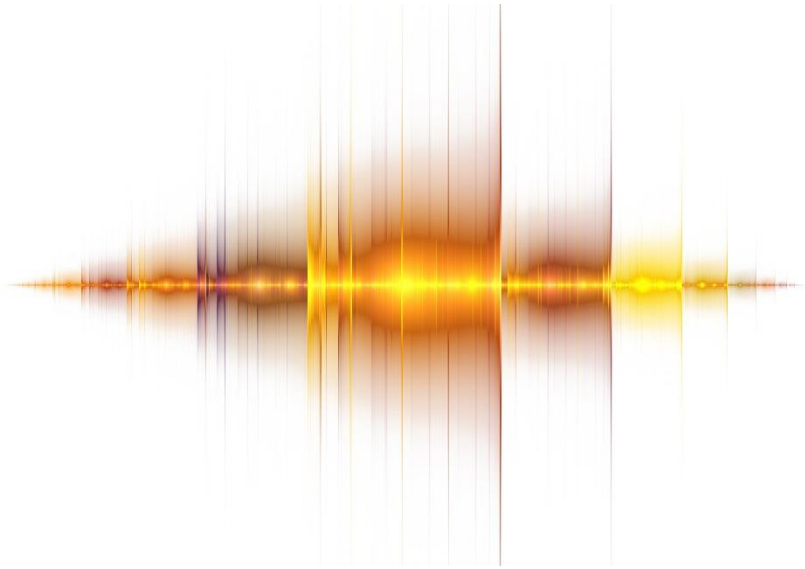
Cambridge Assessment International Education

Teaching Pack

Convection currents

Cambridge O Level

Physics 5054



Version 2.0

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Introduction

This pack will help you to develop your learners' experimental skills as defined by assessment objective 3 (AO3 Experimental skills and investigations) in the course syllabus.

Important note
Our *Teaching Packs* have been written by **classroom teachers** to help you deliver topics and skills that can be challenging. Use these materials to supplement your teaching and engage your learners. You can also use them to help you create lesson plans for other experiments.

This content is designed to give you and your learners the chance to explore practical skills. It is not intended as specific practice for Paper 5 (Practical Test) or Paper 6 (Alternative to the Practical Test).

There are two options for practising experimental skills. If you have laboratory facilities this pack will support you with the logistics of running the experiment. If you have limited access to experimental equipment and/or chemicals, this pack will help you to deliver a virtual experiment.

This is one of a range of *Teaching Packs*. Each pack is based on one experiment with a focus on specific experimental techniques. The packs can be used in any order to suit your teaching sequence.

The structure is as follows:

Briefing lesson (1 hour*)
This lesson introduces the focus experimental skills to be developed. It also introduces any content needed for your learners to understand the experiment being carried out in the *Lab lesson*.

Lab lesson (1 hour*)	
Option 1: run the experiment	**Option 2: virtual experiment**
This lesson allows the experiment to be run with your learners, providing an opportunity to practise the experiment skills introduced in the *Briefing lesson*.	This lesson allows your learners to complete a virtual experiment, providing an opportunity to practise the experiment skills introduced in the *Briefing lesson*.

Debriefing lesson (1 hour*)
This lesson consolidates and builds on the progress learners have made. In some cases, it will also provide the opportunity to practise extended writing skills.

** the timings are a guide only; you may need to adapt the lessons to suit your circumstances.*

In this *Teaching Pack* you will find the lesson plans, worksheets for learners and teacher resource sheets you will need to successfully complete this experiment.

Experiment: Convection currents

This *Teaching Pack* focuses on a convection current experiment.

Convection is the main way that thermal energy is transferred in fluids. In this experiment, your learners will observe convection in fluids and learn how density changes could be used to explain this type of thermal energy transfer.

This experiment has links to the following syllabus content (see syllabus for detail):

- 9.2 Convection

The experiment covers the following experimental skills, adapted from **AO3: Experimental skills and investigations** (see syllabus for assessment objectives):

- make and record observations, measurements and estimates
- interpret and evaluate experimental observations and data.

Prior knowledge

Knowledge from the following syllabus topics is useful for this experiment:

- 4.3 Density
- 8.1 Energy forms
- 11.3 Thermal expansion of solids, liquids and gases
- 11.1 Specific heat capacity

Going forward

The knowledge and skills gained from this experiment could be useful when you teach ideal gases and the thermal properties of matter.

Briefing lesson: Observations, measures & estimates

Resources	• Bunsen burner • Scissors (one pair per learner) • Split pins (one per learner) • Straws or lolly sticks (one per learner) • Tea lights (one per learner) • Worksheets A, B, C and D • Worksheet B: Suggested answers
Learning objectives	By the end of the lesson: • ***all*** learners should be able to describe the process of convection as one of the ways thermal energy is transferred • ***most*** learners should be able to explain the role of convection in everyday phenomena • ***some*** learners will be able to evaluate the role of convection and the way it transfers thermal energy.

Timings	Activity
5 min	**Starter/Introduction** Give your learners Worksheet A. Give them time to discuss the questions in small groups before they write down and/or share their answers.
5 min	**Main lesson** Ask if anyone can assess the thermal energy transfer from the flame without using any measuring instruments. Give them two minutes for thinking individually and then the rest of the time to share their ideas with the class.
10 min	As a demonstration to the class, set the Bunsen burner on the yellow safety flame. Show your learners how near you can move your hand to the flame from the side, stopping when it gets too hot. Ask them to predict how near you will be able to get your hand above the flame. Demonstrate this to see if their predictions are true. Ask them to explain why you can get your hand so much closer to the flame from the side compared to from above. Make sure you correct possible statements such as 'heat rises' to 'hot air rises if surrounded by cooler air'. Introduce the idea of convection currents.
20 min	Hand out Worksheet B and allow your learners time to complete the tasks. Then ask them to exchange their sheets and to peer-mark each other's work based on the example answers (see Worksheet B: Suggested answers). **Safety** Circulate the classroom at all times during the activity to ensure learners do not start a fire with the tea lights.
10 min	When studying convection your learners need to be aware that heat itself does not rise and that it is actually particles with energy and density changes that lead to the transfer of thermal energy. Hand out Worksheet C and ask them to complete the correct statements about convection.
10 min	**Plenary** Give your learners Worksheet D which shows a hot air balloon. Ask them to write a short paragraph to explain how it works.

