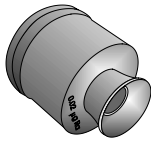
Type number 1	Radioactive rocks	© CLEAPSS 2019
Description		Supplied as a set, for example by Philip Harris or Griffin & George. These usually contain thorium or uranium minerals. Typical radioactive minerals offered by educational suppliers are allanite, autunite, davidite, monazite, phosphuranylite, uraninite and torbenite. The school's geography or geology department may also keep rocks of this type, sometimes collected in the field by enthusiasts. The RPS (Schools) may wish to ensure that the control measures described here are applied equally to these.
Use	To demonstrate that natural rocks contain radioactive minerals. A rock should be regarded as radioactive if the count rate at the surface is more than 50% above the background count.	
Original activity	Varies, but can be up to 8.5 kBq g^{-1}.	
Radionuclide	Thorium-232: 1.4 x 10^{10} years and/or uranium-238: 4.5 x 10^{9} years and decay chains. Uranium in rocks also comprises about 0.7% uranium-235.	
Main radiations	α, β, γ	
Hazard	External irradiation of the body, including possibly more sensitive organs such as the eyes. Internal irradiation of the body due to rock fragments being inhaled, absorbed through the skin or through wounds, or swallowed. Radon gas in the decay chain can cause contamination of surroundings. Thorium and uranium compounds are also toxic.	
Risk assessment	The external dose rates and risks of loose material are significant, but the risks are low with the control measures in place.	
Control measures	Purchase radioactive rocks from educational suppliers. Only keep small samples – as a rough guide no more than 10 cm^3 each sample – and keep in a sealed plastic bag or other sealed transparent container when using them to avoid the spread of contamination. Avoid much larger samples. Always follow the Standard Operating Procedures for the use of radioactive sources. Radioactive rocks should be treated in the same way as other radioactive sources.	
During use	The rocks should not be touched with the hands. They are best left in their transparent containers. Beware of loose contamination.	
Inspection	Annually or after use by students. A rock should be checked for damage and any chips or fragments disposed of. Forceps or disposable gloves should be used to handle rocks. Take care to avoid chipping the rock with the forceps. Handling time with gloves should be kept short.	
Leak test of source	Not required.	
Contamination check of container	Annually or if damage to the rock is suspected. The container should be cleaned if necessary.	
Storage and labelling	Radioactive rocks are best stored in sturdy, transparent plastic bags or containers with secure lids. A plastic bag is better if the rock is friable (crumbly). The containers should be labelled with a radioactive warning sign and the name of the rock, and kept in the steel store cabinet or a locked display cupboard. If rocks are displayed, they must be kept in a locked cabinet at least 500 mm away from the person viewing them. The count rate at the viewing position must be similar to the background count rate.	
Spill or drop	Wear a lab coat and disposable gloves. If a rock is dropped, check the area where it fell for contamination, and decontaminate it if necessary. See section 9.2.	
Availability	Available from Philip Harris and other suppliers.	
Standard School Holding	No limit, other than what is justified for curriculum use.	

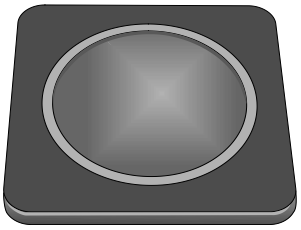
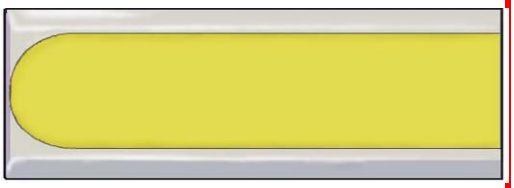
Type number 2	Smoke alarm	© CLEAPSS 2019
Description		Most domestic smoke alarms use an ionisation chamber smoke detector. This is a small metal chamber containing a radioactive source. If smoke enters the chamber, the level of ionisation reduces, decreasing the flow of electric current in a circuit and triggering a siren.
Use	To show that many domestic smoke alarms contain a radioactive source. To explain the widespread agreement that the very low radiological risk, compared to the substantial benefits in life-saving, make it well worth installing such devices in the home.	
Original activity	Typically 37 kBq (1 µCi).	
Radionuclide and half-life	Americium-241: 432.6 years.	
Main radiations	α, γ. The α radiation is not normally detectable because of shielding by the ionisation chamber wall.	
Hazard	External irradiation of the body, including possibly more sensitive organs such as the eyes. Internal irradiation of the body due to substances being inhaled, absorbed through the skin or through wounds, or swallowed.	
Risk assessment	The residual risk is low with the control measures in place. Note: these control measures are not required for smoke alarms when used in the home, as they are extremely unlikely to suffer damage in the normal position, fixed to the ceiling. Climbing a stepladder to reach the alarm is likely to present a far greater risk to health and safety than the radioactive material in the smoke alarm.	
Control measures	Always follow the Standard Operating Procedures for the use of radioactive sources. Do not dismantle detectors other than removing the outer case cover to show the ionisation chamber.	
During use	The plastic cover of the smoke alarm may be opened for observation, to detect ionising radiation and to insert the battery. Under no circumstances should the metal ionisation chamber be opened. The test button or smoke can be used to trigger the alarm.	
Inspection	Annually and after use by students. Check that the ionisation chamber is undamaged.	
Leak test of source	Annually or if damage is suspected. The accessible surfaces of the ionisation chamber should be wipe tested. This applies only to smoke alarms used as examples of radioactive sources. Do not leak test installed smoke alarms.	
Contamination check of container	Not required unless leakage is suspected.	
Storage and labelling	A smoke alarm should be put in a strong, sealable plastic bag (to avoid any contamination from other sources). The bag should be labelled with a radioactive warning sign and kept in the steel store cabinet.	
Spill or drop	Wear a lab coat and disposable gloves. If a smoke alarm is dropped, it is most unlikely that any radioactive spill will occur. If it is damaged, sweep the fragments into a strong plastic bag and tie it up. Check the area for contamination, and decontaminate it if necessary. See section 9.2.	
Availability	Sold by hardware stores.	
Standard School Holding	Up to five 40 kBq Am-241 smoke detectors. Some older detectors are Ra-226, and some are above 40 kBq – do not acquire these.	

