



Datalogging with Handheld Technology.

KS3 Science Unit 8B Respiration Germinating Peas

This year 8 unit provides opportunities for the use of temperature and carbon dioxide sensors alongside other methods such as the use of hydrogencarbonate indicators, as can be seen in the following extract from the QCA specification.

<i>Learning Objectives</i>	<i>Possible Teaching Activities</i>	<i>Learning Outcomes</i> Pupils	<i>Points To Note</i>
<ul style="list-style-type: none"> ◆ to use thermometers of different kinds ◆ that respiration can be represented by a word equation: glucose + oxygen gives carbon dioxide + water, and this reaction releases energy ◆ to explain observations using scientific knowledge and understanding 	<ul style="list-style-type: none"> ◆ Present pupils with a range of observation activities, eg <ul style="list-style-type: none"> – <i>observing a temperature difference between germinating peas and boiled peas</i> – <i>yeast generating bubbles of carbon dioxide which are passed into lime water</i> – <i>germinating peas and maggots in separate gauze cages over hydrogencarbonate indicator</i> – <i>water weed shielded by black paper in hydrogencarbonate solution producing carbon dioxide ...</i> ◆ Discuss their observations to establish that the hydrogencarbonate indicators show that the living material was producing carbon dioxide and the increased temperature measured by the thermometers shows that the living material was also releasing energy... 	<ul style="list-style-type: none"> ◆ record temperatures, reading scales accurately ... ◆ explain the increased temperature in terms of energy release during respiration 	<ul style="list-style-type: none"> ◆ Teachers will need to explain the use of the hydrogencarbonate indicator if pupils have not used it previously. ◆ Pupils' attitudes to the appropriate care of living organisms need to be handled sensitively. ◆ Sensors and computer software can be used to monitor temperature and other changes in germinating peas...

Safety

- ♦ wash hands and wipe the bench with disinfectant after handling live material.

Datalogging kit

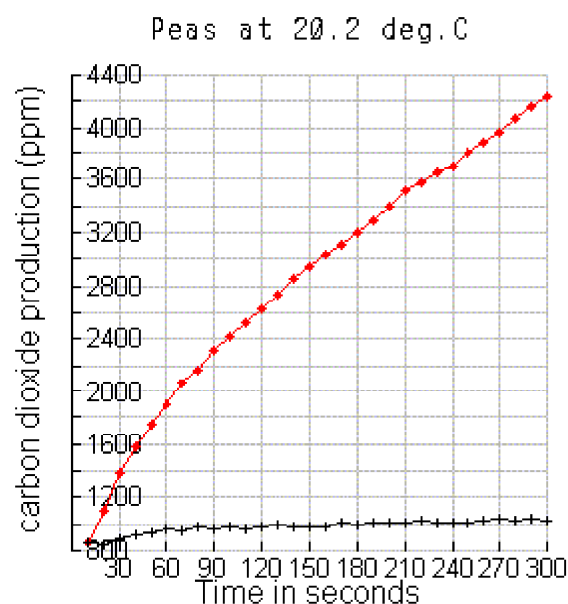
- ♦ TI-73, TI-82, TI-83 or TI-83plus graphing calculator.
- ♦ CBL or CBL2, **with fresh alkaline cells or AC adaptor.**
- ♦ CO₂ gas sensor.
- ♦ 2 x temperature sensors.
- ♦ TI-GRAPH LINK™ software and cable to link to computer.
- ♦ chembio application (TI-83 plus) or program group (TI-73, TI-82 and TI-83).
- ♦ Optional: ViewScreen™ to project calculator screen via an OHP, with VS calculator.
- ♦ TI InterActive™ or spreadsheet application.

Apparatus required

- ♦ a supply of germinating and boiled peas.
- ♦ 2 x vacuum flasks.
- ♦ calibrated Nalgene bottle (supplied with CO₂ sensor).
- ♦ cotton wool.

Useful web sites

www.ti.com/calc/docs/graph.htm
www.vernier.com
www.oxford-educational.co.uk
www.qca.org.uk



Lists of data from pea germination activities can be transferred to TI InterActive™, or, using TI-GRAPH LINK™, saved as .txt files and opened in spreadsheet applications.

This graph shows carbon dioxide production in germinating peas and boiled peas.

Activity 1

Heat production in germinating peas.