Lab lesson: Option 1 – run the experiment

Resources	• An ice cube made from strongly coloured water (from food colouring) • Warm water • Clear beaker • Equipment for practical as outlined in Teacher notes • Worksheets E, F and G
Learning objectives	By the end of the lesson: • ***all*** learners should be able to describe the processes of convection as one of the ways thermal energy is transferred • ***most*** learners should be able to link density differences to convection • ***some*** learners should be able to evaluate the role of gravity in buoyant force

Timings	Activity
10 min	**Starter/Introduction** Fill a clear glass with warm water. Show your learners the coloured ice cube. Ask them to guess what will happen when you put the ice cube in the water and leave it for a while. Give them time to either write down or sketch their ideas in their exercise book or discuss with their partner. Add the ice cube to the glass/beaker of water. Let them observe what happens. Either have a class discussion or ask them to write what they observe.
35 min	**Main lesson** Your learners can do the main experiment in pairs, or in small groups if necessary. During the experiment they should refer to Worksheet E, which shows them the method to use. They can record their observations using Worksheet F. **Safety** Circulate the classroom at all times during the experiment to make sure that your learners are safe and that the data they are collecting is accurate. Standard lab rules apply regarding how to use Bunsen burners.
15 min	**Plenary** Hand out Worksheet G. Once learners have had time to complete the tasks, discuss some of the answers as a class or in small groups. With more able learners, you may like to discuss the role of gravity in buoyant force, hence the floating due to density differences.

Teacher notes

Watch the *Teacher walkthrough* video and read these notes.

For starter demonstration:

- an ice cube made with water stained with food colouring (the darker the colour, the better the effect)
- warm water
- clear drinking glass or a large beaker.

Each group will require:

- Bunsen burner
- tripod and gauze
- 600cm^3 heat resistant beaker
- potassium manganate(VII) crystals
- tweezers
- heat-proof mat

Safety

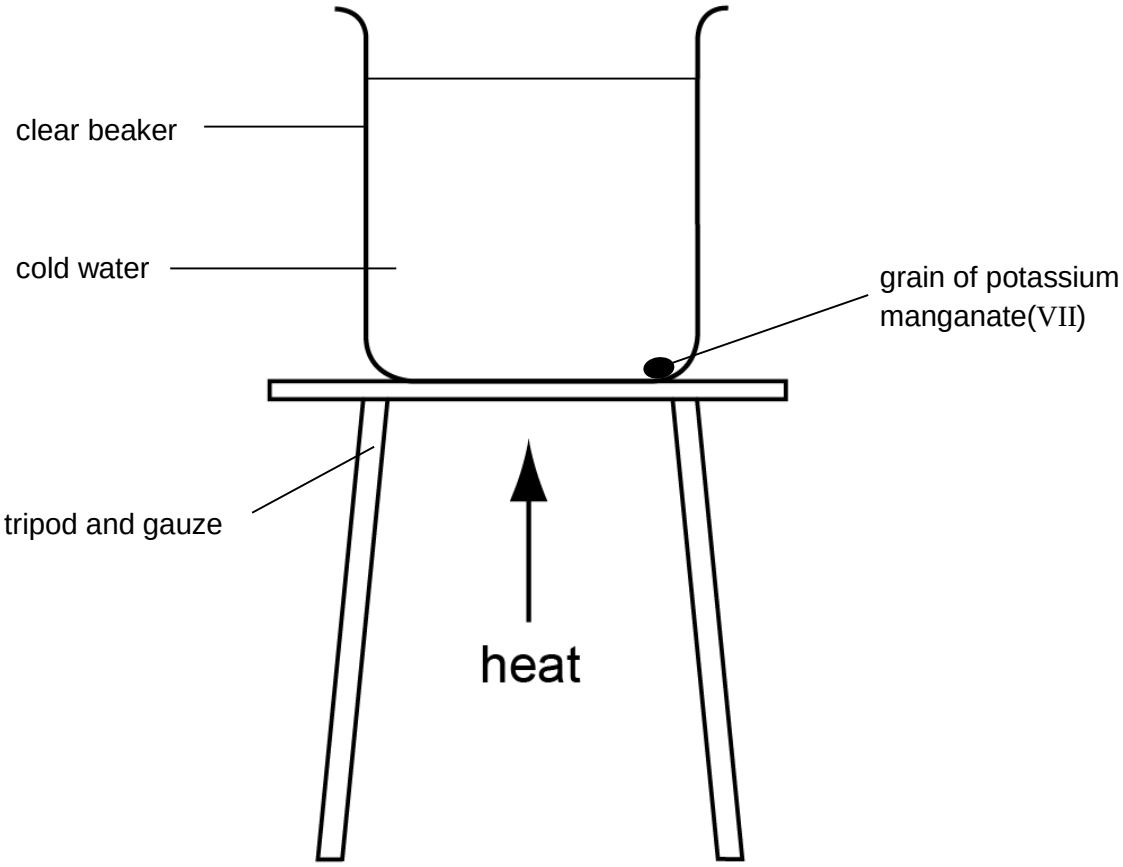
The information in the table below is a summary of the key points you should consider before undertaking this experiment with your learners.

It is your responsibility to carry out an appropriate risk assessment for this experiment.

