**Worksheet answers**

**Activity 3**

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| **Reported problem/observation from chemists** | **Suggested solution** |
| “I am not observing any drips falling from the condenser. Boiling is weak/not occurring. The equipment is heated with a stirrer hotplate set to 70°C and the solvent is ethanol.” | Heating method is set to below the boiling point of the solvent (78°C). Increase heating. |
| “The condenser is getting hot, and vapour is escaping from the open (top) end.” | The water may not be flowing fast enough or at all, or the heating is much too vigorous. |
| “The condenser is attached to the water and the water is on, but the condenser is not filling correctly, and there are a lot of bubbles and air space in the water jacket.” | Water is probably connected the wrong way (in through the top instead of the bottom). |
| “The boiling liquid is bubbling into the condenser and leaking from the joint between the flask and the condenser. I am using a 100 ml flask, and there is around 85 ml of liquid total in the reaction.” | There is much more solvent in the flask than is safe. Liquid volume should not be much more than half the flask capacity. Some students may consider bumping as a problem here. |

**Plenary**

1. Refluxing is used to heat up and hold reactions with volatile solvents/reactants at high temperatures for long periods of time, without loss of solvent/reactants.
2. Oxidation is the gain of oxygen, the loss of hydrogen, or the loss of electrons.
3. The reaction of hexanol to form hexanoic acid is an oxidation, because hexanol gains an oxygen and loses two hydrogens, to form hexanoic acid.
4. butan-1-ol + 2[O] 🡪 butanoic acid + water

CH3CH3CH3CH2OH + 2[O] 🡪 CH3CH3CH3COOH + H2O

1. The condenser is used to cool and recondense any reactant or solvent vapours which have reached their boiling point and changed state to the gas state and rise up into the condenser. The condenser therefore needs to be positioned vertically above the reaction flask so reactants/solvents can drip back down into the reaction vessel. For the condenser to work as efficiently as possible, the water inlet needs to be at the bottom of the condenser and the outlet needs to be at the top of the condenser.
2. The drip rate from the condenser back into the flask below is important as it provides information on how efficient the condenser is. If the drip rate is too slow, it suggests the condenser is not cold enough or not very efficient, which may mean some reactant/solvent is being lost out of the top, decreasing the product yield.
3. Anti-bumping granules are used to reduce the risk of the reaction mixture bumping, which can cause product loss, and is a safety concern.
4. The correct position of the condenser will ensure no reactant/solvent loss, which will encourage a higher reaction rate, a more complete reaction, and therefore a higher yield. Complete and secure seals between the reaction vessel and condenser ensures no hot reaction mixture or gases can escape and cause burns. An efficient condenser will also ensure no hot gases are given off out of the top of the equipment setup, and potentially cause burns.