Online Answers

Achievement Standard 90943 (Science 1.4)

Unit 11: Practice assessments (page 47)

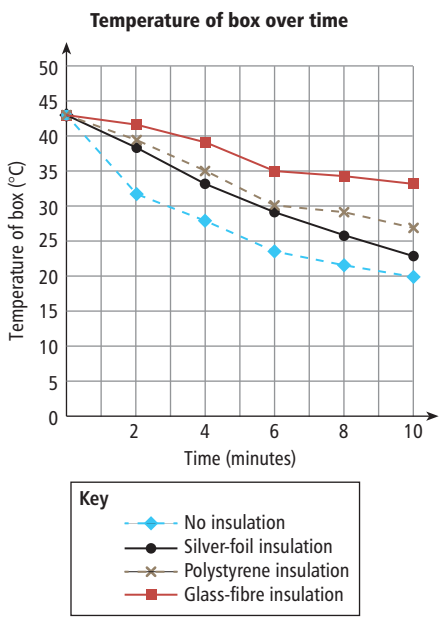
Practice assessment 1: Warmer, dryer homes

Task 1: Possible results

The values in the following table, graph and answers are examples only.

Time (min)	Temperature of box (°C)			
	No insulation	Glass-fibre insulation	Silver-foil insulation	Polystyrene insulation
0	43	43	43	43
2	32	42	38	39
4	28	39	33	35
6	24	35	29	30
8	22	34	26	29
10	20	33	23	27

Task 2: Analysis



1. The decrease in temperature for the wooden box with no insulation was 23 °C.
2. The insulation that allowed the temperature to decrease the least in 10 minutes was the glass fibre.
3. From my graph, I conclude that when the box is not insulated, heat energy is lost at a greater rate than when it is insulated. I can also conclude that all three types of insulation reduced the rate at which heat was lost from the wooden box, but that in our experiment the box with glass fibre retained the most heat.

Task 3: Report

Heat energy is always transferred from hot objects to cold objects, or from a hot object to its surroundings. In a warm home with a wooden floor, heat energy from within the home can be transferred through the wooden floor to the surroundings. In a similar way, the uninsulated wooden box in the investigation lost heat quickly to its surroundings.

Insulation is anything that slows or stops the transfer of heat energy from one place to another. Different types of insulation are used to reduce the amount of heat that is lost by different methods of heat transfer in homes.

Any hot object radiates heat, so a warm home radiates heat energy. Because radiant heat energy does not need a medium to travel through, a wooden floor cannot slow down or prevent the loss of radiant heat. Shiny, smooth surfaces, such as the silver foil used in the investigation, reflect radiant heat. Attaching silver foil beneath a floor reduces the rate of heat loss by radiation, because the foil reflects the radiant heat back into the room.

Heat can also be transferred by conduction. Conduction occurs when heat energy is passed from particle to particle by vibration. Solid objects, such as the wooden floor in a home, have particles that are close together, so the floor conducts heat energy. Air is a poor conductor of heat energy because the particles in air are far apart, making it hard for the particles to bump into each other and transfer the heat. The glass-fibre and polystyrene sheets used in the investigation have air trapped in them, which makes them poor conductors of heat. They therefore help reduce the transfer of heat energy by conduction. The investigation showed that the rate at which heat energy was lost when these insulators were used was far less than when the box had no insulation.

From the investigation, I found that when a wooden box has no insulation, heat energy is lost at a far greater rate than when the box is insulated. I found that all the insulating products that were used reduced the rate at which heat energy was lost and therefore conclude that insulating wooden floors would help reduce the rate at which heat is lost from homes. With under-floor insulation, homeowners might not need to continually heat their homes (they might still need to, for other reasons) and therefore would not pay as much for their heating bills as they would without insulation.

To achieve this (practice) assessment

The report describes the implications of insulating wooden floors, including four of the following:

- Identifies the direction of heat flow.
- Identifies that insulation reduces the rate of transfer of heat energy.
- Describes the process of conduction.
- Describes the process of radiation.
- Describes the properties of a particular type of insulation in terms of conduction and/or radiation.
- Draws conclusions from the investigation.
- Identifies that all wooden floors lose heat energy, leading to higher heating bills.

For Merit: 'Achievement' plus includes TWO explanations; for example:

- Explains how air helps to reduce heat transfer by conduction.
- Explains how silver foil helps to reduce heat transfer by radiation.
- Links the idea of using more power to heat the home continually with increased power bills.

Practice assessment 2: It's a wrap

Task 1: Possible results

The values in the following table, graph and answers are examples only.