Substance	Hazard	First aid
Potassium manganate(VII) Solid	 GHS03 (*oxidising* **O**)  GHS07 (*moderate hazard* **MH**)  GHS09 (*hazardous to the aquatic environment* **N**)	**In the eye:** flood the eye with gently-running tap water for at least 10 minutes. See a doctor. **Swallowed:** wash out the mouth with water. Do not induce vomiting. Sips of water may help cool the throat and help keep the airway open. See a doctor. **Spilt on the skin or clothing:** remove contaminated clothing and rinse it. Wash off the skin with plenty of water.
	Risk of cuts due to sharps, e.g. broken glass or scalpels. Wounds can lead to infection, especially if the blade or point is contaminated.	**Minor cuts:** Rinse the wound with water. Get the casualty to apply a small, sterile dressing.

Substance	Hazard	First aid
		Severe cuts: Lower the casualty to the floor. Raise the wound as high as possible. If feasible, ask the casualty to apply pressure on or as close to the cut as possible, using fingers, a pad of cloth or, better, a sterile dressing (adding further layers as necessary). If the casualty is unable to do so, apply pressure yourself, protecting your skin and clothes from contamination by blood if possible. Leave any embedded large bodies and press around them. Send for a first aider.
	Burns	Flood burnt area with water for at least 10 minutes. For serious injuries see a doctor.

Experiment set-up



Teacher method

This is your version of the method for this experiment that accompanies the *Teacher walkthrough* video.

Do not share this method with learners. Give them Worksheet E.

Before you begin
Plan how you will group your learners during the experiment.

Think about:
- the number of groups you will need (group size 2–4 learners)
- the amount of equipment required.

Experiment
Circulate during the experiment in case learners encounter any difficulties.

Steps	Notes
1. Fill the beaker with tap water up to about 600 cm^3	
2. Place a gauze on the tripod and the beaker on top of that.	
3. Set up the Bunsen burner below the tripod.	
4. Using the tweezers drop a small piece of potassium manganate(VII) so that it falls close to one side of the beaker.	*Make sure learners drop the crystal as close to the beaker side as they can. They should take care not to disturb the water.*
5. Heat the base of the beaker using a small flame, just under where the piece of crystal has fallen.	*The heat should be gentle and only focused directly under the potassium manganate(VII) crystal.*

Clean-up
During and/or after the experiment learners should:
- avoid skin contact with the coloured water and dispose of this in a chemical waste container
- tidy up their work space
- ensure any spillages are reported to you
- return all equipment and any unused chemicals to you.

Lab lesson: Option 2 – virtual experiment

Resources	• Virtual experiment video • Worksheet H • An ice cube made from strongly coloured water (from food colouring) • Warm water • Clear beaker
Learning objectives	By the end of the lesson: • ***all*** learners should be able to describe the processes of convection as one of the ways thermal energy is transferred • ***most*** learners should be able to link density differences to convection • ***some*** learners should be able to evaluate the role of link gravity in buoyant force

Timings	Activity
5 min	**Starter/Introduction** Ask your learners what would happen if they dropped some ink into cold water? Into hot water? Allow them time to think of some suggestions.
10 min	**Main lesson** Fill a clear glass with warm water. Show them the coloured ice cube. Ask them to guess what will happen when you put the ice in the water and leave it for a while. Give them time to either write down or sketch their ideas in their exercise book or discuss with their neighbours. Add the ice cube to the glass/beaker of water. Let them observe what happens. Either have a class discussion or ask them to write what they observe.
5 min	Hand out Worksheet H. Your learners will need to complete the sheet as they watch the video. You can pause the video to give them time to do this. Please feel free to make some of the questions the basis of some class / group discussions.
30 min	Now you can start the video. Please have a whole class discussion on the alternative options as well as the correct option in the multiple-choice questions on the worksheet.
10 min	**Plenary** Ask your learners to work in groups of two or three to discuss the following: • Can you explain why the heating element of a kettle is at the base of the kettle? • How can the concept of density be used to explain convection currents? Extension question: • What is the role of gravity in buoyant force? Spend a few minutes reviewing your learners' answers at the end.

Debriefing lesson: Convection currents

Resources	• Worksheets I and J • Suggested answers for Worksheets I and J
Learning objectives	By the end of the lesson: • ***all*** learners should be able to describe the processes of convection as one of the ways thermal energy is transferred • ***most*** learners should be able to link the density differences to convection • ***some*** learners should link gravity to buoyant force

Timings	Activity
15 min	**Starter/Introduction** Arrange your learners into groups of two or three. Make enough copies of Worksheet I for one per group. Ask the groups to explain how their understanding of convection as a means of thermal energy transfer is shown in each image. They should write their answers next to the pictures once they have discussed them as a group.
15 min	**Main lesson** Ask groups to exchange their answer sheets. Either display or hand out the marking criteria (Worksheet I: Suggested answers). The groups should peer-mark the responses to each image. Where needed, they should add detail or alter the answers to make sure that they are correct.
20 min	Hand out Worksheet J to give learners the opportunity to work individually on some past exam-paper questions. The learners can discuss their answers where necessary with a partner. Circulate during this activity to give feedback and/or support.
10 min	**Plenary** Provide the answers to the exam questions (Worksheet J: Suggested answers) and allow learners to mark their work. They should write corrections where necessary. You may want them to do this in a different colour.

