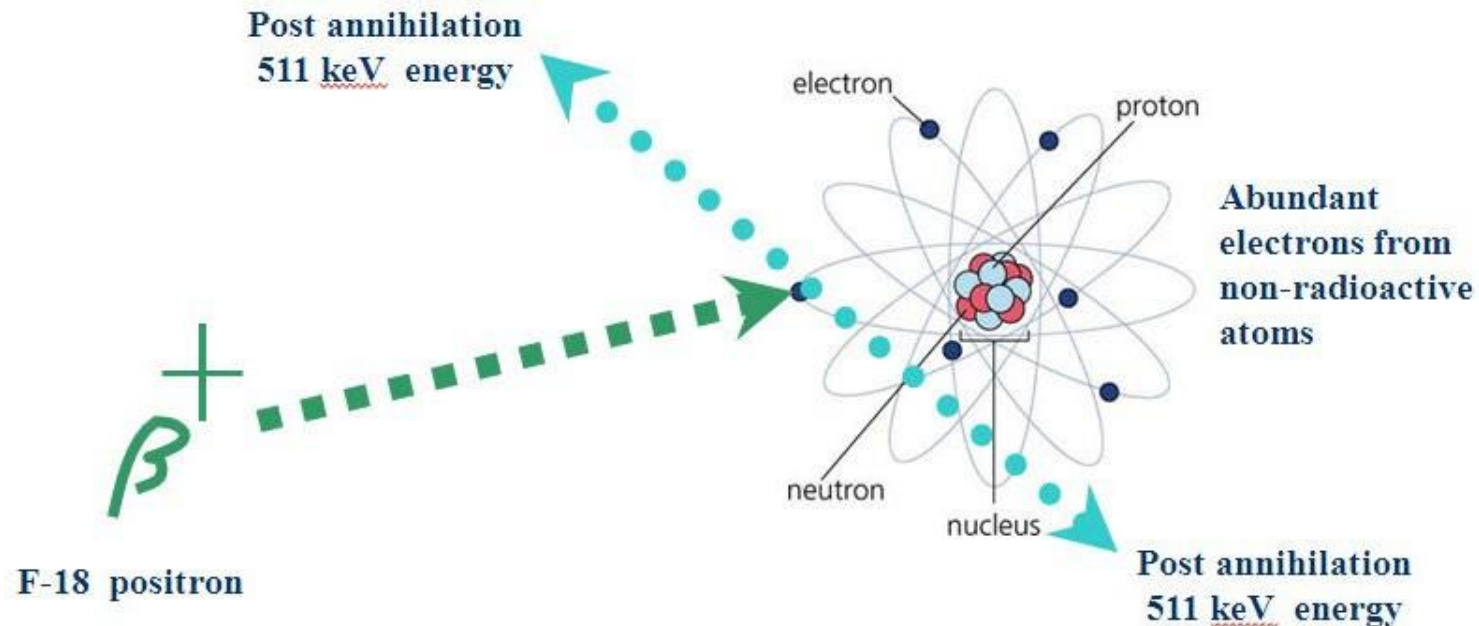
- C-11 = 960 keV
- F-18 = 635 keV
- N-13 = 1190 keV
- Zr-89 = 909 keV
- O-15 = 1735 keV

- The emitted positron travels a short distance before it combines with a free electron in an annihilation reaction (see next page)



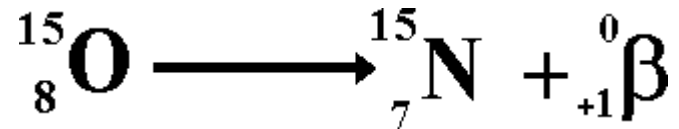
Review: Protons and Positron Radiation Cont'd

- Annihilation reactions are the result of a collision between the emitted positron and an always present electron (see diagram below)
- The masses of both positron and electron are completely annihilated releasing a total energy of 1.022 MeV
- The 1022 keV energy is released in the form of two 511 keV energy photons that radiate at exactly opposite directions (180 degrees) of one another
- Annihilation occurs on the average every 10^{-9} seconds
 - Positron emitting radioactive atoms have short half lives because of this rapid reaction.
- Since these annihilation photon energies are considered very high (511 keV), the radiation can penetrate deep into thick dense material (e.g. deep into a person's torso)
 - Dense metal is required to attenuate this energy (e.g. tungsten).