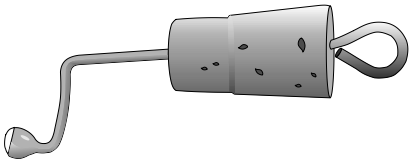
Type number 3a	Not recommended – dispose Radioluminescent (radium-painted) timepieces (including dials removed from them)	© CLEAPSS 2019
Description	 Clocks and watches with radium paint so they radioluminesce (glow in the dark). Note that although the radioluminescence gradually decreases over the years as the paint deteriorates, to the point where it barely glows in the dark, the radioactivity remains almost unchanged.	
Original use	To demonstrate radioluminescence using a radioactive material.	
Original activity	Luminous dials: there is little information available. Timepieces have been reported at 5 to 50 kBq.	
Radionuclide and half-life	Radium-226 (promethium-147 and tritium have also been used). Ra-226: 1600 years; Pm-147: 2.6 years; tritium: 12.6 years.	
Main radiations	α, β, γ including emissions from the decay chain.	
Reason for withdrawal from use	These are at least 50 years old, and invariably the radium paint has deteriorated. The paint can flake away, often too small to be seen easily.	
Hazard	Internal irradiation of the body due to flakes of luminous paint being inhaled, absorbed through the skin or through wounds, or swallowed.	
Risk assessment	The risk of contamination from the radium paint is unacceptably high. Radium-painted timepieces are now only an item of historic interest; it does not show a modern application of radioactivity.	
Storage and labelling	The item should be placed in a sealed bag and labelled ‘DO NOT USE’. Place this in the steel store cabinet and make arrangements to dispose of it promptly.	
Spill or drop	Wear a lab coat and disposable gloves. If a source is dropped, check the area where it fell for contamination, and decontaminate it if necessary. See section 9.2.	
Disposal	See section 12.	

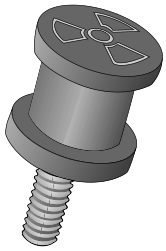
Type number 3b	Not recommended – dispose Spinthariscopes	© CLEAPSS 2019
Description		A device used to view scintillations from a low-activity radioactive source, often a spot of radium paint, with a screen that scintillates.
Original use	To demonstrate radioluminescence.	
Original activity	The Philip Harris spinthariscopes were 740 Bq (0.02 µCi). The Griffin types are of similar activity.	
Radionuclide and half-life	Usually radium-226: 1600 years.	
Main radiations	α, β, γ including emissions from the decay chain.	
Reason for withdrawal from use	These are old and there is no straightforward way of checking the condition of the actual source inside.	
Hazard	Internal irradiation of the body due to flakes of self-luminous paint being inhaled, absorbed through the skin or through wounds, or swallowed.	
Risk assessment	The source could have deteriorated inside but there is no easy way of checking.	
Storage and labelling	The item should be placed in a sealed bag and labelled ‘DO NOT USE’. Place this in the steel store cabinet and make arrangements to dispose of it promptly.	
Spill or drop	Wear a lab coat and disposable gloves. If a source is dropped, check the area where it fell for contamination, and decontaminate it if necessary. See section 9.2.	
Disposal	See section 12.	

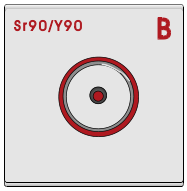
Type number 3c	Not recommended – dispose Radioluminescent instruments that are not timepieces	© CLEAPSS 2019
Description		Radium-based paint was in regular use in the first half of the 20th century to make various objects self-luminous in the dark. Old military items can have high activities from radium paint.
Original use	To demonstrate radioluminescence.	
Original activity	There is little information available. Marine compasses can be up to 400 MBq.	
Radionuclide and half-life	Usually radium-226 (promethium-147 and tritium have also been used). Ra-226: 1600 years; Pm-147: 2.6 years; tritium: 12.6 years.	
Main radiations	α, β, γ including emissions from the decay chain.	
Reason for withdrawal from use	The activity can often be well above the current exemption limit. These devices were never exempt under the previous exemption orders, and, strictly, schools should not have acquired them. The paint deteriorates and the radium paint becomes brittle and can flake away, often too small to be seen. The phosphorescent material degrades with age and no longer produces significant luminescence. Radon outgassing can cause significant contamination.	
Hazard	External irradiation of the body, including possibly more sensitive organs such as the eyes. Internal irradiation of the body due to flakes of self-luminous paint being inhaled, absorbed through the skin or through wounds, or swallowed.	
Risk assessment	This type of instrument can present a greater risk than other sources commonly used in schools. Luminous instrument dials (especially military instruments such as altimeters and compasses) are often well above 200 kBq of Ra-226 and should not be kept.	
Storage and labelling	The item should be placed in a sealed bag and labelled ‘DO NOT USE’. Place this in the steel store cabinet and make arrangements to dispose of it promptly.	
Spill or drop	Wear a lab coat and disposable gloves. If a source is dropped, check the area where it fell for contamination, and decontaminate it if necessary. See section 9.2.	
Disposal	See section 12.	

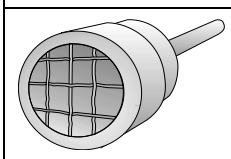
Type number 4a	Not recommended – dispose Scintillation plate	© CLEAPSS 2019
Description		Various designs featuring spots of radium paint on a plate. The Panax design has two radium paint spots; one is much weaker than the other. The Panax plates are in boxes of 20 labelled PS-308. The picture left shows a Panax plate and the boxed set it was taken from.
Typical dimensions	Varies. Panax type scintillation plates are length 65 mm, width 25 mm, thickness ~ 2 mm.	
Original use	To observe radioluminescence, and individual scintillations with a magnifier.	
Original activity	Depends on type, and often it was not specified. From measurements carried out by CLEAPSS on the Panax type, the higher activity spot is about 4 kBq, the lower activity spot is about 100 Bq. Other types are likely to be similar.	
Radionuclide and half-life	Usually radium-226, 1600 years. .	
Main radiations	α, β, γ including emissions from the decay chain.	
Reason for withdrawal from use	The paint deteriorates and the radium paint becomes brittle and can flake. The phosphorescent material degrades with age and no longer produces significant scintillations. The Panax boxed set produces radon which causes significant contamination inside the storage cardboard box and on nearby surfaces.	
Hazard	External irradiation of the body, including possibly more sensitive organs such as the eyes. Internal irradiation of the body due to flakes of self-luminous paint being inhaled, absorbed through the skin or through wounds, or swallowed.	
Risk assessment	The sources are well beyond their recommended working life and a risk assessment does not support extending their service life. The radium can easily be damaged and cause contamination. If you need to handle the plates or boxed set, do it by the edges with gloved hands and avoid touching or knocking the paint spots.	
Storage and labelling	The items, or boxed set, should be placed in an air-tight plastic bottle and labelled 'DO NOT USE'. Place the bottle in the steel store cabinet and make arrangements to dispose of the plates promptly. If the plates are in their cardboard box, don't take them out. Just dispose of the whole box.	
Spill or drop	Wear a lab coat and disposable gloves. If a source is dropped, check the area where it fell for contamination, and decontaminate it if necessary. See section 9.2.	
Disposal	See section 12.	

Type number 4b	Becquerel plate	© CLEAPSS 2019
Description	A radioactive substance lines a recess in a plastic plate, normally protected by a transparent cover or case. Most were originally supplied by Griffin & George, Philip Harris and Panax.	
		