Worksheets and answers

	Worksheets	Answers
For use in the *Briefing lesson*:		
A: Convection questions	**14**	**28**
B: Convection currents	**15–16**	**29**
C: Convection common mistakes	**17**	**30**
D: Convection in action	**18**	**31**
For use in *Lab lesson: Option 1*:		
E: Method	**19**	**—**
F: Observing convection currents	**20**	**—**
G: Investigating convection currents	**21**	**32**
For use in *Lab lesson: Option 2*:		
H: Virtual experiment record sheet	**22–23**	**33–34**
For use in the *Debriefing lesson*:		
I: Convection in action	**24**	**35**
J: Convection questions	**25–27**	**36**

Worksheet A: Convection questions

1. Look at the diagram below. Describe what would happen to air in the room if we turned on the heater?

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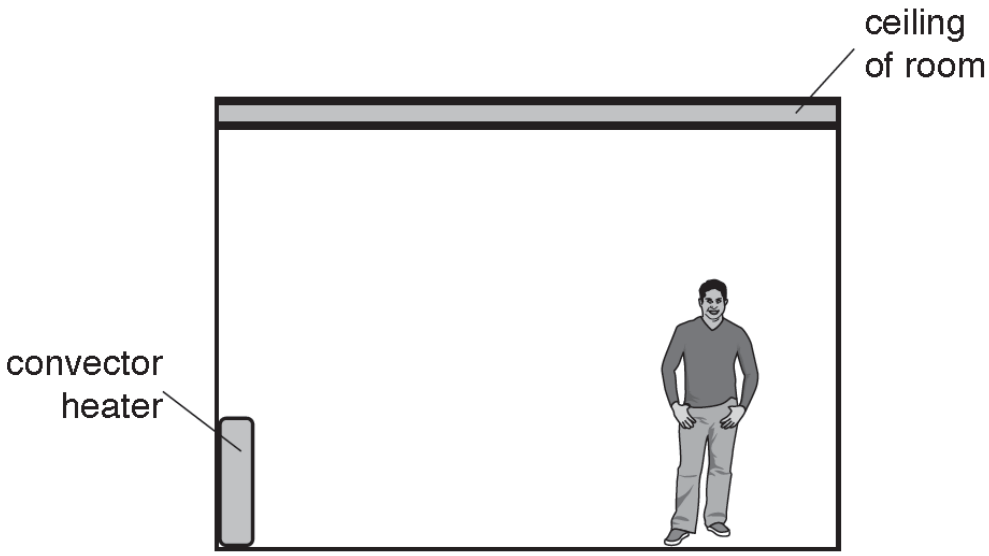

2. Draw labelled arrows on the diagram to show how the heat would be transferred around the room.

3. Explain how the thermal energy is transferred.

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Worksheet B: Convection currents

Aim:
To build a paper windmill that will show how convection currents make objects move.

You will use:

- A drawing pin or split pin
- A pair of scissors
- A tea light
- A straw or lolly stick

Constructing the windmill:

1. Cut along the solid lines on the template.
2. Use a pin to carefully make a hole at each point marked on the shape (there should be one in the centre and another at each corner).
3. Without creasing it, gently fold each corner to line up the corner holes with the central hole.
4. Place the split pin through all the layers as shown in the picture.
5. Carefully push the pin into your lolly stick or straw and open the split pin to secure the windmill together.
6. Blow on the windmill; you may need to loosen the pin if it does not turn freely.
7. Now hold your windmill, pin-side down above a lit tea light. DO NOT hold it too close to the flame.
8. Record your observations in the spaces below.

Observe and record the changes you see if you increase the distance between the windmill and the flame.

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Observe and record the changes you see if you decrease the distance between the windmill and the flame. Take care not to put the windmill too close to the tea light.

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Can you explain what is happening to make the windmill spin?

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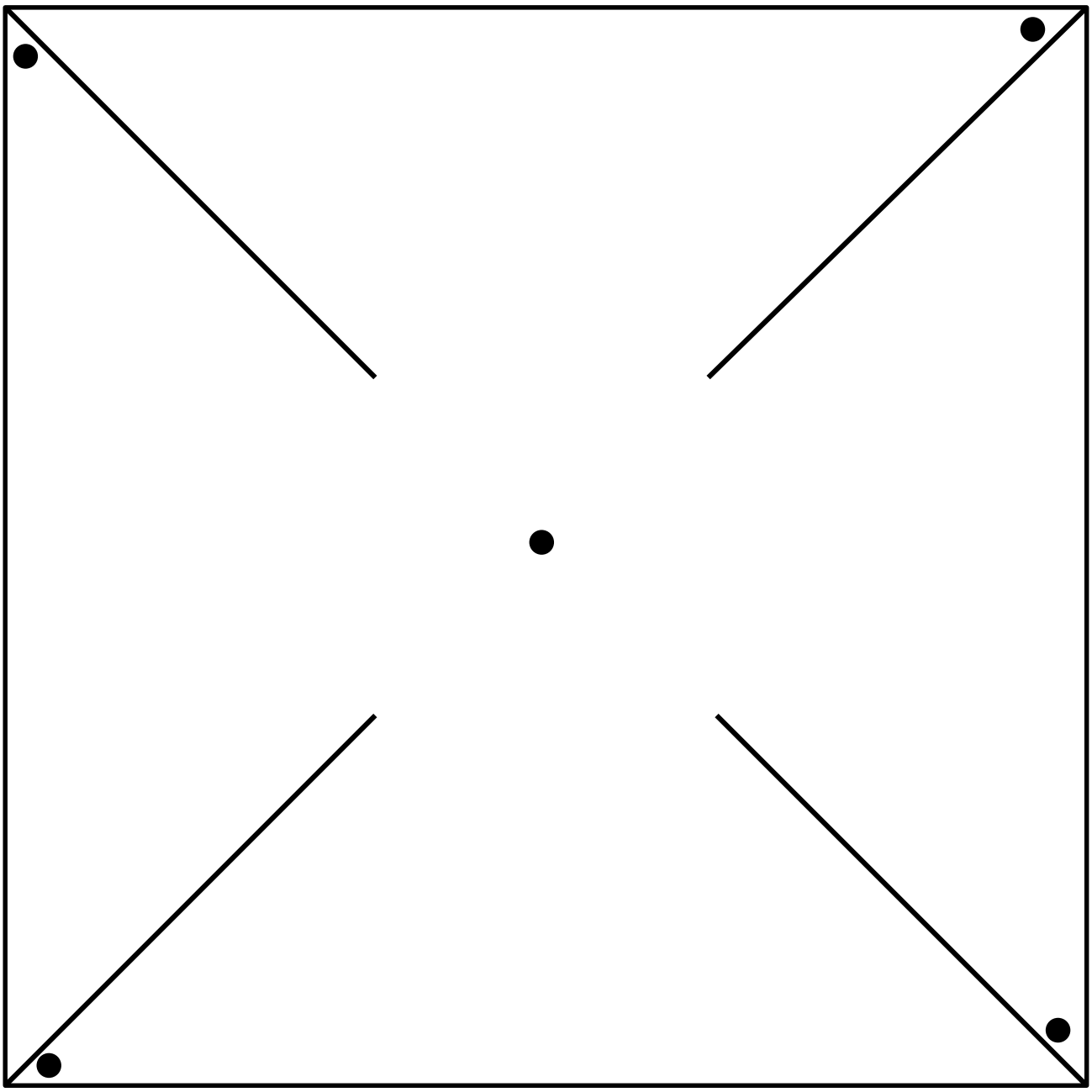
Worksheet B: Convection currents