1. Place some damp cotton wool in the bottom of two vacuum flasks. Fill one with germinating peas and the other with boiled peas. Push the long stainless steel temperature sensors well down into both flasks. Seal both flasks with cotton wool.
2. Attach the calculator to the CBL/CBL2.
3. Open the chembio application/program and press enter to get to the following screen.

```

***MAIN MENU***
1:SET UP PROBES
2:COLLECT DATA
3:VIEW GRAPH
4:VIEW DATA
5:FIT CURVE
6:RETRIEVE DATA
7:QUIT
    
```

4. Select SET UP PROBES and follow the on screen prompts to place the temperature sensors in channel 1 and channel 2.
5. Select 2: COLLECT DATA from the MAI N MENU.
6. Select 2: TIME GRAPH.
7. For a 24 hour sampling period, sampling every 15 minutes works well; enter 900 or (15*60). To record a data point at hour 24 (i.e.86400 seconds), enter 97 or (24*4)+1 samples; this will actually show an EXPERIMENT LENGTH of 87300.0S on the screen.
8. Select 1: USE TIME SET UP.
9. PRESS [ENTER] TO BEGIN COLLECTING DATA.

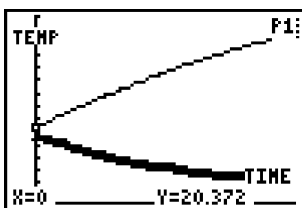
The calculator will now show the following screen:

```

PERFORMING
EXPERIMENT...
WHEN CBL SHOWS
DONE, CHOOSE
RETRIEVE DATA
ON NEXT SCREEN.
[ENTER]
    
```

The CBL screen can be used to trace the progress of the experiment. With the CBL 2, however, it is necessary to keep a separate record of time as there is no screen.

10. Detach the calculator, press ENTER and then 7: QUI T. At this stage the TI-83 plus will show an ERR: I NVALI D DIM message; however, just press enter again to quit.
11. After sampling has finished (**and it is important for the CBL/CBL2 to have finished collecting data**), re-attach the calculator, enter the chembio application/program and select 6: RETRI EVE DATA from the MAI N MENU. After the MAKE SURE CBL SHOWS DONE message, the screen will show TIME IN L1, DATA IN L2, L3.
12. Press enter to show both curves on the screen.



In this example, the top curve shows a steady rise in temperature with germinating peas, with the bottom curve showing a steady decrease with boiled peas reflecting a decrease in the ambient temperature.

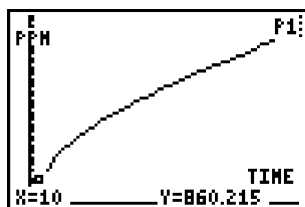
The temperature rise here is 6.79°C.

Activity 2

Carbon dioxide production in germinating peas.

For this activity, two runs are suggested, one for germinating peas and one for boiled peas, requiring only one carbon dioxide sensor. As the runs are of five minutes each, all data can be collected quickly. If two sensors are available, however, only one run is necessary, with both sensors being attached to the same CBL/CBL2.

1. Place peas in the Nalgene bottle (one quarter full), **but do not place the sensor in the bottle at this stage.**
2. Attach the calculator to CBL/CBL2, open chembio app/program to get *****MAIN MENU*****.
3. Select SET UP PROBES and follow the prompts to place the CO₂ sensor in channel 1.
4. On the CALI BRATI ON screen, select 1: USE STORED.
5. Select 2: COLLECT DATA and 2: TIME GRAPH. The CO₂ sensor starts flashing @ one per sec..
6. When the PLEASE ALLOW SYSTEM 30 SECONDS TO WARM UP message appears, **wait for 90 seconds.**
7. For the sampling, 30 samples @ 10 second intervals works well.
8. Then selecting 1: USE TIME SET UP, set Ymin = 300, Ymax = 5000, Yscl = 100.
9. **Now place the sensor in the bottle**, for the original CBL wait a further 90 seconds, and then PRESS ENTER TO BEGIN COLLECTING DATA. *A real-time graph appears on the calculator screen.*
10. At the end of the sampling period, TIME will be in L1 and PPM (parts per million) in L2.
11. Press enter to display the final graph.
12. Quit the application/program and **if the sensor continues flashing, detach it from the CBL/CBL2.**



This example for germinating peas shows an increase in CO₂ concentration of 3372 PPM over 5 minutes, at 20.2°C

Possible Extension Work.

- carbon dioxide production by other living organisms, such as yeast, maggots and green plants.
- carbon dioxide production by respiring yeast at different temperatures.

Links.

- the use of a carbon dioxide sensor in an investigation into the ventilation of rooms, in *Unit 8F Compounds and mixtures*.
- in *Unit 9C Plants and photosynthesis*, the use of a carbon dioxide sensor in conjunction with a light sensor to investigate carbon dioxide levels around green plants over a 24 hour period.