	Becquerel plate	Panax-type yellow plate. Also in black.
Typical dimensions	Length 38 mm, width 38 mm, thickness 4 mm.	Length 85 mm, width 30 mm, thickness 4 mm
Original use	Used to produce blackening (fogging) of photographic film, replicating Henri Becquerel's accidental discovery of radioactivity. However this is rarely done now, particularly as photographic film is no longer commonplace.	
Original activity	Depends on type, but uranium types are usually less than 100 kBq.	
Radionuclide and half-life	Uranium oxide paint or encapsulated uranium oxide powder. Panax types also have dummies with manganese oxide. Some Panax plates are yellow in colour. These contain uranyl nitrate, and some are dummies with sulfur. Uranium is mainly uranium-238 with up to 0.7% uranium-235 and decay chains. Uranium-238: 4.5×10^9 years.	
Main radiations	α, β including emissions from the decay chain.	
Reason for withdrawal from use	The Panax plate seals regularly fail and cause contamination. The uranium oxide coating on other types commonly show deterioration, losing their integrity and causing contamination.	
Hazard	External irradiation of the body, including possibly more sensitive organs such as the eyes. Internal irradiation of the body due to substances being inhaled, absorbed through the skin or through wounds, or swallowed.	
Risk assessment	The sources are well beyond their recommended working life and a risk assessment does not support extending their service life.	
Storage and labelling	The non-radioactive dummies should be taken out and disposed of separately as chemical waste. The radioactive items should be placed in a sealed bag and labelled 'DO NOT USE'. Place the bag in the steel store cabinet and make arrangements to dispose of plates promptly.	
Spill or drop	Wear a lab coat and disposable gloves. If a source is dropped, check the area for contamination, and decontaminate it if necessary. See section 9.2.	
Disposal	See section 12.	

Type number 5	Diffusion (Taylor) cloud chamber radium paint source	© CLEAPSS 2019
Description		This source is part of a diffusion (Taylor) cloud chamber from Griffin & George, Irwin and others. It is a sample of radium-based luminous paint in a small metal cup attached to a thin, cranked rod, which is mounted in a cork. See specific risk assessment 15, *Thoriated tungsten welding electrode* for an alternative.
Typical dimensions	Length 70 mm, height 25 mm, diameter of cup 5 mm. Some have a plain end. Some types a spots of paint in a plastic block.	
Use	Observation of tracks produced by ionisation due to alpha particles.	
Original activity	Typically 0.74 kBq (0.02 μCi).	
Radionuclide and half-life	Radium-226: 1600 years.	
Main radiations	α, β, γ including emissions from the decay chain.	
Reason for withdrawal from use	The plated ends are regularly showing corrosion with loss of radium paint. The paint binder also fails owing to the years in a radiation field. Often the missing paint is not noticed until the source stops working in the cloud chamber. There is a much safer alternative, the thoriated TIG welding rod. See CLEAPSS source type 15.	
Hazard	Internal irradiation of the body due to flakes of the paint particles being inhaled, absorbed through the skin or through wounds, or swallowed.	
Risk assessment	The sources are well beyond their recommended working life and a risk assessment does not support extending their service life, particularly as small paint particles are easily overlooked and could easily cause personal contamination.	
Storage and labelling	Place them in a sealable plastic bag and label ‘DO NOT USE’. Place the bag in the steel store cabinet and make arrangements to dispose of sources promptly.	
Spill or drop	Wear a lab coat and disposable gloves. If a source is dropped, check the area for contamination, and decontaminate it if necessary. See section 9.2.	
Disposal	See section 12.	

Type number 6	Expansion (Wilson) cloud chamber radium source	© CLEAPSS 2019
Description		This source is part of an expansion (Wilson) cloud chamber. It consists of a metal foil radium source shaped into a cylinder around the centre of a brass assembly that screws into the chamber. Supplied by Philip Harris as part of an expansion cloud chamber apparatus.
Typical dimensions	Diameter 7 mm, height 8 mm (excluding threaded shaft).	
Use	Observation of tracks produced by ionisation due to alpha particles.	
Original activity	Typically 37 kBq (1 µCi).	
Radionuclide and half-life	Radium-226: 1600 years.	
Main radiations	α, β, γ including emissions from the decay chain.	
Hazard	External irradiation of the body, including possibly more sensitive organs such as the eyes. Internal irradiation of the body due to substances being inhaled, absorbed through the skin or through wounds, or swallowed.	
Risk assessment	The residual risk is low with the control measures in place.	
Control measures	Always follow the Standard Operating Procedures for the use of radioactive sources.	
During use	This source should be kept in its cloud chamber. It should not be touched.	
Inspection	Annually and after use by students. Check the source (left in the cloud chamber) remotely for damage, eg with a small mirror or an inexpensive USB endoscope (snake scope).	
Leak test of source	Annually or if damage is suspected. The outer surfaces should be tested.	
Contamination check of container	Due to the very small amounts of radon gas emitted from radium sources, the inside of the cloud chamber should be checked annually and decontaminated if necessary. This is also required if leakage is suspected.	
Storage and labelling	It is usually best not to try to remove the source from this type of cloud chamber because the thread can be tight and removal may damage the source. Therefore the whole chamber should be labelled with a radioactive warning sign and stored in a labelled, locked cupboard, preferably near to the main store cabinet. It is normally best not to keep the whole cloud chamber in the steel store cabinet itself, because it would be difficult to clean if contaminated by other sources. It may also be too large to fit in the cabinet.	
Spill or drop	Wear a lab coat and disposable gloves. If a cloud chamber source is dropped, check the area where it fell for contamination, and decontaminate it if necessary. See section 9.2.	
Availability	These sources have not been available for many years. At the end of the useful service life, replace the expansion cloud chamber with a diffusion cloud chamber that uses a thoriated TIG rod as a source (CLEAPSS type 15).	
Standard School Holding	The total activity of all sealed sources should not exceed 1.2 MBq, and no single sealed source should be above 400 kBq. If practicable, choose sources no greater than 200 kBq.	

Type number 7	No longer recommended – dispose Perspex slide sources – Labgear					© CLEAPSS 2019
Description		The active substance or foil source is held in a plastic slide with epoxy resin. Strontium-90, americium-241 and radium-226 foil sources have small holes in the plastic slide. The cobalt-60 source has a small pellet of cobalt metal wire. The thorium-232 source is a powder mixed into the epoxy resin. Some slides have a protective wire mesh.				
Typical dimensions	Length 50 mm, width 50 mm, thickness 3.5 mm.					
Original use	To investigate the basic properties of ionising radiations.					
Original supplier	These sources have not been available for many years. The supplier was Labgear Ltd. The foils were from Nycomed Amersham.					
Radionuclide and half-life (years)	**Co-60 5.27**	**Sr-90 28.8**		**Am-241 432.6**	**Ra-226 1600**	**Th-232 1.4 x 10^{10}**
Main radiations	γ, β	β		α, γ	α, β, γ	β, γ (α)
Original activity kBq (μCi)	37 (1) 185 (5)	37 (1)	185 (5)	3.7 (0.1) 185 (5)	185 (5)	37 (1)
Labgear code	C	B	E	A	D	F
Reason for withdrawal from use	The plastic is degraded by the radiation field. There is also evidence that the foil surfaces are likely to have degraded to an unsafe condition.					
Risk assessment	The sources are well beyond their recommended working life and a risk assessment does not support extending their service life. The radium source has a relatively high beta field and it should not be handled directly.					
Storage and labelling	Place a 50 mm square sheet of 2 mm thick aluminium slide or 1 mm thick lead slide on each side of the radium-226 and strontium-90 sources to shield the beta radiation. Place each Labgear source in an individual small container and label them ‘DO NOT USE’. Make arrangements to dispose of the sources promptly.					
Spill or drop	Wear a lab coat and disposable gloves. If a source is dropped, check the area where it fell for contamination, and decontaminate it if necessary. See section 9.2.					
Disposal	See section 12.					

