

# ➤ Think Inside the Box: Glove Box Handling Techniques

## Objectives

Students will:

Learn what a glove box is and why radiochemists use them.

In a simulated 'glove box' participants will mix different 'solutions' of dyed water together to make a target chemical. To simulate how radiochemists handle radioactive materials and solutions.

## Fast facts

**Subject:** Chemistry

**Age range:** 11+ years old

**Ambassador preparation time:** 30 minutes

**Demonstration time required:** 10 minutes

**Location:** Science Fair

## Overview

When handling any hazardous material, we need to protect ourselves and the environment.

Radiochemists handle radioactive materials every day. Radioactive materials emit some or all of alpha, beta and gamma radiation. We have protective measures to protect lab staff from each of these forms of radiation.

Glove boxes are used to shield radiochemists from alpha radiation.

## Equipment

Glove box (separate instructions attached to make the glove box if you so wish):

- Large clear plastic box (37 L)
- Rapid cure epoxy resin adhesive
- Adjustable stainless steel hose clamp
- 4-inch inner PVC plastic duct pipe
- Long length, heavy duty, chemical resistant gloves

Activity:

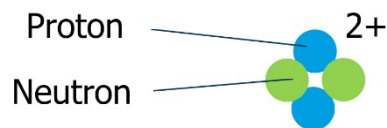
- 3 x 250 mL conical flask
- Food colouring (3 x primary colours)
- Squeezy plastic pipettes
- Tape

*Links to purchase the equipment are given at the end of the guide (Equipment Purchase Links section).*

## Background

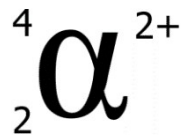
Radioactive samples have three different kinds of decay: alpha, beta and gamma.

**Alpha** particles are from the nucleus of a radioactive atom. They consist of two protons and two neutrons and hence have a + 2 charge.

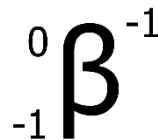
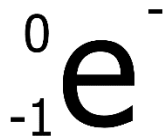


Alpha particles travelling through air can be stopped by paper.

Alpha particles have the same make up as a helium nucleus (2 proton and 2 neutrons) so you will see them written as any of the below:



**Beta** particles are formed when a neutron splits up into a proton and an electron. You will see them written as either of the below:

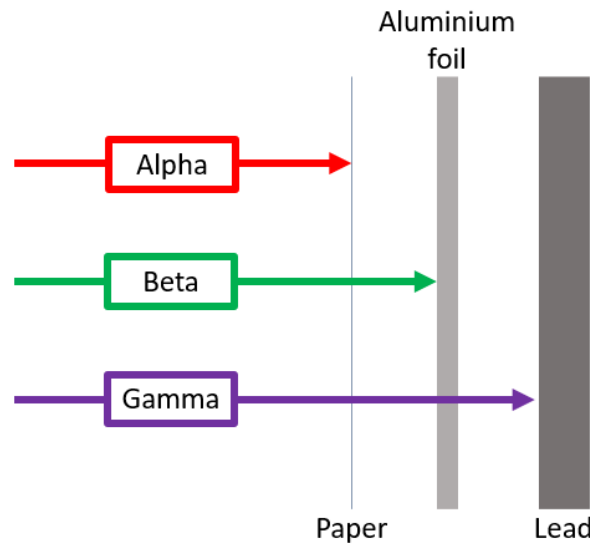


When travelling through air beta particles can be stopped by a thin layer of aluminium foil, such as the kitchen foil you'll see in your own kitchen.

**Gamma** waves are electromagnetic waves that come from the nucleus of a radioactive particle. They do not change the nature of the atom they come from.

They are the most penetrating type of radioactive decay and thick lead or concrete is needed to stop them. They are written as:





*Figure 1: Alpha particles are stopped by paper, beta particles by aluminium foil and gamma rays by thick lead.*

Active handling facilities are laboratories that are licensed to handle radioactive material. They are licensed because they have the appropriate facilities in place to safely handle these materials. One of these is a glove box



*Figure 2: Glove boxes at the National Nuclear Laboratory (NNL) in the UK*

These glove boxes provide the researcher with physical protection from alpha radiation, as alpha particles can not penetrate the box. So, when handling any alpha emitting materials or solutions it must be done in a glove box.