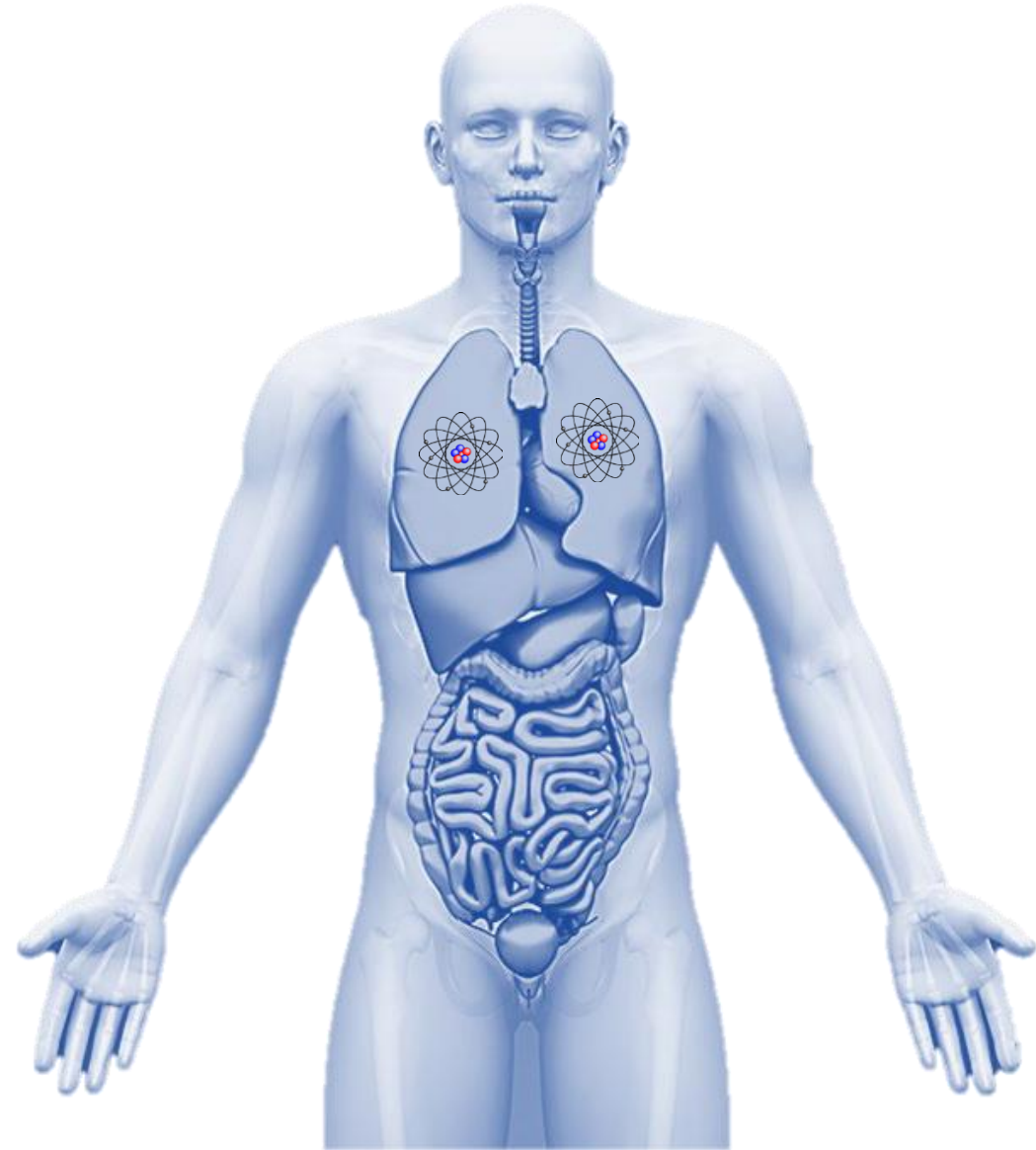


About Oxygen-15

- O-15 is a radioisotope of oxygen, frequently used in PET imaging
- O-15 can be used in PET as a liquid for injection or as a gas for inhalation
- O-15 gas is produced in the cyclotron through deuteron bombardment of nitrogen-14: $^{14}\text{N}(\text{d},\text{n})^{15}\text{O}$
- O-15 decays by positron emission with a ***half life of 122 seconds***



Radiation Safety of Gases



- Due to gaseous nature of the radioactivity, extra vigilance must be taken with respect to radiation safety
- Radioactive gas is difficult, if not impossible to detect by human senses due to its colourless and usually odourless nature
- Requires a different set of radiation safety procedures than injectable radioisotopes to prevent internal radiation exposure by inhalation

Experimental Procedure

- O-15 gas is produced in the cyclotron
- The gas is transferred from the cyclotron to the PET/MRI Suite (B5-233c) using a pressurized metal line that runs along the outside of the building.
- The subject will inhale the O-15 gas while undergoing a PET/MRI scan
- Exhaled radioactive CO₂ from the subject will be captured in an air tank in the PET/MRI Equipment room (B5-233e) to decay

Radiation Safety

- The CO₂ expired air tank will catch the exhaled radioactive air from the subject
- In the case of a leak in the tubing in the PET/MRI suite from the subject to the expired air tank, it is possible that some radioactive gas will leak out into room air
- To prevent unnecessary exposure to staff/public from leaked O-15, an SOP has been created with step-by-step instructions on how to conduct the experiment. Sections include:
 - Pre O-15 Gas Delivery
 - Receipt and Administration of O-15 Gas
 - Post O-15 Gas Administration
 - Procedures for Unusual Incidences
- Adhering to this SOP will drastically reduce the potential of unnecessary radioactive exposure to staff/public during this experiment

What's next

- Contact the Lawson RSO (Charis Johnson-Antaran) with proof of completion of LearningEdge O-15 module.
 - RSO email: charis.johnsonantaran@lawsonresearch.com
- RSO will send you the Safe Delivery and Administration of O-15 Gas Procedure.
- Once you have reviewed the above procedure, the RSO will meet with you to discuss any questions/concerns.
- You and the RSO will sign a log sheet acknowledging agreement and understanding of the Safe Delivery and Administration of O-15 Gas Procedure.
- You are approved to work with O-15 gas