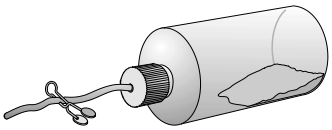
Type number 8a	Cup sources				© CLEAPSS 2019
Description		This is the most common type of sealed source used in schools and colleges, originally supplied by Philip Harris, Griffin, Panax and others. The radioactive substance is sintered into a metal foil and is usually secured at the base of a metal cup by a circlip, but sometimes it is glued in place. In some newer designs of foils, the radioactive material is anodised into the foil surface. The open end of the cup is covered with wire mesh. It has a stem for handling and mounting. Details of the radionuclide and original activity are usually stamped on the back of the cup, next to the stem. A serial number may be engraved there too. Cup sources are supplied in a small lead pot with a lead lid, inside a suitably-labelled wooden container.			
Typical dimensions	Length 22 mm, diameter 13 mm, stem diameter 4 mm.				
Use	To investigate the basic properties of ionising radiations.				
Original activity	3.7 kBq (0.1 µCi) to 370 kBq (10 µCi), depending on type. Most commonly 185 kBq (5 µCi).				
Radionuclide and half-life (years)	**cobalt-60** **5.27**	**strontium-90** **28.8**	**americium-241** **432.6**	**plutonium-239** **2.41 x 10^4**	**radium-226** **1600**
Main radiations	γ (β)	β	α, γ	α	α, β, γ
Colour code (if present)	Green	Yellow	Brown	Blue	Red
Hazard	External irradiation of the body, including possibly more sensitive organs such as the eyes. Internal irradiation of the body due to substances being inhaled, absorbed through the skin or through wounds, or swallowed.				
Risk assessment	The residual risk is low with the control measures in place.				
Control measures	Always follow the Standard Operating Procedures for the use of radioactive sources.				
During use	This type of source should be manipulated by the stem and kept at least 100 mm from the hand – long forceps are ideal. Only one source should be used at a time. Between investigations, the source should be returned to its container.				
Inspection	Annually and after use by students. Check the whole source for signs of damage. View the active foil surface using a plane mirror on the bench, or remotely with a digital camera. Never point the foil surface towards your eyes. Keep a record of any blemishes, particularly to the foil surface.				
Leak test of source	Annually or if damage is suspected. The outer surface should be tested.				
Contamination check of container	Not required unless leakage is suspected. For radium sources, small amounts of radon gas can be emitted, so an annual check should be made on the containers of these sources, and they should be cleaned if necessary.				
Storage and labelling	The source should be stored in its lead-lined container, labelled with a radioactive warning sign and kept in the steel store cabinet.				
Spill or drop	Wear a lab coat and disposable gloves. If a source is dropped, check the area where it fell for contamination, and decontaminate it if necessary. See section 9.2.				
Availability	Currently sold by Edu-lab, Philip Harris, SciChem and Timstar.				
Standard School Holding	The total activity of all sealed sources should not exceed 1.2 MBq. No single sealed source should be above 400 kBq. If practicable, choose sources no greater than 200 kBq.				

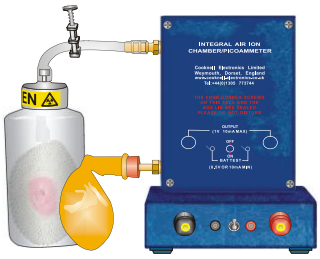
Type number 8b	Panax source S4	© CLEAPSS 2019
Description		This was a relatively high-activity collimated beta source. It is from a Panax teaching kit. The source has a slit, which is normally covered by a close-fitting aluminium cup. The manufacturer did not put a warning trefoil on the plastic base, or put it into any special container, so it is easily mistaken for a piece of apparatus such as an absorber. The activity will be lower than when new owing to the 28 year half-life.
Typical dimensions	Length 50 mm, width 45 mm, depth 25 mm (including collimator and metal storage cap).	
Use	To investigate deflection of beta radiation by a magnetic field.	
Original activity	330 kBq (9 μCi).	
Radionuclide and half-life	Strontium-90: 28.8 years.	
Main radiations	β.	
Hazard	External irradiation of the body, including possibly more sensitive organs such as the eyes. Internal irradiation of the body due to substances being inhaled, absorbed through the skin or through wounds, or swallowed.	
Risk assessment	The residual risk is low with the control measures in place.	
Control measures	Always follow the Standard Operating Procedures for the use of radioactive sources.	
During use	This type of source should be held by the plastic edges. The aluminium cap should be removed with plastic forceps, making sure your hand is not placed in front of the source slit. The aluminium cap should be replaced immediately after you have finished the investigation using the source.	
Inspection	Annually and after use by students. Check the whole source for signs of damage. There is no point in remotely looking into the source slit because little of the foil can be seen.	
Leak test of source	Annually or if damage is suspected. The outer surface should be tested.	
Contamination check of container	Not required unless leakage is suspected.	
Storage and labelling	Put a small radioactivity warning sign directly on the plastic body. The source should be stored in a suitable small container, labelled with a radioactive warning sign and kept in the steel store cabinet.	
Spill or drop	Wear a lab coat and disposable gloves. If a source is dropped, check the area where it fell for contamination, and decontaminate it if necessary. See section 9.2.	
Availability	These sources have not been available for many years. They can be used until the end of their safe working lives. Replacement with another source of this high an activity is not recommended.	
Standard School Holding	The total activity of all sealed sources should not exceed 1.2 MBq. No single sealed source should be above 400 kBq. If practicable, choose sources no greater than 200 kBq.	

