Convection: following a coloured water plume

Student activity • observation and reasoning

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The question

What does a coloured warm-water plume reveal about fluid motion?

Watch a small source of warm coloured water in a larger tank. Compare it with a room-temperature control and explain buoyancy.

Equipment

- Clear water tank, tray, two matching small vials and staff retrieval handle
- Food colouring, thermometer and warm water at 45–50 °C

Staff lower and retrieve the vials. Keep water at 50 °C or below, handle glass carefully and wipe spills promptly. Do not taste the dye. This activity uses no flame, smoke, sparkler or potassium manganate(VII).

Course coverage: Shared Physics / Double Award: 4.6, 4.7, 4.9. Convection in fluids.

Plan, model or apparatus sketch

Draw a labelled setup or force diagram; include the measured quantities.

Method and reasoning

Read the whole sequence before starting

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1. Observe a clear tank of room-temperature water on a spill tray. Staff measure the tank temperature and prepare a small open vial containing the same water with a few drops of food colouring.

2. Staff place the room-temperature coloured vial upright on the tank floor without tipping it. Allow disturbances to settle and record the movement for two minutes.

3. Staff remove the control, let the tank settle, and place a matching vial of coloured water at 45–50 °C on the floor in the same way, temporarily covering its mouth during lowering.

4. Staff uncover the vial underwater using the prepared handle. Watch from the side; sketch the plume at the start, after 30 seconds and after two minutes.

5. Compare the warm trial with the control. Describe the bulk movement before explaining it in terms of expansion, density and buoyancy.

6. Draw a possible circulation route, but label return flow as inferred unless it is visible. Apply the explanation to a room radiator, distinguishing convection from radiation.

Cleanup

- Let the water cool, empty it at the sink and rinse the tank and vials.

Record your evidence

Blank spaces are for your own work

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Reference and task data

Both trials use the same small concentration of food colouring. Dye traces water motion but also diffuses; a coloured streak alone does not establish a complete convection loop.

Stage	Control observation	Warm-vial observation
Start		
30 seconds		
2 minutes		

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. Why include the room-temperature control?

2. Why can warm water rise?

3. What carries energy in convection?

4. Does convection occur in a rigid solid?

5. Why should the tank be left still?

6. Is all heating by a radiator convection?