Cut out the windmill template along the solid lines.

Make a hole at each of the marked points.



Worksheet C: Convection common mistakes

The table below shows some common mistakes about convection. Complete the table by using the words at the bottom of the sheet to fill in the blanks. The first one has been done for you.

Common mistake	Correction
Heat rises.	When surrounded by *cooler* fluid, the warmer region of the fluid moves *upwards*.
If an object is heated, its particles expand (get larger). That's why the density decreases.	If an object is heated, the average separation of its particles …….. The same amount of matter now occupies a ……. volume. This leads to a ……. in density.
Cold sinks.	Cooler fluid ……. the warmer fluid that has risen.
Convection is energy transfer in a *liquid* when warm particles transfer heat energy into colder regions.	Convection is thermal energy transfer in a fluid (liquid or gas). When particles in a warmer region ……. energy they move into …… regions carrying this …… with them.
Air is a good insulator.	Trapped air is a good insulator because it …… the amount of …… that can take place.

~~cooler~~	reduction	convection
larger	~~upwards~~	increases
energy	replaces	cooler
limits	gain	

Worksheet D: Convection in action

Look at the picture of the hot air balloon.

Using your knowledge of convection, can you explain how the hot air balloon works? Don't forget to think about how it both rises and sinks.

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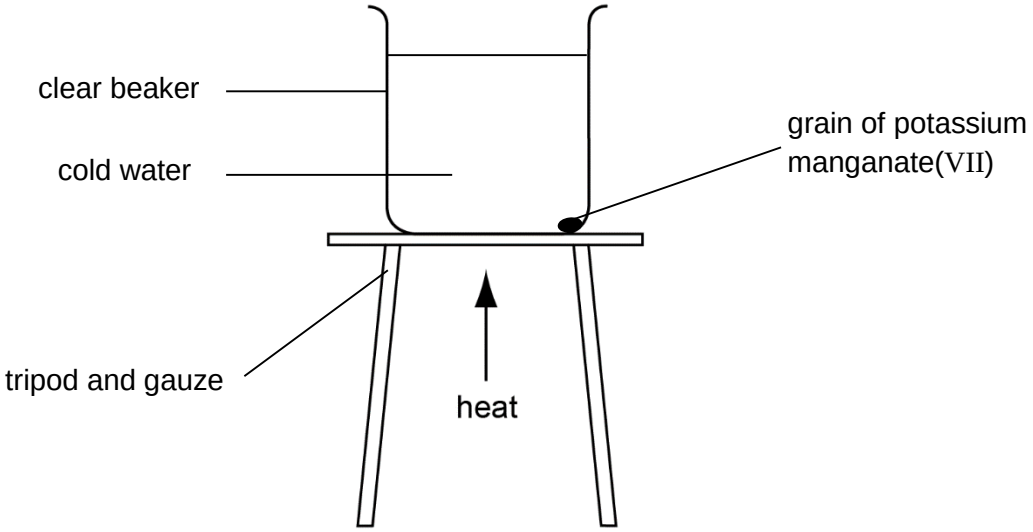
Worksheet E: Method

Fill the beaker with about 600 cm^3 of water.

Set up your equipment as shown in the diagram below.

Do not light the Bunsen burner yet



Allow the water in the beaker to settle and become completely still.

While the water is settling, light the Bunsen burner and put it on a gentle heat. Do not put it under the beaker yet.

While you are not using the Bunsen burner to heat, make sure it is on the yellow safety flame.

Using the tweezers, pick up a piece of potassium manganate(VII).

Be careful potassium manganate(VII) is harmful and dangerous to the environment. Do not let it touch your skin or allow it to go into the sink.

Very carefully drop the piece of potassium manganate(VII) into the beaker, placing it as close to the side of the beaker as you can get it.

Make sure you disturb the water as little as possible.

Place the Bunsen burner directly under the grain of potassium manganate(VII).

Observe the coloured water as it rises

Condensation will form on the beaker. Do not try to wipe it off in case you knock the beaker.

Worksheet F: Observing convection currents

Use the space below to record your observations.

Be as specific as you can about how the coloured water moves.

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Use this space to make a labelled drawing of your observations.

Worksheet G: Investigating convection currents

Answer the following questions.

1. State one similarity and one difference between the demonstration you saw at the beginning of the lesson and the convection investigation you have just completed.

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2. Use your understanding of convection currents to explain the similarity and the difference you stated in the previous question.

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3. What factors define the density of an object?

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4. How does heating the water affect its density?