Type number 8c	Isotrak educational sources				© CLEAPSS 2019
Description			The source assembly is made up of a source (a sealed stainless steel capsule or a metal foil or disc), housed in a recess in an aluminium rod. The rods are supplied in a metal cylinder, which can hold one (as shown in the illustration) or more rods in a 'well'. The radioactive end of the rod is stored downwards into the metal cylinder well.		
Typical dimensions	Length 85 mm, diameter 12 mm. The source is recessed 8 into the end of the rod.				
Use	To investigate the basic properties of ionising radiations.				
Original activity	74 kBq (2 μCi), 370 kBq (10 μCi) for the larger Cs-137 source, and 342 kBq (9.2 μCi) for a mixed nuclide source.				
Radionuclide and half-life (years)	**cobalt-60** **5.27**	**strontium-90** **28.8**	**americium-241** **432.6**	**sodium-22** **2.6**	**caesium-137** **30.1**
Main radiations	γ (β)	β	α, γ	β^+	γ, β
Hazard	External irradiation of the body, including possibly more sensitive organs such as the eyes. Internal irradiation of the body due to substances being inhaled, absorbed through the skin or through wounds, or swallowed.				
Risk assessment	The residual risk is low with the control measures in place.				
Control measures	Always follow the Standard Operating Procedures for the use of radioactive sources.				
During use	This type of source should be held by the non-source end of the aluminium rod, with the source end directed away from the body. *Make sure you know which is the source end*. Only one source should be used at a time. Between investigations, the source should be returned to its container, the source end of the rod goes into the metal cylinder well.				
Inspection	Annually and after use by students. Check the whole source for signs of damage. View the recessed surface using a plane mirror on the bench or remotely with a digital camera. Never point the foil surface towards your eyes. Keep a record of any blemishes, particularly to the source surface.				
Leak test of source	Annually or if damage is suspected. The outer surface should be tested, but avoid contact with the actual active surface of the source.				
Contamination check of container	Not required unless leakage is suspected.				
Storage and labelling	The source should be stored in its metal cylinder, in its original can packaging labelled with a radioactive warning sign and kept in the steel store cabinet.				
Spill or drop	Wear a lab coat and disposable gloves. If a source is dropped, check the area where it fell for contamination, and decontaminate it if necessary. See section 9.2.				
Availability	Currently supplied by SciChem.				
Standard School Holding	The total activity of all sealed sources should not exceed 1.2 MBq. No single sealed source should be above 400 kBq,				

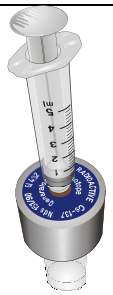
Type number 9a	Protactinium generator (Philip Harris or ScienceScope type) NOT DIY versions. See Type 9b	© CLEAPSS 2019
Description		A thin-walled fluoropolymer bottles containing an aqueous solution of acidified uranyl(VI) nitrate beneath an organic solvent. The cap is sealed onto the bottle, and there is usually an additional exterior seal. The acid is moderately concentrated hydrochloric acid. The solvent in some designs becomes a thick goo over time, and ceases to work. Keep in mind the limited service life and the cost of disposal. Disposal must be by registered waste carrier, and the costs are currently several £100s.
Use	When the bottle is shaken, protactinium passes into the top organic liquid layer. Its decay can then be investigated by placing a GM tube very close to the organic layer.	
Original activity	Old Philip Harris version: 45 kBq (1.2 µCi). Sciencescope and current Philip Harris version: 20 kBq (0.5 µCi).	
Radionuclide and half-life	Uranium-238: 4.5 x 10^9 years, decay chain thorium-234: 24 days and protactinium-234m: 72 s. Uranium also comprises up to 0.7% uranium-235.	
Main radiations	Mainly β, (α blocked by the bottle wall)	
Hazard	Concentrated hydrochloric acid is corrosive. Organic solvent, depending on design (eg pentyl ethanoate (amyl acetate)), is harmful and flammable. See CLEAPSS *Hazcards* for specific information on chemical hazards. Uranyl(VI) nitrate is toxic and radioactive. Internal irradiation of the body due to substances being inhaled, absorbed through the skin or through wounds, or swallowed.	
Risk assessment	The external radiation is low. The greatest risk is from contamination if the bottle is damaged through poor handing or storage. The residual risk is low with the control measures in place..	
Control measures	Always follow the Standard Operating Procedures for the use of radioactive sources. Do not attempt to make your own protactinium generators.	
During use	Never try to open the generator bottle. Wear disposable gloves, splash proof goggles and lab coat when working with and using the generator bottle. Before use, inspect it for any damage. Use the generator bottle over a tray to contain the solution if it does spill. The bottle may be held by hand, but for no longer than necessary. Shake the bottle gently over the tray. Immediately after use, return the bottle, upright, into its secondary outer container. A spill kit (see *Spills or drop* below) should be readily available. Report spills immediately.	
Inspection	Annually, as well as before any use. Check for any signs of damage or deterioration.	
Leak test of source	Annually or if damage is suspected. Dry wipe around the cap and any suspect areas but do not open the bottle.	
Contamination check of outer container	Annually or if leakage is suspected. Check the container the bottle stands in and clean if necessary. If you find contamination, the bottle or the cap seal is probably failing.	
Storage and labelling	The bottle should be labelled on the lower half, indicating that it is a radioactive protactinium generator. There should also be a label on a cover or a strip of adhesive tape over the cap stating that it must not be removed. Keep the bottle upright in a larger plastic container with a tight-fitting lid. This should also be labelled. Store the protactinium generator bottle, in its secondary container, in the steel store cabinet. If there is a leak from the generator, the secondary container will help prevent hydrochloric acid fumes damaging other sources.	
Spill or drop	Wear a lab coat, splash proof goggles and disposable gloves. Spills of a few cm^3 can be mopped up with a tissue. Contain larger spills with a mineral absorbent and scoop it into a bucket with sodium carbonate and water. Check the surface where the spill occurred for contamination, and decontaminate it if necessary. See section 9.2.	
Availability	Version currently sold by Philip Harris and resellers.	
Standard School Holding	No specific limit, other than what is justified for curriculum use. The total mass of uranium held as a radiochemical should not exceed 100 g.	

Type number 9b	Protactinium generator (DIY versions) **CLEAPSS now advises that schools do not make protactinium generators**. School-made generators that are over five years old should be disposed of now. If you have one less than five years old, you may keep it for another two years, after which you should dispose of it. Replace it with a type 9a, 11 or 13 source.	
Description		A bottle containing an aqueous solution of acidified uranyl(VI) nitrate beneath an organic solvent. There are various designs and recipes, the common organic solvent is pentyl ethanoate (amyl acetate). The acid is moderately concentrated hydrochloric acid. The generators tend not to give good results after several years, probably due to a gradual deterioration of the organic solvent and impurities in it.
Use	When the bottle is shaken, protactinium passes into the top organic liquid layer. Its decay can then be investigated by placing a GM tube very close to the organic layer.	
Original activity	It depends on the formulation.	
Radionuclide and half-life	Uranium-238: 4.5 x 10^9 years, decay chain thorium-234: 24 days and protactinium-234m: 72 s. Uranium also comprises up to 0.7% uranium-235.	
Main radiations	Mainly β, (α blocked by the bottle wall)	
Hazard	Concentrated hydrochloric acid is corrosive. The organic solvent, depending on design (eg pentyl ethanoate (amyl acetate)), is harmful and flammable. See CLEAPSS *Hazcards* for specific information on chemical hazards. Uranyl(VI) nitrate is toxic and radioactive. Internal irradiation of the body due to substances being inhaled, absorbed through the skin or through wounds, or swallowed.	
Risk assessment	There is a significant risk from the failure of the cap seal or bottle. The plastic bottles in school-made versions become degraded by the contents, particularly the bottle seals. There have been many cases of serious contamination and damage caused by failed bottles.	
Control measures	Always follow the Standard Operating Procedures for the use of radioactive sources.	
During use	Never try to open the generator bottle. Wear disposable gloves, splash-proof goggles, and lab coat when working with and using the generator bottle. Before use, inspect it for any damage. Use the generator bottle over a tray to contain the solution if it does spill. The bottle may be held by hand, but for no longer than necessary. Shake the bottle gently over the tray. Immediately after use, return the bottle, upright, into its secondary outer container. A spill kit (see *Spills or drop* below) should be readily available. Report spills immediately.	
Inspection	Annually, and before any use. Check for any signs of damage or deterioration. If the cap is accessible, check that it remains secure and the bottle has not deteriorated.	
Leak test of source	Annually or if damage is suspected. Dry wipe around the cap and any suspect areas, but do not open the bottle.	
Contamination check of outer container	Annually or if leakage is suspected. Check the container that the bottle stands in, and clean if necessary. If you find contamination, the bottle or the cap seal is probably failing.	
Storage and labelling	The bottle should be labelled on the lower half, indicating that it is a radioactive protactinium generator. There should also be a label on a cover or a strip of adhesive tape over the cap stating that it must not be removed. Keep the bottle upright in a larger plastic container with a tight-fitting lid. This should also be labelled. Store the protactinium generator bottle, in its secondary container, in the steel store cabinet. If there is a leak from the generator, the secondary container will help prevent hydrochloric acid fumes damaging other sources.	
Spill or drop	Wear a lab coat, splash-proof goggles, and disposable gloves. Spills of a few cm^3 can be mopped up with a tissue. Contain larger spills with a mineral absorbent and scoop it into a bucket with sodium carbonate and water. Check the surface where the spill occurred for contamination, and decontaminate it if necessary. See section 9.2.	
Availability	Not applicable	
Standard School Holding	No specific limit, other than what is justified for curriculum use.	

