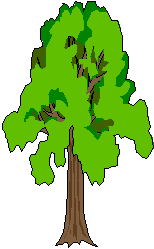
[**VISUAL PHYSICS ONLINE**](http://www.physics.usyd.edu.au/teach_res/hsp/sp/spHome.htm)

**Experiment PA32A**

**Growing Trees: Is this a viable solution to the energy problem?**

A possible renewable fuel for the future could be the wood from trees. ***But is this a viable option?***

You can carry out a simple experiment to get some evidence to support or reject the possibility of growing trees as an alternative fuel.

**Equipment Requirements**

A thermometer, tongs, test tube, beaker, water, measuring cylinder, matches (use one match for heating - try to burn the whole match)

***Please place burnt matches in beaker to protect table.***

***At the end, empty beaker in garbage pin and clean beaker and test tube.***

# Physics knowledge you may require

Density ρ = *m*/*V*

ρwater = 1000 kg.m-3 = 1 g.mL-1

The amount of energy *Q* (joules, J) needed to raise the temperature of a material of mass *m* (kilogram, kg) by *ΔT* (°C) is

*Q* = *m c ΔT*

*c* is the specific heat capacity of the material.

*c*water = 4190 J.kg-1.°C-1

### Volume of match

*V* = *A L =* *L*1 *L*2 *L*3

*V* volume, *A* cross-sectional area, *L* length

For a family of 3-4 persons, the typical use of energy for hot water heating is in the order of 4000 kWh per year.

**Measurements and Calculations**

1. Measure the dimensions of your match.
2. Calculate the volume of your match, *V*match.
3. Estimate the dimensions of your tree.
4. Calculate the volume of your tree, *V*tree.
5. Calculate the number of matches in one tree, *N*match.
6. Add a small volume of water to a test tube. Determine the mass of the water you added, *m*.
7. Record the initial temperature of the water, *T*i.
8. Heat the water with the match & record the max. temperature reached, *T*f,
9. Calculate the energy liberated by one match to heat the water, *Q*match.
10. Calculate the energy from a tree that could be utilised to heat water, *Q*tree.
11. Calculate the number of joules (J) in one kilowatt-hour (kWh).
12. Calculate the energy in joules required for heating water, *Q* for a family of 3-4 persons. Assume the energy for hot water heating is 4000 kWh per year.
13. Estimate the number of trees required for the heating water (family), *N*f.
14. Estimate the number of trees required for the heating water (Sydney), *N*S.

Assume the trees are grown in a forest which has a square shape. Estimate the length of one side of this square, *L*S?

Compare your answers with other groups.

What do you think? - is the growing of trees a viable alternative as a fuel?

**Sample Results**

(a) Measure the dimensions of your match.

***L*1 = 43 mm = 43x10-3 m *L*2 = *L*3 = 2 mm = 2x10-3 m**

(b) Calculate the volume of your match, *V*match.

***V*match = *L*1 *L*2 *L*3 = (43)(2)(2) x10-9 m3 = 1.72x10-7 m3**

(c) Estimate the dimensions of your tree.

***L*1 = 0.5 m *L*2 = 0.5 m *L*3 = 3.0 m**

(d) Calculate the volume of your tree, *V*tree.

***V*tree = (0.5)(0.5)(3.0) m3 = 0.75 m3**

(e) Calculate the number of match in one tree, *N*match.

***N*match = *V*tree / *V*match = 0.75 / 1.72x10-7 = 4.4x106**

(f) Add a small volume of water to a test tube. Determine the mass of the water you added, *m*.

***V*water = 30 mL *m* = 30 g = 30x10-3 kg**

(g) Record the initial temperature of the water ***T*i = 22.0°C**

(h) Heat the water with the match & record the max. temp ***T*f = 28.2 °C**

(i) Calculate the energy liberated by one match to heat the water, *Q*match.

***Q*match = *m c* Δ*T* = (30x10-3)(4180)(28.2 – 22.0) J = 7.7x102 J**

(j) Calculate the energy from a tree that could be utilised to heat water, *Q*tree.

***Q*tree = *N*match *Q*match = (4.4x106)(7.7x102) J = 3.4x109 J**

(k) Calculate the number of joules (J) in one kilowatt-hour (kWh).

**1 kW = 103 W 1 h = (60)(60) s = 3.6x103 s**

**energy 1 kWh = (103)(3.6x103)** = **3.6x106 J**

(l) Calculate the energy in joules required for heating water, *Q*.

***Q* = 4x103 kWh = (4x103)(3.6x106) J = 1.4x1010 J**

(m) Estimate the number of trees required for the heating water (family), *N*f.

***Q* = *N*f *Q*tree *N*f = *Q* / *Q*tree = 1.4x1010 / 3.4x109 = 4**

(n) Estimate the number of trees required for the heating water (Sydney), *N*S.

**population Sydney = 4x106**

**number of families = 106**

***N*S = 4x106**

(o) Assume the trees are grown in a forest which has the shape of square. Estimate the length of one side of this square, *L*S?

**area for one tree *A* = (2)(2) m2**

**area for all trees *A*trees = *L*S2 = (2)(2)(4x106) m2 = 1.6x107 m2**

***L*S = √(1.6x107) m = 4x103 m = 4 km**