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5. What happens to the temperature of the heated water as it rises?

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Worksheet H: Virtual experiment record sheet

Answer the questions.

1. Convection is the way thermal energy is transferred in:

   a) liquids b) gases c) fluids d) solids

2. State one safety precaution you would take when using the equipment shown.

……

3. Predict what might happen to the potassium manganate(VII) crystal when it is dropped into the water.

……

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4. What is the crystal doing to the water?

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5. Which statement best explains what you can observe?

   a) The crystal is burning and rising in the water.
   b) Water gains thermal energy; its particles move more energetically. The warm water is less dense and rises.
   c) Crystals get warmer and start to show vigorous upwards movement.

Worksheet H: Virtual experiment record sheet

6. Record your observations of the way the purple water has moved in this experiment.

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7. What is the main reason for the coloured water moving downwards?

    a) It is getting heavier.
    b) It is getting less dense as it cools down.
    c) It is getting denser again as it cools down.
    d) Its density increases as its temperature increases.

8. Name one other event in which convection currents are observed.

……

……

Worksheet I: Convection in action

Discuss in your groups how convection is being used in each of the images below. Make a note of your ideas next to each picture.

Item and its description	How convection is used
Car radiator Water runs through it and is piped around the engine. The radiator sits at the front of the car behind the grill so air can flow over it. It is made up of many fine pipes which give it a very large surface area. 	…… …… …… …… …… …… ……
Air conditioning unit These units are placed close to the ceiling. They have vents which pass through the wall allowing air to move from the room to the outside. 	…… …… …… …… …… …… ……
Gliding birds Many birds use thermals to glide. This means that they do not have to use energy flapping their wings to gain height. Instead they use air currents to do the work for them. 	…… …… …… …… …… …… ……

Worksheet J: Convection question 1

Fig. 1.1 shows a domestic hot water system.

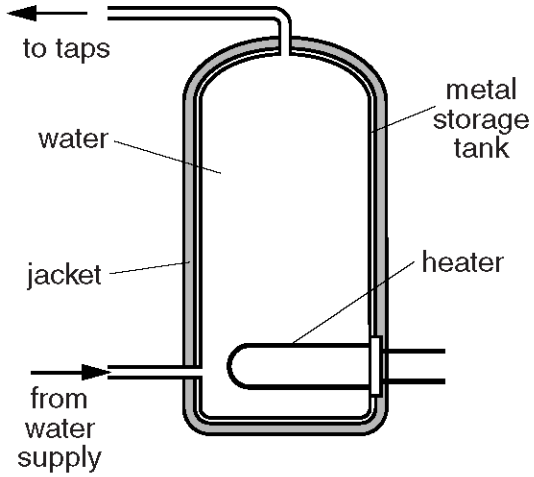

Fig. 1.1

(a) The heater is placed at the bottom of the storage tank.

(i) Name the process by which water in contact with the heater becomes hot.

..... [1]

(ii) **1.** Explain how the water at the top of the storage tank becomes hot. Include the word *density* in your answer.

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..... [3]

2. State the name given to this process.

..... [1]

Worksheet J: Convection question 2

The student warms the beaker and liquid on an electric heater as shown in Fig. 2.2.

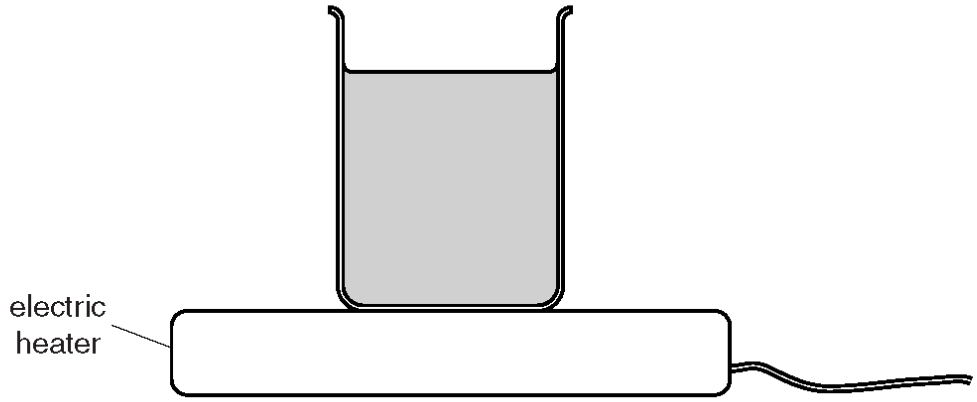

Fig. 2.2

(i) State the name of the process by which thermal energy is transferred through the glass of the beaker.

.....[1]

(ii) Explain how thermal energy is transferred throughout the liquid by convection.

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.....[3]

Worksheet J: Convection question 3

Fig. 3.1 shows a cross-section through a room.

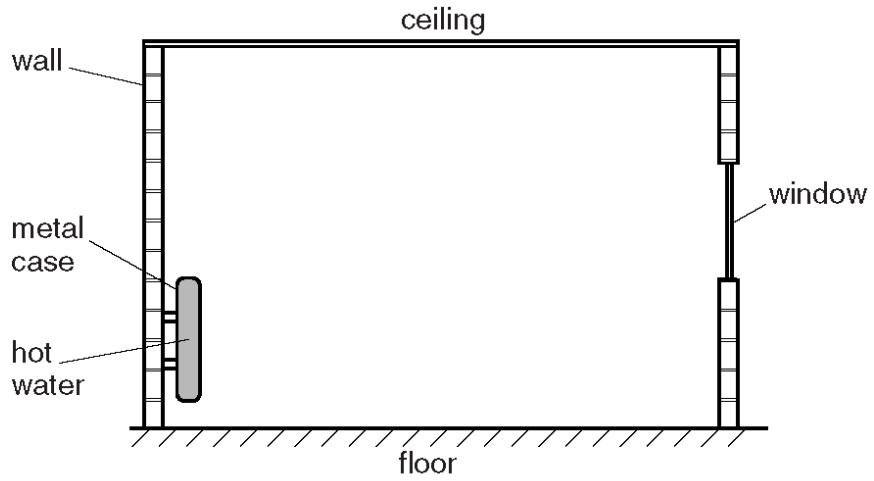


Fig. 3.1

The room is heated by a heater containing hot water. The heater is mounted on one wall, as shown.

