Safety

Electricity

8A1

Recall that high voltages carry a risk of electrocution and high currents carry a risk of overheating and fire.

Mains voltages are potentially lethal. Before you investigate the insides of a unit make sure both you and it are safe. Be aware that some components can retain a charge for a period of time after the unit is switched off and unplugged and that some equipment, particularly valve equipment, can have higher than mains potential voltages inside.

You should be aware of your own knowledge and your own limitations. If you are in doubt about the safest way to handle something you should seek advice or leave it to a qualified individual.

High currents are also a risk element and can be present with surprisingly low voltages. Short circuits, particularly across the terminals of a power supply or large battery, can quickly lead to high currents, overheating wires and potentially causing fires.

If you are tinkering with equipment make sure that you have removed all rings and metallic wristwatches, bracelets and other jewellery to avoid an inadvertent short circuit being created.

8A2

Recall that where a safety earth has been fitted that it must not be removed.

Recall that special care is needed with earthing arrangements and that a competent professional must be consulted before making any modifications.

The mains earth is an important safety feature. Its purpose is to protect you if a fault develops and prevent cases or other exposed metalwork from becoming live.

If your equipment is fitted with an earth safety lead then you should not remove it, doing so introduces a risk of cases and exposed metalwork becoming live in the event of a fault developing.

Installing an RF earth has some safety implications. Depending on the age of your electrical installation you may have a system called Protective Multiple Earthing (PME) then the installation of an RF earth needs special consideration.

You can determine if you have PME by asking your District Network Operator (DNO). To find out who is the DNO you may have to contact the company that you pay for your electricity supply. If you can't contact your DNO a qualified professional will be able to identify the systems in use.

There is advice on the RSGB website and this is kept up to date and should be referred to in the first instance.

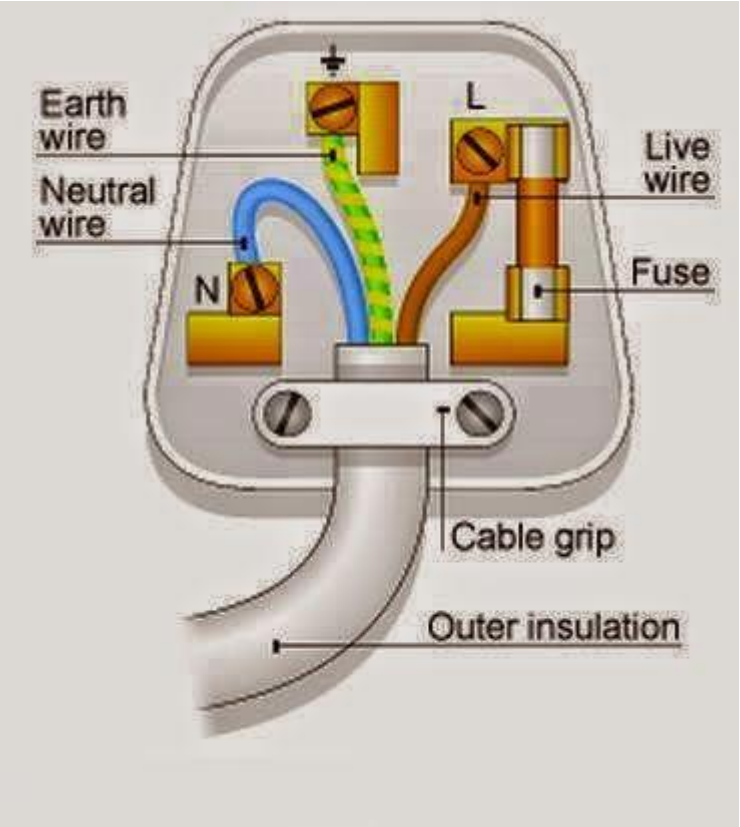
https://rsgb.org/main/technical/emc/emc-publications-and-leaflets/

8A3

Recall the correct way to wire a 3-pin mains plug.

