**ACTIVITY: Latent heat of vaporisation**

**Activity idea**

In this activity, students watch a teacher demonstration, and the results will allow an estimate of the latent heat of vaporisation of water to be made.

By the end of this activity, students should be able to:

* recognise some of the hazards present when experimenting with steam
* gain an understanding of the huge amount of energy need to convert water at 100°C into steam at the same temperature
* apply the law of energy conservation of energy to trace the conversion of electrical energy into heat energy
* calculate a value for the latent heat of vaporisation of water.

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**Introduction/background**

As a result of extensive hydrogen bonding between water molecules, the latent heat of vaporisation value for water is very high (2260 kJ/kg). There are numerous practical methods for determining this value, and each involves working with steam at 100°C. In a busy classroom setting, this can prove to be hazardous. It is best that this activity is performed as a teacher demonstration.

Knowledge of what latent heat is, how it comes about and the uses made of it are key components in understanding how modern household devices like heat pumps and refrigerators operate.

This demonstration experiment will allow an estimate of the latent heat of vaporisation of water to be made.

**What you need**

* Copies of student handout: [Calculating latent heat](#handout)
* Household electric jug with known power rating
* Top-loading electronic balance (up to 2 kg loading)
* Timing device

**What to do**

1. Hand out copies of the student handout [Calculating latent heat](#handout) and have students complete it as you carry out the demonstration.
2. Have students note the power rating of the electric jug.
3. Half fill the jug with warm tap water and place it (minus the lid) on the electronic balance.
4. Connect the jug to mains supply and switch on.
5. Allow the water in the jug to come to the boil.
6. When steam is coming freely from the jug, have students note the reading (m1) on the electronic balance.
7. Start the timer and allow the jug to boil until the mass m1 has decreased by 50 g. Have students note the reading on the electronic balance (m2).
8. Stop the timer and have students record the time elapsed.
9. Have students complete the calculations on the handout and discuss.

**Student handout: Calculating latent heat**

|  |  |  |
| --- | --- | --- |
|  |  | *Complete the boxes*  |
| Power rating of the electric jug |  | kW |
|  |  |  |
| Mass of jug + water (m1) |  | g |
|  |  |  |
| Mass of jug + water after boiling (m2) |  | g |
|  |  |  |
| Time elapsed |  | s |

***Calculations***

|  |  |  |
| --- | --- | --- |
| 1. Electrical energy supplied
 | = |  power rating x time of boiling |
| = | x |
|  |  |
| = | kJ |
|  |  |  |
| 1. Mass of water boiled off
 | = | m1 -m2 |
|  | = | g |
|  |
| 1. Heat energy needed to convert water at 100°C to steam at 100°C is given by the relation mLv where m is the mass of steam and Lv is the latent heat of vaporisation of water, so heat energy needed = mLv, according to the law of conservation of energy ‘heat taken in = heat supplied’,
 |  |  |
|  so (from 1 above), we have that mLv | = | kJ |
| 1. Hence, Lv =
 | = | kJ ÷ (m1- m2) |
|  | = | kJ/g |
|  |  |  |
|  | = | kJ/kg |

1. Compare this result with the accepted value of 2260 kJ/kg.
2. To gauge how big this amount of energy is, consider the following:
* The same amount of energy would allow 5.39 kg of water (a small bucketful) at 0°C to be heated up to its boiling point at 100°C.
* To heat 1 kg of water at 0°C to 100°C requires 419 kJ, and to convert it from water at 100°C to steam at 100°C requires an additional 2260 kJ.