(i) By what process does thermal energy pass through the metal case of the heater in Fig. 3.1?

..... [1]

(ii) State the two main processes by which the thermal energy from the heater is transferred to the whole room.

1. .....

2. .....

[2]

(iii) On Fig. 3.1, draw arrows to show how the air moves in the room. [2]

Worksheet A: Answers

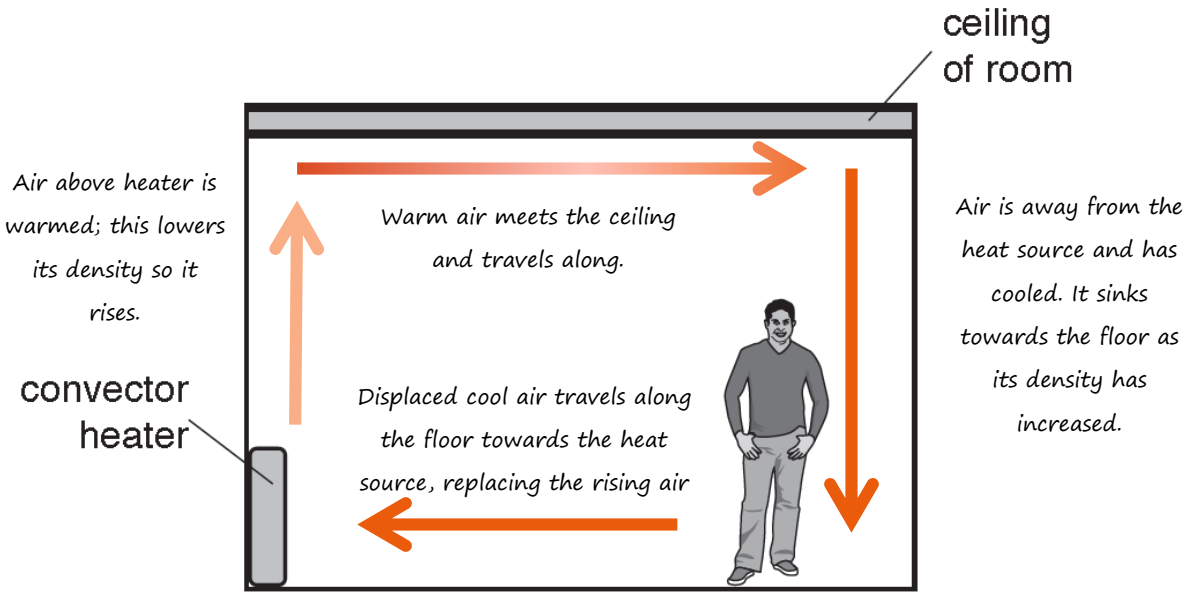
These are suggested answers.

1. Look at the diagram below. Describe what would happen to air in the room if we turned on the heater?
   Warm air would begin to rise towards the ceiling. This would displace cooler air closer to the ceiling which would be forced downwards.

2. Draw labelled arrows onto the diagram to show how the heat would be transferred around the room.

3. Explain how the thermal energy is transferred.

   The temperature of the air surrounding the convector heater increases. This volume of air is now less dense than the surrounding air. As the surrounding air is cooler, and more dense, the heated air rises. Cooler air replaces the risen air. The cycle continues.



Worksheet B: Answers

Aim:
To build a paper windmill that will show how convection currents make objects move.

You will use:

- A drawing pin or split pin
- A pair of scissors
- A tea light
- A straw or lolly stick

Constructing the windmill:

9. Cut along the solid lines on the template.
1. Use a pin to carefully make a hole at each point marked on the shape (there should be one in the centre and another at each corner).
2. Without creasing it, gently fold each corner to line up the corner holes with the central hole.
3. Place the split pin through all of the layers as shown in the picture.
4. Carefully push the pin into your stick or straw and open the split pin to secure the windmill together.
5. Blow on the windmill; you may need to loosen the pin if it does not turn freely.
6. Now hold your windmill, pin-side down above a lit tea light. DO NOT hold it too close to the flame.
7. Record your observations in the spaces below.

Observe and record the changes you see if you increase the distance between the windmill and the flame.

The further the distance between the windmill and the tea light, the slower the spinning. After a certain distance there is no spinning at all.

Observe and record the changes you see if you decrease the distance between the windmill and the flame. Take care not to put the windmill too close to the tea light.

The smaller the distance between the windmill and the tea light, the faster the spinning.

Can you explain what is happening to make the windmill spin?

- *When heated, air particles gain energy and move more rapidly.*
- *They move further away from one another, increasing the average distance between particles.*
- *The same amount of matter now occupies a larger volume of space.*
- *Therefore, the air expands and becomes less dense.*
- *If an object is surrounded by a denser fluid, it rises through the medium.*
- *It rises into the cold areas and denser, cold air falls into the warm areas.*
- *This upwards movement of the air makes the windmill spin.*

Worksheet C: Answers

The table below shows some common mistakes about convection. Complete the table by using the words at the bottom of the sheet to fill in the blanks. The first one has been done for you.