It is important to ensure that only the correct plugs that are properly wired are used to connect mains devices to the mains supply. Loose wires and adapters should be avoided. Key facets of a well-wired mains plug are:

- The flex must be held captive by the cord grip. Do not rely on the fixing to the metal conductors themselves
- Each wire within the flex must be securely connected to the correct pin of the plug
    - Brown = Live
    - Blue = Neutral
    - Yellow/Green = Earth
- The insulation should continue to close up to the pin
- Frays and whiskers must be avoided
- All the strands must be secured
- The flex itself must be in good condition



8A4

Recall that fuses to be fitted in accordance with manufacturer's instructions.

Recall that a fuse is a thin wire designed to melt, breaking the circuit, when passing an excessive current.

Recall that the reason for a blown fuse needs to be properly investigated.

The fuse is another aspect of the mains safety system. A fuse consists of a thin wire designed to melt when too much current is present before anything else is damaged. However, a fuse can only provide this protection if it is correctly rated.

Most plugs come supplied with a 13A fuse which is almost always far too great a rating and fuses should be changed to match the manufacturer's recommendations. Whilst heavy current items such as washing machines, dryers and fridges/freezers might need a 13A fuse to allow them to draw the amount of current that pumps and motors might need, a TFT monitor will never require 13A and will be damaged by current levels much lower than this. Low current devices, which covers a lot of the equipment we are likely to have in a normal shack, need to have low current fuses fitted in accordance with the manufacturer's recommendations.

If a fuse blows, particularly if the same fuse blows repeatedly, then the cause should be investigated since something might have become faulty.

8A5

Understand that a Residual Current Circuit Breaker with Overcurrent protection (RCBO) will give better protection against electric shock than relying solely on a conventional fuse which only protects against excessive current.

Note: The candidate should appreciate that an RCBO will detect currents to earth of about 30mA whereas a fuse will only blow at several amps and only when the fault is a short circuit (L-N or L-E).

The candidate should also understand that contact with both live and neutral may cause fatal injury.

The mechanics of RCBO operation (differential current sensing) is not examinable.

A fuse only provides protection against excessive current and only protects against faults that create a Live-Neutral or Live-Earth short circuit.

A higher level of protection is provided by a Residual Current Circuit Breaker with Overload Protection (RCBO). The overload protection is an electro-mechanical fuse that cuts the circuit if the current exceeds a preset limit much as a conventional wire fuse would, but has the advantage of being resettable.

The residual current element compares the current flowing in the neutral line with the current flowing in the live line. Under safe and normal circumstances the current in the neutral and live lines should be equal, any difference indicates that some of the current has found its way to earth. An RCBO will trip at differences as low as 30mA.

If someone has touched one or other of the live or neutral lines some of the current in that line will divert to earth through the person touching the wire. The RCBO will quickly trip removing the current and potentially saving lives or reducing injury.

Note that if both live and neutral wires are touched at the same time the balance between both lines will remain the same and the RCBO will not detect the fault and will not prevent a potentially fatal electric shock.

8A6

Recall that work inside equipment should only be carried out with the power sources disconnected.

Recall why it is important to follow the manufacturer's instructions for servicing equipment.

If you decide that you are competent and properly equipped to work inside your radio equipment then you will need to ensure that the equipment is safe whilst you are working on it. Remove any source of power and allow any internal charge to dissipate before opening the equipment.

Make sure you have the manufacturer’s service manual or information and work in accordance with the manufacturer's recommendations.

In some cases the equipment once repaired may also need to be calibrated or set up and this process must be completed to ensure the continued safe and correct operation of the equipment once re-assembled and reintroduced to the shack.

8A7

Understand that all equipment should be controlled by a clearly marked master switch, the position of which should be known to others in the house or club.

Recall that, in the event of an accident or fire involving electricity, the first action is to switch off the power.

Recall that the casualty must not be touched unless the power has been switched off.

Within any typical shack, there are likely to be a number of devices plugged into the mains supply and, if you're lucky enough, you may also have a workbench.

You should lay your shack and working area out so that there is a single master switch that can isolate all of the equipment in the shack.

This master switch allows the shack to be isolated from power in the event of an accident or problem but will only be of maximum value if it is both clearly marked and known to other occupants of the house.