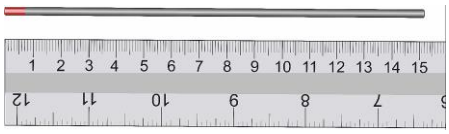
Type number 10	No longer recommended – dispose Radon-220 (thoron) generator (powder version)	© CLEAPSS 2019
Description		Originally called a thoron generator, but more correctly termed a radon-220 gas generator. It is a plastic squeeze bottle containing about 20 g of a thorium compound in powder form (usually thorium hydroxide or carbonate). Very small quantities of radon-220 gas are produced by the radioactive decay series of thorium. To let radon gas out, but keep the powder in, two discs of chamois leather are fitted in the cap to act as a filter. Some used a muslin bag to hold the powder in the bottle. They usually have a tube and Mohr clip fitted.
Typical dimensions	No standard bottle size, but usually less than 50 mm diameter and less than 150 mm length.	
Original use	Generating radon-220 for demonstrating and measuring the half-life of a radioactive material.	
Original supplier	Panax, Philip Harris, Griffin.	
Radionuclide and half-life	Thorium-232 and decay chain. Thorium-232: 1.4×10^{10} years.	
Main radiations	α, β, γ including emissions from the decay chain.	
Reason for withdrawal from use	The plastic becomes degraded by age and the radiation field. Thorium powder is very radiotoxic by inhalation. The gas mantle version of the radon generator presents a much lower risk.	
Risk assessment	This type of radon generator can present a greater risk than other sources commonly used in schools. These sources are now well beyond their recommended working life and a risk assessment does not support extending their service life given that there is a safer alternative.	
Storage and labelling	*The bottle must not be opened*. Place the radon generator in a sealed bag and label it 'DO NOT USE'. Keep it in the steel store cabinet. Make arrangements to dispose of it promptly	
Spill or drop	Wear a lab coat, disposable gloves and dust mask (FFP3). If a source is dropped, check the area where it fell for contamination, and decontaminate it if necessary. See section 9.2.	
Disposal	See section 12.	

Type number 11	Radon-220 generator (gas mantle version)	© CLEAPSS 2019
Description		A polythene squeeze bottle containing thoriated gas mantles (mantles impregnated with thorium oxide). Very small quantities of radon-220 (thoron) gas are produced by the radioactive decay series of thorium. When the generator is not in use, a Mohr clip on a single rubber tube prevents gas escaping. In the version manufactured by Cooknell, the radon generator is connected to an ionisation chamber and an integral picoammeter.
Use	When the bottle is squeezed, radon gas travels along the tube into a port on a separate, closed, ionisation chamber, where the short half-life of the gas can be determined. The exhaust port on the chamber is by fitting a small party balloon over the port. Unsealed systems should not be used.	
Original activity	Typically 6 kBq (0.16 µCi) (four gas mantles).	
Radionuclide and half-life	Thorium-232: 1.4 x 10^{10} years, and decay chain, including radon-220: 56 seconds.	
Main radiations	α, β, γ including emissions from the decay chain.	
Hazard	Thorium compounds are toxic and radioactive. Internal irradiation of the body due to substances being inhaled, absorbed through the skin or through wounds, or swallowed.	
Risk assessment	The thorium is impregnated into the gas mantle fabric, so the release of any significant thorium dust will be unlikely. Radon gas should not escape if the apparatus is used carefully – even if it did, the concentration in the air would be extremely low. Caution is needed if the bottle splits or the top needs to be removed, as there can be fragments of mantle which could be released. The residual risk is low with the control measures in place.	
Control measures	Always follow the Standard Operating Procedures for the use of radioactive sources. Gas mantles are regarded as low-level radioactive artefacts.	
During use	The bottle must not be opened. An extremely small volume of radon gas is required, so the bottle should only be squeezed gently two or three times. The Cooknell ionisation chamber is sealed, and should not be opened.	
Inspection	Annually, as well as before and after each use. If the bottle, filter or tubing show any sign of deterioration or damage, that component must be replaced. If the bottle needs to be opened, special precautions, as for spills and drops below, must be followed.	
Leak test of source	Annually or if damage is suspected. Do not open the bottle. The outer surfaces and the cap should be leak tested by dry wipe.	
Contamination check of container	Not required unless fragments of mantle are suspected of having escaped from the bottle. If so, the plastic storage bag should be checked and replaced if necessary.	
Storage and labelling	With the clip closed, disconnect the tube and bottle from the apparatus. The bottle with tube should be placed in a strong, self-sealing plastic bag and kept in the steel store cabinet. The bottle should have a small label indicating that it contains thoriated gas mantles for generating radon. Another label close to the cap should make it clear that the top must not be removed.	
Spill or drop	If the bottle breaks, the gas mantles may release a few fragments, so care is needed. Wear a lab coat, dust mask (FFP3) and disposable plastic gloves. Carefully pick up the bottle and gas mantles with a tissue and place them in a bag. Dab the bench area with sticky tape to pick up any fragments. Check the area for contamination, and decontaminate it if necessary. See section 9.2	
Availability	Currently sold by Cooknell Electronics Ltd (Weymouth) and Timstar.	
Standard School Holding	No specific limit, other than what is justified for curriculum use.	