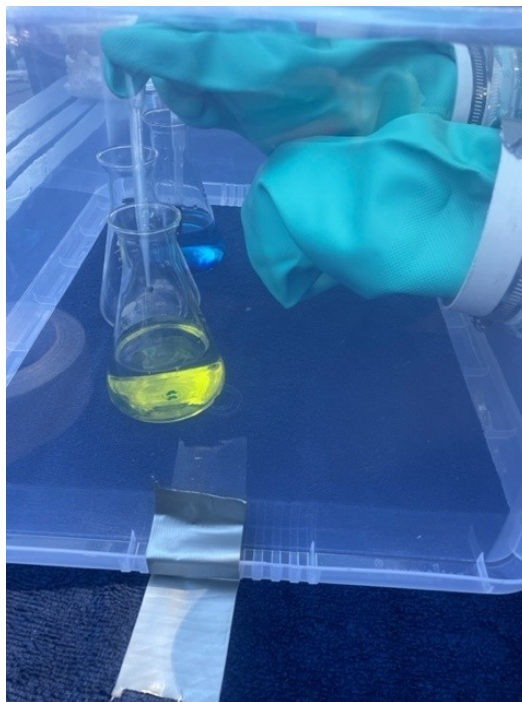
➤ **Glove box handling techniques**

We are simulating a radiochemist working in a glove box in this activity.

**Demonstration**

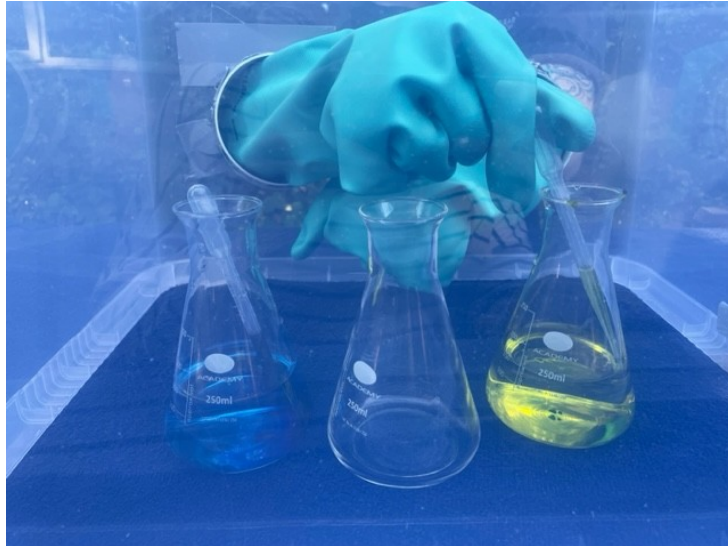
If you are preparing your own glove box please see the attached instructions.

1. Fill two of the three 250 mL conical flasks with ~ 150 mL tap water.
2. Add a small amount of food dye to each conical flask. So each one is a separate primary colour, in this example we are using blue and yellow. (note only a VERY small amount of the dye is needed).
3. Place a plastic squeezezy pipette into each of the two dyed solutions and place them 'into' the glove box on a slat, stable surface- likely a table. Tape the glove box down to the table to stop it from moving during the activity. The activity is very simple, the participant will put their hands into the glove box. They will then use the squeezezy pipettes to mix the two dyes together and create a third colour in the empty conical flask. It may sound simple but it's harder than it looks in the glove box!

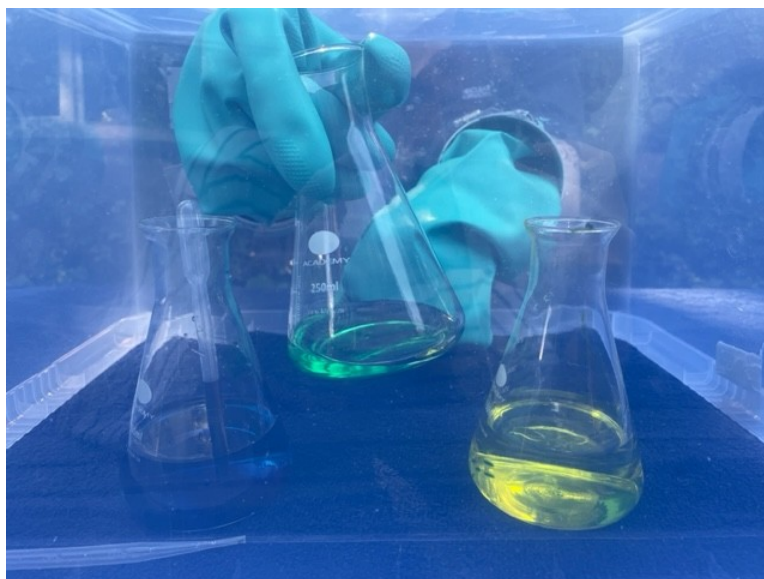


*Figure 3: Glove box set up, note the tape to hold it in place on the table*

➤ **Glove box handling techniques**



*Figure 4: Glove box activity being demonstrated.*



*Figure 5: Here the user is 'swirling' (mixing) the final solution together. This is a lab technique we use to mix solutions together, you can demonstrate this to the students if you feel comfortable. If not they mix very well just using the pipette to stir the solution.*



➤ **Glove box handling techniques**



*Figure 6: an example of a user trialing the glove box activity.*



*Figure 7: The mixed solutions out of the box for a better view.*

4. The demonstration is now complete. You can dispose of the 'mixed' solution down any sink, or bulk together for disposal at the end. Continue to use the primary colour solutions until they run out, then remake them.
5. When putting the activity away: wash and dry the glassware, store the glassware back in the bubble wrap, wash the pipettes and put back in the kit for re-use, handle the box with care as to not damage it and remove and dispose of the tape.