If there is an accident or injury then the first action must always be to isolate the area and the casualty from power to allow rescuers to act safely.

8A8

Recall that some batteries can supply very high currents which can be hazardous if subjected to short circuit.

Recall that battery charging must be in accordance with manufacturer instructions and that lithium batteries, in particular, can cause fire and explosion if not properly treated.

Understand that different battery technologies require different charging techniques and must use the correct type of charger.

Car batteries are designed to provide very high currents for short periods of time required to start a cold engine. This can be dangerous if a car lead/acid battery is short-circuited when very high currents can flow capable of generating high heat levels and melting conductors resulting in a fire.

Other hazards are present with car lead/acid batteries, charging can release hydrogen which can be explosive, particularly in confined spaces, and spills can result in acid coming into contact with skin or furnishings.

Sealed lead/acid batteries, often referred to as SLABs, are safer.

Different battery chemistries require different charging techniques; lead/acid batteries are reasonably straightforward and older Ni-Cad and Nickel Metal Hydride batteries can be charged by a variety of basic chargers. However, batteries based around Lithium chemistry need to have the correct charger applied to them. Fast charging of Lithium batteries is potentially dangerous and can result in battery fires and use of the wrong charging techniques can unbalance the cells and damage them.

If rechargeable batteries came supplied with a charger then it is advisable to use that charger and not to assume that it can be used for batteries of different chemistry unless it is clearly stated in the chargers instructions that it can be.

Using tools

8B1

Recall that eye protection must be worn when using tools to prevent eye damage from small metal particles (swarf).

Working on wood and particularly metal with power tools like drills, Dremels, jigsaws and grinders will result in small flecks of wood or metal (referred to as swarf) being flung off the tool's moving parts. These can be dangerous and eye protection should be worn to avoid damage to sensitive organs. Swarf also tends to be sharp so avoid sweeping down a workbench with your hands, use a brush instead.

8B2

Recall that all tools, including power tools, can be hazardous and should be handled with care and appropriate precautions are taken.

Incorrectly handled or inappropriately used tools have the potential to cause injury. Use the right tool for the job and use it carefully, even hand tools have sharp edges.

Make sure you fix whatever it is that you're working on and always try to cut or drill away from you so that slips have less chance of moving the tool towards your body.

8B7

Recall that eye protection must be worn when soldering to prevent solder or flux from splashing into the eyes.

Recall that a soldering-iron stand must be used to avoid skin contact with the hot bit of the iron when not in use.

Recall that soldering work stations must be well ventilated to avoid inhalation of solder fumes, which can cause breathing problems particularly to asthmatics.

Although Foundation Licensees are not allowed to construct or modify transmitting equipment there is nothing to stop you constructing station accessories, interfaces or receivers for your shack. Construction remains one of the most enduring aspects of the hobby and can provide much satisfaction in its own right.

Soldering, not surprisingly, contains or carries a few risks that must be managed but are relatively straightforward to address:

1. Solder, resin and flux are heated to high temperatures during the soldering process and can spit. Avoid eye injuries by wearing eye protection whilst soldering.
2. Soldering irons are hot. This might sound obvious, and indeed it should be obvious, but it is important that when the iron is not in use but kept hot for the next soldering operation that the iron is placed safely so that it can't fall and can't be accidentally touched by using a soldering iron stand
3. Fumes from soldering are unpleasant and can cause problems for people who already have respiratory complaints such as asthma. Always work in a well-ventilated area to avoid a concentration of fumes.

Working at height

8C1

Recall that antenna erection is potentially hazardous and that it is advisable to have someone to help you.

Understand the need for at least one adult to be present.

Any working at height carries attendant risks of falling. Antennas are often large, heavy and unwieldy making them difficult to handle, especially when also trying to negotiate or work from a ladder. It is no surprise that working at height regulations that apply to construction sites require the use of fixed scaffold or mobile elevating platforms rather than relying on ladders.