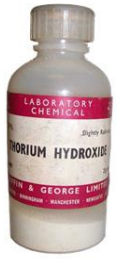
Type number 12	Gas mantles (thoriated)	© CLEAPSS 2019
Description		Gas mantles, intended for use with camping gas and similar lamps, comprise a fabric impregnated with various compounds (to increase luminosity). When first used in a lamp, the fabric burns away, leaving a fragile mesh of ash. Some mantles use thorium compounds because these give high luminosity. These are becoming difficult to obtain as most brands now no longer use thorium.
Use	To show that 'domestic' objects may be naturally radioactive. Also useful as a simple check source to test detection equipment is functioning.	
Original activity	Of one mantle, typically 1 kBq (0.03 µCi).	
Radionuclide and half-life	Thorium-232: 1.4×10^{10} years, and decay chain.	
Main radiations	α, β, γ including emissions from the decay chain.	
Hazard	Thorium compounds are very toxic and radioactive. Internal irradiation of the body due to substances being inhaled, absorbed through the skin or through wounds, or swallowed.	
Risk assessment	Gas mantles are available to the general public. The concentration of radon in the air would be extremely low. And certainly before the mantle is burnt, there is little risk of inhalation of thorium dust, because the thorium is impregnated into the fabric of the mantle. The residual risk is low with the control measures in place.	
Control measures	Always follow the Standard Operating Procedures for the use of radioactive sources. Gas mantles are regarded as low-level radioactive artefacts. Do not use burnt gas mantles because the fine ash easily causes contamination	
During use	Keep the unused gas mantle, including the plastic or cellophane envelope in which it is supplied, into a small sealable plastic bag.	
Inspection	Check that the mantle is in good condition and not fraying.	
Leak test of source	Not applicable.	
Contamination check of container	Not required unless it is suspected fragments of mantle may have escaped from the bag.	
Storage and labelling	Gas mantles should be put in a strong, sealable plastic bag, labelled with a radioactive warning sign and kept in the steel store cabinet.	
Spill or drop	Wear a lab coat and disposable gloves. If a gas mantle is dropped, it is unlikely that any radioactive spill will occur. Check the area for contamination, and decontaminate it if necessary. See section 9.2.	
Availability	Camping shops, hardware stores. Many stockists only supply non-radioactive gas mantles, and this is usually stated on the packaging.	
Standard School Holding	No limit, other than what is justified for curriculum use.	

Type number 13	Caesium-137/barium-137 elution source	© CLEAPSS 2019
Description		The Isotrak generator comprises a small plastic cylinder containing 33 kBq of caesium-137 absorbed in an ion-exchange resin. When the system is eluted (ie, a special solution is passed through it using a syringe), the decay product barium-137m is removed from the generator in the solution. This allows the barium-137m decay to be monitored with a GM tube. The eluent (low hazard) is a very pure, slightly acidic solution of sodium chloride. Note that an earlier design of this type of generator used a different eluent which is completely unsuitable for the current Isotrak design.
Typical dimensions	Diameter 40 mm, length 60 mm (including two plastic storage caps).	
Use	The generator will yield up to 1000 small liquid samples containing the barium-137m isotope. The short half-life of this can be easily measured.	
Original activity	Typically 33 kBq (0.9 µCi).	
Radionuclide and half-life	Caesium-137: 30.1 years; barium-137m: 2.6 minutes.	
Main radiations	γ (β)	
Hazard	External irradiation of the body, including possibly more sensitive organs such as the eyes. Internal irradiation of the body due to substances being inhaled, absorbed through the skin or through wounds, or swallowed.	
Risk assessment	The dose rate near the surface is low, so in the short time the generator and eluate are handled, the equivalent dose on the hands will be negligible. There is a risk arising from undesirable release of caesium-137 into the eluate. Data from the supplier shows that the bleed-through using the eluent provided with the generator is very low: less than 50 Bq cm^{-3}. The residual risk is low with the control measures in place.	
Control measures	Always follow the Standard Operating Procedures for the use of radioactive sources. Only staff who have been trained in using this source should handle it.	
During use	Wear disposable gloves, a lab coat and eye protection. Work over a drip tray lined with absorbent material such as paper. Check that the correct eluent (ie, as supplied with the source) is used. Do not attempt to make your own eluent, it could ruin the source..	
After use	After at least 30 minutes, the eluate can be poured down the drain and flushed with several litres of water. The disposable gloves and paper liner can be placed in a plastic bag, tied off (do not label the plastic bag) and placed in the normal refuse. Monitor the area immediately around where the source was used to check there is no contamination.	
Records	On the use log, record, list the name(s) of anyone who handled the source and note the volume eluted.	
Inspection	Annually, as well as before and after each use. Check for any signs of damage or deterioration.	
Leak test of source	Annually or if damage is suspected, by dry wipe of the plastic body.	
Contamination check of container	Annually or if leakage is suspected. It is sufficient to check the container the source is kept in. Clean if necessary. If you find contamination, the source may be leaking so further investigation is required.	
Storage and labelling	The source should be stored in its original container, labelled with a radioactive warning sign and kept in the steel store cabinet.	
Spill or drop	Wear a lab coat, disposable gloves and eye protection. If a source is dropped, or the eluate is spilt, check the area where it fell for contamination, and decontaminate it if necessary. See section 9.2.	
Availability	Supplied by HTSL and others.	
Standard School Holding	No individual source may exceed 40 kBq. You can hold up to 10 of these sources if you can justify it. Note: the versions of this source above 40 kBq are not exempt from EPR permitting.	

Type number 14	Uranium-coloured domestic glassware and ceramic items	© CLEAPSS 2019
Description	 	Glass and ceramic items with radioactive compounds added (eg uranium oxide). These include green vaseline glass and the red/orange glaze on older Fiestaware crockery.
Typical dimensions	Not applicable.	
Use	To show that some domestic items are radioactive. Using a GM tube close to the item, an increased count is demonstrated, compared with background radiation. Vaseline glass may also be shown to fluoresce under ultraviolet radiation (see other CLEAPSS guidance on the safe use of ultraviolet).	
Original activity	Vaseline glass is typically less than 2% uranium by mass. The glaze used on radioactive Fiestaware is typically less than 15% uranium by mass. The count rate by a GM detector can be surprisingly high.	
Radionuclide and half-life	Uranium is mainly uranium-238 with up to 0.7% uranium-235 and decay chains. Uranium-238: 4.5×10^9 years.	
Main radiations	α, β, γ including emissions from the decay chain of uranium-238 and uranium-235.	
Hazard	External irradiation of the body, including possibly more sensitive organs such as the eyes. Internal irradiations of the body due to substances being inhaled, absorbed through the skin or through wounds, or swallowed. Uranium compounds are also very toxic.	
Risk assessment	The residual risk is low with the control measures in place.	
Control measures	Always follow the Standard Operating Procedures for the use of radioactive sources. Do not handle items more than is needed for the demonstration. Be wary of acquiring items that give high surface count rates – above 100 counts per second with a ZP1481 almost touching the glass or ceramic surface with the GM end cap removed.	
During use	Use in a tray, to contain fragments in the event of damage. This also allows direct handling time to be kept to a minimum.	
Inspection	Annually, as well as before and after any use. Items which are chipped or cracked should be disposed of.	
Leak test of source	Annually or if damage is suspected. The outer surfaces of the item should be tested.	
Contamination check of container	Not required unless leakage is suspected.	
Storage and labelling	These items may be kept in protective packaging (eg bubble wrap), inside a sturdy container or strong plastic bag. Use a label with a radioactive warning sign and the words ‘ceramic/glassware with low radioactive content’.	
Spill or drop	If one of these glass or ceramic items is dropped and breaks, the greater hazard will be from sharp edges. However, care must also be taken to avoid contamination from the low amounts of radioactive material present. Wear a lab coat, dust mask (FFP3) and disposable gloves. Use forceps to transfer larger broken fragments onto several layers of newspaper. Carefully sweep up the remainder with a dustpan and soft brush and put it onto the newspaper. Wrap the fragments and dust in the newspaper and bind it with sticky tape. Put it into a sturdy plastic bag and tie it off. Check the area where it fell for contamination, and decontaminate it if necessary. See section 9.2.	
Availability	Available through second-hand and antiques dealers.	
Standard School Holding	No limit, other than what is justified for curriculum use.	