Common mistake	Correction
Heat rises.	When surrounded by *cooler* fluid, the warmer region of the fluid moves *upwards*.
If an object is heated, its particles expand (get larger). That's why the density decreases.	If an object is heated, the average separation of its particles *increases*. The same amount of matter now occupies a *larger* volume. This leads to a *reduction* in density.
Cold sinks.	Cooler fluid *replaces* the warmer fluid that has risen.
Convection is energy transfer in a liquid when warm particles transfer heat energy into colder regions.	Convection is thermal energy transfer in a fluid (liquid or gas). When particles in a warmer region *gain* energy they move into *cooler* regions carrying this *energy* with them.
Air is a good insulator.	Trapped air is a good insulator because it *limits* the amount of *convection* that can take place.

~~cooler~~ ~~reduction~~ ~~convection~~

~~larger~~ ~~upwards~~ ~~increases~~

~~energy~~ ~~replaces~~ ~~cooler~~

~~limits~~ ~~gain~~

Worksheet D: Answers

Look at the picture of the hot air balloon.

Using your knowledge of convection, can you explain how the hot air balloon works? Don't forget to think about how it both rises and sinks.

This is a suggested answer:

The heater above the basket heats the air in the balloon. As this air is warm, the particles spread further apart and so the density of the air in the balloon is reduced. This low density air is now more buoyant that the air around the balloon and so the balloon rises.

To come back towards the ground, hot air is released from the top of the balloon and the heater is switched off. This allows the air in the balloon to cool, and so it becomes less buoyant and the balloon sinks.

Worksheet G: Answers

These are suggested answers.

1. State one similarity and one difference between the demonstration you saw at the beginning of the lesson and the convection investigation you have just completed.

   Both demonstrate convection currents. In the demonstration, the convection currents form from the top of the water to the lower regions. In the investigation, they occur in the opposite direction.

2. Use your understanding of convection currents to explain the similarity and the difference you stated in the previous question.

   In the demonstration, the surrounding warm water melts the floating ice cube. The resulting coloured water is very cold. This cold, dense water sinks to the bottom of the glass. However, in the investigation, convection currents are generated from the bottom of the water to the upper regions. The thermal energy is given to the water from the flame at the bottom of the beaker. This warm, less dense water rises, replaced by cooler water.

3. What factors define the density of an object?

   Mass and volume

4. How does heating the water affect its density?

   It increases in temperature means the particles move more energetically and begin to spread apart. This means that the same amount of water now occupies a larger space. That leads to a lower density.

5. What happens to the temperature of the heated water as it rises?

   It drops as the heated water moves away from the thermal energy source and meets with cooler water.

Worksheet H: Answers

Answer the questions.

1. Convection is the way thermal energy is transferred in:

   c) fluids

2. State one safety precaution you would take when using the equipment shown.

When not using the Bunsen burner, set it to the yellow safety flame

Allow hot glassware to cool before handling.

Use tweezers to prevent potassium manganate(VII) touching the skin.

3. Predict what might happen to the potassium manganate(VII) crystal when it is dropped into the water.

It will begin to dissolve.

4. What is the crystal doing to the water?

The dissolving potassium manganate(VII) is making the water purple.

5. Which statement best explains what you can observe?

   b) Water gains thermal energy; its particles move more energetically. The warm water is less dense and rises.

Worksheet H: Answers

6. Record your observations of the way the purple water has moved in this experiment.

As the Bunsen burner is moved underneath the potassium manganate(VII) crystal, the purple water begins to rise up the side of the beaker. Once it reaches the surface of the water the purple colouring travels across towards the opposite side of the beaker. Once at the opposite side, the purple water begins to sink towards the bottom of the beaker. Once at the base of the beaker where it is warmer again, the process repeats itself.

7. What is the main reason for the purple water moving downwards?

c) It is getting denser again as it cools down.

8. Name one other event in which convection currents are observed.

Convection in the mantle of the Earth

Convection in rooms due to heating or cooling systems

Convection currents in the oceans

Convection currents in the atmosphere

Worksheet I: Answers

These are suggested answers.

Item and its description	How convection is used
Car radiator Water runs through it and is piped around the engine. The radiator sits at the front of the car behind the grill so air can flow over it. It is made up of many fine pipes which give it a very large surface area. 	The water is heated by the car engine. This eventually passes through the radiator. Here cool air is driven over the radiator and the warm air is moved away. This cools the temperature of the water inside the radiator, helping to cool the engine.
Air conditioning unit These units are placed close to the ceiling. They have vents which pass through the wall allowing air to move from the room to the outside. 	The air conditioning unit generates cold air due to the chemicals inside it. It is placed high on the wall so the cold air sinks towards the floor. The sinking cold air displaces the warm air, forcing it up and back towards the unit. Warm air as a by-product of the work of the conditioning unit is vented outside.
Gliding birds Many birds use thermals to glide. This means that they do not have to use energy flapping their wings to gain height. Instead they use air currents to do the work for them. 	Rising air thermals are produced when the ground heats the air above it. This produces up draughts of warm, buoyant air. Birds take advantage of these rising air currents to glide effortlessly.

Worksheet J: Answers

Question	Answer	Mark
1 (a) (i)	conduction	1
1 (a) (ii) 1.	water expands when heated	1
	density (of warm water) decreases OR reverse argument	1
	warm water rises	1
1 (a) (ii) 2.	convection	1
		Total: 5
2 (i)	conduction	1
2 (ii)	warm(ed) liquid expands NOT particles expand	1
	density of warm(ed) liquid decreases NOT particles become less dense	1
	less dense liquid / warm liquid rises NOT heat rises	1
		Total: 4
3 (i)	conduction	1
3 (ii)	convection	1
	radiation	1
3 (iii)	arrows indicating air moving up above heater	1
	complete convection current indicated	1
		Total: 5

Cambridge Assessment International Education
The Triangle Building, Shaftesbury Road, Cambridge, CB2 8EA, United Kingdom
t: +44 1223 553554
e: info@cambridgeinternational.org www.cambridgeinternational.org