Clearly, we are not required to erect a scaffold tower or hire a MEWP to put up an antenna. However, we should proceed with caution and apply common sense:

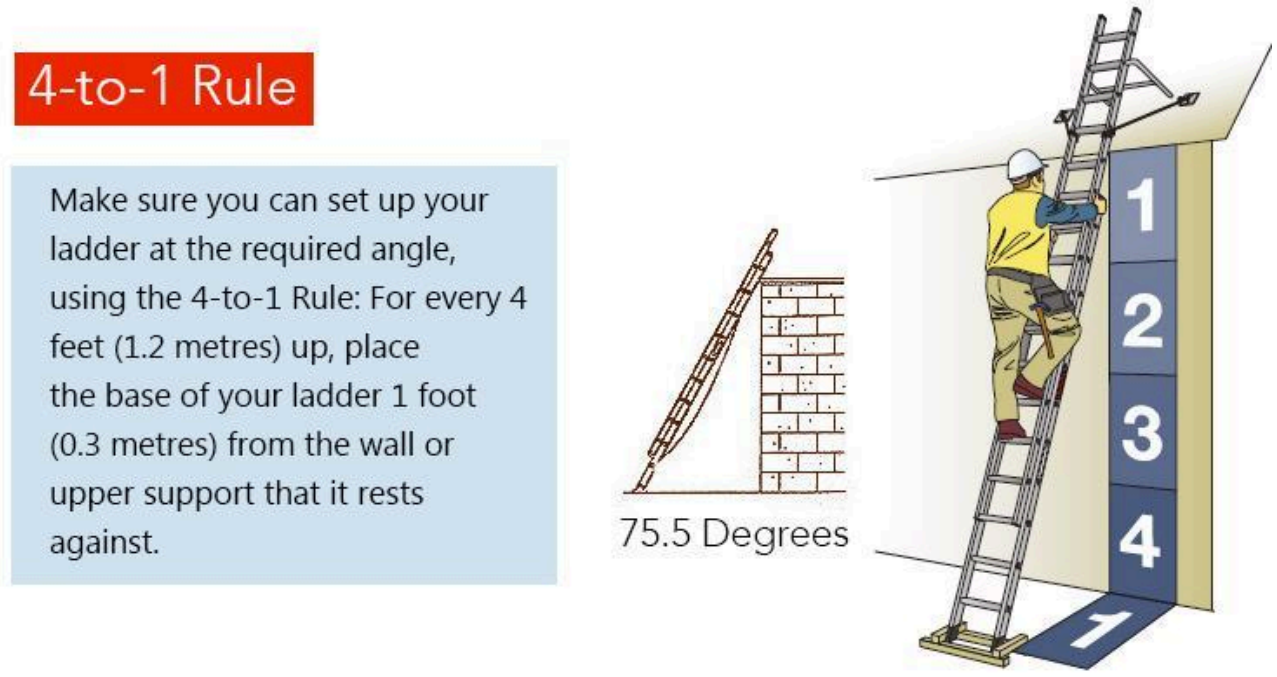
1. **Don't work alone**. Make sure there is someone with you at ground level to steady the ladder, pass tools and materials up to you and if the worst happens to summon help
2. **Watch your surroundings**. Don't work close to overhead lines, particularly power lines
3. **Pre-assemble**. Minimise the tasks being undertaken at height by pre-assembling components whilst making sure that each assembly can be easily handled whilst working from a ladder

8C2

Recall that a ladder should be used at the correct angle (4:1 height-to-base ratio).

Understand that ladders must be adequately secured to prevent them slipping.

Understand why it is important not to overreach from a ladder, to prevent falling off.



It might be tempting to just pop a ladder up and climb up to fix or adjust something, this is the way that accidents can happen. Remember to take that little bit of extra time to ensure that your ladder is secure: the base can't slip away, the top is resting against a secure spot. Some ladders come with or can have added to them, additional ties, straps or extensions that can make the ladder more secure. If you have these desirable features please use them.

Plan what you are going to do and where the ladder has to be positioned to reach the task at hand without having to reach from the ladder. If you can't reach, come down, reposition the ladder safely and then climb back.