### Equipment Purchase List with Links

- Large clear plastic box (35 L)
  - o [https://www.amazon.co.uk/gp/product/B001EIWQPY/ref=ppx\\_yo\\_dt\\_b\\_asin\\_image\\_o07\\_s00?ie=UTF8&psc=1](https://www.amazon.co.uk/gp/product/B001EIWQPY/ref=ppx_yo_dt_b_asin_image_o07_s00?ie=UTF8&psc=1)
- Rapid cure epoxy resin adhesive
  - o [https://www.amazon.co.uk/gp/product/B079BX9VWG/ref=ppx\\_yo\\_dt\\_b\\_asin\\_image\\_o04\\_s01?ie=UTF8&psc=1](https://www.amazon.co.uk/gp/product/B079BX9VWG/ref=ppx_yo_dt_b_asin_image_o04_s01?ie=UTF8&psc=1)
- Adjustable stainless steel hose clamp clips
  - o [https://www.amazon.co.uk/gp/product/B08L799Z66/ref=ppx\\_yo\\_dt\\_b\\_asin\\_image\\_o00\\_s01?ie=UTF8&th=1](https://www.amazon.co.uk/gp/product/B08L799Z66/ref=ppx_yo_dt_b_asin_image_o00_s01?ie=UTF8&th=1)
- 4-inch inner PVC plastic duct pipe
  - o [https://www.amazon.co.uk/gp/product/B00YLIOWXI/ref=ppx\\_yo\\_dt\\_b\\_asin\\_image\\_o06\\_s02?ie=UTF8&th=1](https://www.amazon.co.uk/gp/product/B00YLIOWXI/ref=ppx_yo_dt_b_asin_image_o06_s02?ie=UTF8&th=1)
  - o [https://www.amazon.co.uk/gp/product/B00YLIOWXI/ref=ppx\\_od\\_dt\\_b\\_asin\\_image\\_s01?ie=UTF8&th=1](https://www.amazon.co.uk/gp/product/B00YLIOWXI/ref=ppx_od_dt_b_asin_image_s01?ie=UTF8&th=1)
- Long length, heavy duty, chemical resistant gloves
  - o [https://www.amazon.co.uk/gp/product/B089QH78Y/ref=ppx\\_od\\_dt\\_b\\_asin\\_image\\_s01?ie=UTF8&th=1](https://www.amazon.co.uk/gp/product/B089QH78Y/ref=ppx_od_dt_b_asin_image_s01?ie=UTF8&th=1)
- 3 x 250 mL conical flask
  - o [https://www.amazon.co.uk/gp/product/B00GDV83HC/ref=ppx\\_yo\\_dt\\_b\\_asin\\_image\\_o00\\_s01?ie=UTF8&th=1](https://www.amazon.co.uk/gp/product/B00GDV83HC/ref=ppx_yo_dt_b_asin_image_o00_s01?ie=UTF8&th=1)
- Food colouring (3 x primary colours)
  - o [https://www.amazon.co.uk/gp/product/B00GBLCRC6/ref=ppx\\_yo\\_dt\\_b\\_asin\\_image\\_o00\\_s01?ie=UTF8&th=1](https://www.amazon.co.uk/gp/product/B00GBLCRC6/ref=ppx_yo_dt_b_asin_image_o00_s01?ie=UTF8&th=1)
- Squeezy plastic pipettes
  - o [https://www.amazon.co.uk/gp/product/B0838THXL2/ref=ppx\\_yo\\_dt\\_b\\_asin\\_image\\_o00\\_s00?ie=UTF8&psc=1](https://www.amazon.co.uk/gp/product/B0838THXL2/ref=ppx_yo_dt_b_asin_image_o00_s00?ie=UTF8&psc=1)
- Tape
  - o [https://www.amazon.co.uk/gp/product/B09HXZG8XS/ref=ppx\\_yo\\_dt\\_b\\_asin\\_image\\_o04\\_s00?ie=UTF8&psc=1](https://www.amazon.co.uk/gp/product/B09HXZG8XS/ref=ppx_yo_dt_b_asin_image_o04_s00?ie=UTF8&psc=1)