Type number 15	Thoriated tungsten welding electrode	© CLEAPSS 2019
Description		Thoriated tungsten electrodes are intended for TIG (Tungsten Inert Gas) welding, and typically contain about 1% or 2% thorium oxide. (Rods with a red tip have 2%.) They may be available in packs of 10 but can usually be purchased individually.
Typical dimensions	Diameter 3 mm, length 150 mm. Other diameters are available.	
Use	Can be used in a diffusion (Taylor) cloud chamber in place of the small radium paint sources, which are no longer available. The cloud chamber may need to be modified by having an additional 3.5 mm hole drilled 7 mm above the chamber floor. The electrode is held in place by inserting it into a bung or cork at each end.	
Original activity	Red-tipped (2%) rods are about 3.2 kBq.	
Radionuclide and half-life	Thorium-232: 1.4 x 10^{10} years, and decay chain.	
Main radiations	α, β, γ including emissions from the decay chain.	
Hazard	Thorium compounds are very toxic and radioactive. Internal irradiation of the body due to substances being inhaled, absorbed through the skin or through wounds, or swallowed.	
Risk assessment	The rods are readily available to the general public. The surface equivalent dose rate is very low. The thorium is evenly dispersed throughout the rod (during manufacture, tungsten and thorium oxide powder are sintered into a metal alloy electrode and the thorium is firmly bound into the metal). It is almost inconceivable that thorium could be released, even if the rod were roughly handled. (Small amounts of thorium are released when grinding the electrode, or to a lesser extent during welding.) The residual risk is low with the control measures in place.	
Control measures	Always follow the Standard Operating Procedures for the use of radioactive sources. Thoriated tungsten electrodes are regarded as low-level radioactive artefacts. Use electrodes that conform to BS EN ISO 26848:2004	
Inspection	Check that the electrode surface is clean and free from obvious defects.	
Leak test of source	Annually, carry out a simple wipe test (using dry filter paper).	
Contamination check of container	Not required.	
Storage and labelling	Remove from the cloud chamber and put them back in the plastic storage case in which they are normally supplied. Keep with other radioactive sources in the steel store cabinet-.	
Spill or drop	Due to the design, it is almost inconceivable that thorium oxide would be released even if the electrode were broken. See section 9.2.	
Availability	SWP brand, type WT20 supplied through welding supplies shops.	
Standard School Holding	No limit, other than what is justified for curriculum use.	

Type number 16	No longer recommended – dispose Uranyl(VI) nitrate-6-water (uranyl nitrate) See source type number 17	
Description		

Type number 17	No longer recommended – dispose Uranium and thorium compounds as radiochemicals (including uranyl nitrate)	© CLEAPSS 2019
Description		These are classed as unsealed sources. Often their use was not related to their radioactive properties. Uranyl zinc acetate and uranyl magnesium acetate are laboratory reagents that were used to test for sodium. Uranyl acetate, uranyl zinc acetate and uranyl magnesium acetate are used as stains in electron microscopy. Uranium oxide was used in glazes to give green and orange colours. One of the Panax kits has sachets of uranium and thorium compounds to show their radioactivity.
Typical dimensions	Not applicable.	
Original use	Various.	
Original supplier	Various.	
Radionuclide and half-life	Uranium - mainly uranium-238 with up to 0.7% uranium-235 - and decay chains. Uranium-238: 4.5 x 10^9 years. Thorium-232 and decay chain. Thorium-232: 1.4 x 10^{10} years.	
Main radiations	α, β, γ including emissions from the decay chains.	
Reason for withdrawal from use	No relevance to the current science curriculum. Uranyl nitrate should not be kept because school-made protactinium generators are no longer recommended.	
Risk assessment	The risk cannot be justified because the radioactive substances are redundant in schools.	
Storage and labelling	Place each bottle or sachet individually in a sealed bag and label it ‘DO NOT USE’. Keep them in the steel store cabinet. Make arrangements to dispose of them promptly.	
Spill or drop	Wear a lab coat and disposable gloves and dust mask (FFP3). If a source is dropped, check the area where it fell for contamination, and decontaminate it if necessary. See section 9.2.	
Disposal	See section 12.	

Type number 18	Uranium oxide encapsulated disc source	© CLEAPSS 2019
Description		Uranium oxide is encapsulated in a thin envelope, usually an aluminium planchet with an aluminium face permanently sealed together. This source came from the Joint Matriculation Board (JMB) in the 1970s and they were supplied for an A-level practical examination.
Typical dimensions	Diameter 20 mm, thickness ~2 mm.	
Use	Used as a check source, mainly a beta emitter from the Pa-234m in the decay chain.	
Original activity	JMB version is 1.1 kBq (0.03 µCi).	
Radionuclide and half-life	Uranium oxide. Uranium is mainly uranium-238 with up to 0.7% uranium-235 and decay chains. Uranium-238: 4.5 x 10^9 years.	
Main radiations	α, and β emissions from the decay chain. α emissions blocked by the aluminium envelope.	
Hazard	External irradiation of the body, including possibly more sensitive organs such as the eyes. Internal irradiation of the body due to substances being inhaled, absorbed through the skin or through wounds, or swallowed. Uranium oxide is also very toxic.	
Risk assessment	The residual risk is very low with the control measures in place.	
Control measures	Always follow the Standard Operating Procedures for the use of radioactive sources.	
During use	These sources should be handled by the edges, either by gloved hand, or with plastic forceps. Avoid metal tongs or other tools that could damage the source envelope. The metal front is quite thin and could be punctured by careless handling.	
Inspection	Annually and after use by students.	
Leak test of source	Annually or if damage is suspected. Check for evidence of the seal failing around the circumference of the source.	
Contamination check of container	Not required unless leakage is suspected.	
Storage and labelling	Make sure there is durable labelling on one side of the disc stating the activity and that it is uranium oxide. The source can be kept in a small plastic container and kept in the steel store cabinet.	
Spill or drop	Wear a lab coat and disposable gloves. If a source is dropped, check the area where it fell for contamination, and decontaminate it if necessary. See section 9.2.	
Availability	These sources have not been available for many years. Replacement school-made sources are not recommended.	
Standard School Holding	No specific limit, other than what is justified for curriculum use. The total mass of uranium should not exceed 100 g.	