8C3

Understand why, when working at height, a tool belt or similar device to carry tools should be used, and that it will help prevent falling objects.

Understand the need to wear hard hats when working at height or when others are working at height.

When climbing ladders it is best practice to have both hands available to grip the ladder. To carry tools don't attempt to hold them and climb and don't rely on pockets to retain them. It is advisable to use a tool belt which will securely hold a variety of tools reducing the chance that tools will add to injury in the event of a fall.

Whoever is on the ground ensuring that the ladder is safe should wear a hard hat to protect them in the event that tools or other components are dropped. It is advisable for the person on the ladder to be similarly protected to avoid injury from overhead gutters or antenna brackets.

Working with RF

8D1

Recall that the main health effect of exposure to electromagnetic radiation is heating of body tissue and that the eyes are particularly susceptible to damage.

The closer to an antenna the higher the field strength. High field strengths can cause warming of body tissue. Eyes are particularly susceptible to this effect as there is no blood flow to disperse or dissipate the heat and eyes are particularly sensitive organs within the body.

8D2

Recall that guidance on safe levels of RF radiation is available from the government and international bodies, Health Security Agency and the International Commission on Non-Ionising Radiation Protection (ICNIRP).

A particularly high gain antenna may cause localised high field strengths even with relatively low powers but good separation between people and the antenna will obviate this.

The Health Security Agency and the International Commission on Non-Ionising Radiation Protection provide guidance on safe levels of RF radiation and length of exposure.

The licence conditions now require us to assess the likely radiation levels close-in to our antennas using recognised calculators and maintain records of these. Where the calculations show that there is an exclusion zone around an antenna then it is important not to transmit when someone is within the exclusion zone.

Handheld transmitters up to about 5W are unlikely to represent a hazard, especially if the transmission time is kept short. However, it is wise to keep the antenna away from the eyes as much as to avoid poking yourself in the eye as reducing RF heating.

8D3

Recall what a waveguide is and why it is unwise to look down a microwave frequency waveguide or to stand close to or in front of high gain antennas as they may be in use.

High gain antennas are potentially more dangerous than other types of antenna and this is particularly true at microwave frequencies like 10GHz and above. At these frequencies, it is common to use a waveguide in place of a conventional feeder to reduce loss. The RF signal travels within the confines of the waveguide. Looking down the waveguide whilst transmitting concentrates the RF energy into the eyes and presents a considerable risk.

8D4

Recall that antenna elements and other conductors carrying RF should not be touched whilst transmitting.

Recall that antennas should be mounted where people will not come into accidental contact with them.

Note: this does not apply to low powered devices such as hand-held equipment.

RF burns are electric shocks from feeders and antenna elements that are carrying RF power. They tend to occur below the skin and may not be noticed until after they occur.

During transmission, an antenna should not be touched.

When erecting antennas remember to position and secure an antenna where it will not accidentally come into contact with people to avoid them accidentally receiving an RF burn from your transmissions.

Low powered handheld devices are not particularly dangerous.

Lightning

8E1

Recall that particularly high antennas may need special protection against lightning.

Recall that the local authority building department may be able to offer advice.

Lightning that occurs during thunder and electrical storms wants to find a path to earth. Any high metal object makes that path easier and shorter and high objects tend to attract lightning. Tall structures such as church spires and high rise buildings will often have lightning conductors to provide a safe route to earth to avoid damage to the building or injury to people.

A tall metal mast surmounted by a large metal antenna array will attract lightning and you should take special precautions to protect it from a lightning strike. The mast manufacturer and the local Building Control department will be able to provide the necessary specialist advice. Note that large antenna arrays will require planning permission.

Working mobile and portable

8F1

Recall that elevated wires, masts and antennas must be suitably located and secured.

Recall that antennas and feeders must not be sited close to overhead power cables.

Recall that a lethal electric shock can result from antennas and ladders coming into contact with or attracting arcing from overhead lines.

Keeping antennas out of reach of people is always good practice, but it is equally important that the feeders are secured and in the case of twin feed as well as being clear of conducting objects they should also be out of reach as the live RF conductors are exposed.