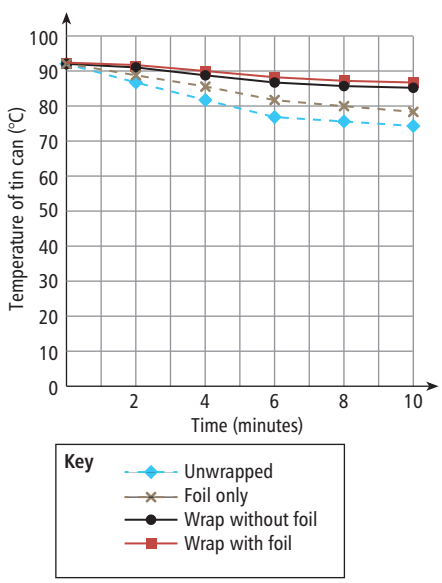
Time (min)	Temperature of water in can (°C)			
	Unwrapped	Foil only	Hot-water cylinder wrap	Hot-water cylinder wrap without foil
0	92	92	92	92
2	87	89	91	90.5
4	82	85	90	89
6	78.5	82	88	87
8	76	80	87	86
10	74	78	86	85

Observations:

- The can felt very hot to the touch with no insulation.
- Cylinder wrap with foil felt warm to the touch when the can was full of hot water.
- The wrap with no silver foil was slightly warm to the touch when the can was filled with hot water.
- The silver foil got very hot when wrapped around the can containing hot water.

Task 2: Analysis

Temperature of can over time



1. No covering. The can without any insulation allowed the water to decrease in temperature most in 10 minutes.
2. The insulation wrap with silver foil was the covering that allowed the water to decrease in temperature the least in 10 minutes.
3. I conclude that the three forms of insulation all reduce the rate of heat loss from hot water in a tin can, but the most efficient insulator is the wrap with silver foil attached.

Task 3: The report

Heat energy is always transferred from hot objects to cold objects, or from a hot object to its surroundings. Hot-water cylinders are used to heat water and to store hot water for use in the home. All hot-water cylinders lose heat energy, even if no hot water is being used. The heat energy is lost from the cylinder in three different ways – by conduction, convection and radiation.

Hot-water cylinders are made of metal, which is a good heat conductor. Conduction is the transfer of heat energy from particle to particle by vibration. In the investigation, heat energy was lost most quickly by conduction from water to metal and then to the air, from the unwrapped metal can.

Hot-water cylinder wraps are often made of materials such as polyester, wool or glass wool. All three materials contain air, trapped between their fibres. Air is a poor conductor of heat energy because the particles in air are far apart and cannot bump into each other easily to transfer heat energy.

All hot objects radiate heat, so a warm hot-water cylinder radiates heat energy. Because radiant heat energy does not need a medium to travel through, a metal cylinder cannot prevent the loss of radiant heat. Shiny, smooth surfaces, such as the silver foil used in the investigation, reflect radiant heat. Therefore, using silver foil as part of the insulation for a hot-water cylinder reduces the amount of heat lost from the cylinder by radiation, because the foil reflects the radiant heat back into the cylinder.

When heat energy has passed to the surroundings of the cylinder, the air around the cylinder becomes less dense and rises, moving away from the cylinder. Cool, denser air replaces the warm air. These convection currents also contribute to heat loss from the cylinder.

The experimental results showed that when the tin can was wrapped with a foil-lined wrapping, the smallest heat loss was experienced over 10 minutes. This suggests that it is important to insulate a hot-water cylinder with a wrap that reduces the rate at which heat is lost by both conduction and radiation of heat energy.

The implications of these results are that by insulating the hot-water cylinder, a homeowner reduces the amount they need to pay for power, because they will not waste power in reheating water that has lost heat energy, and the water will take less time to heat to the desired temperature.

To achieve this (practice) assessment

The report describes the implications of insulating hot-water cylinders, including four of the following:

- Identifies the direction of heat flow.
- Describes the process of conduction.
- Describes the process of radiation.
- Describes properties of a particular type of insulation in terms of conduction and/or radiation.
- Draws conclusions from the investigation.
- Identifies that all hot water cylinders lose heat energy, leading to higher power bills due to increased time required to heat the water.

For Merit: 'Achievement' plus includes TWO explanations; for example:

- Explains how air reduces heat transfer by conduction.
- Explains how silver foil reduces heat transfer by radiation.
- Links the idea of using more power to heat the water with increased power bills (because the heating element is on for longer than it would be if the cylinder was insulated).
- Explains that an insulated cylinder not only heats up faster than an uninsulated cylinder but also cools down more slowly, thereby requiring less heating.