An external antenna will be subject to the ravages of the weather and should be regularly inspected to ensure that it has not been damaged. During high winds, storms and gales high wind loading can be applied to the antenna so it is important to ensure that the antenna is securely mounted or is taken down to prevent damage to the antenna and importantly injury to people should the antenna become dismounted from its fixings.

Overhead lines are particularly dangerous in all situations, not just mobile and portable. When setting up metal ladders coming into contact with power lines can cause a shock, as can antennas coming into contact with power lines. However it is not always necessary for the ladder or antenna to come into contact with the power lines, it is possible, particularly with high voltages, for the current to "arc" over to a ladder or antenna that is simply close to the power line.

8F2

Understand the reasons for not having wires trailing across the floor, trip hazards and the risk of frayed insulation.

When setting up a temporary station such as for a Field Day, Special event or as a demonstration it is important to ensure that all cables are run tidily and safely. Trailing leads in your shack as well as in a temporary environment can cause trip hazards and in a mobile installation can become entwined in critical controls preventing safe operation of a vehicle.

Cables run under carpets is not an acceptable precaution. Although the cable no longer presents a trip hazard it is also out of sight and its condition cannot be monitored. A cable under the carpet can fray and present a potential short circuit without being noticed.

8F3

Recall that excessive volume when wearing headphones can cause damage to hearing.

It is surprisingly easy to cause hearing damage. A sudden loud noise can cause damage and pain but simply listening to too loud a sound will result in hearing loss in the future. It may take some time for this damage to become apparent but the effect is irreversible.

Headphones can make this more apparent, a sound that is not damaging when heard from a speaker at distance from the radio may, when headphones are plugged in, become too loud in the enclosed headphone space close to the eardrum. Try to keep the volume to a minimum, keep turning it down until it is too quiet and turn it up slightly.

Note that headphones can also present an electrical path to the body so don't wear them when you're repairing or working on a piece of equipment.

8F4

Recall that operating in temporary premises and/or outdoors can introduce new hazards e.g. temporary mains connections, trailing cables, damp ground.

Recall the additional safety precautions that should be taken whilst operating in temporary premises and/or outdoors e.g. risk assessment, cable routing, protection, correct fusing, use of RCBO's, no adjustments or repairs to live equipment.

Recall that advice should be sought where you are unsure.

Temporary installations or set-ups present a whole range of additional hazards. Chief amongst these is that the venue or location may be totally new and untried meaning that every cable run, antenna mounting point and operating position will have to be worked out often against a limited time window. The situation may be further exacerbated if the area is to be visited by members of the public unfamiliar with Radio Operation.

Outdoors, damp ground can increase the effects of electric shock and the presence of overhead telephone and power lines can make it unsafe to put up antennas.

When working in a temporary environment pay attention to:

1. Routing of cables: ensure these are safe, do not present trip hazards and cannot be inadvertently touched
2. Equipment positioning: make sure that there is sufficient operating and viewing space around the operating positions and that people can move safely
3. Protection to Equipment: Ensure equipment is securely positioned to prevent it from falling in use and when outdoors that it is protected from rain
4. Antenna stability: ensure that antennas are securely fixed and guyed.
5. Have backup equipment so that anything that malfunctions can be swapped out. If you have to make repairs or adjustments to equipment, do it in an area that is controlled and where there is limited access, do not try to make adjustments or repairs in the public realm.

It is best practice to visit the proposed site of the temporary station ahead of the actual event and plan the installation ensuring that the correct lengths of cables, the correct connectors, the correct equipment, a viable antenna solution and sufficient power will be available. Many venues that are open to the public will require a documented risk assessment and even if they don't require this it is good practice to document what has been considered.

If in doubt, seek advice from suitably qualified people.

8F5

Recall that safety is everybody's responsibility and that one must be alert to any potentially unsafe circumstance, warn others and report the matter to the appropriate person.

Recall this equally applies in your own 'shack' and when entertaining visitors.

No one person is responsible for the safety of any operation, we should all be alert to the circumstances and draw our observations to the attention of all those taking part. This includes making sure that visitors to our "shacks" are safe.