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II. EXPERIMENTAL OBJECTIVES

1) To record an EEG from an awake, resting subject under the following conditions:
   a) Relaxed with eyes closed;
   b) Performing mental arithmetic with eyes closed;
   c) Hyperventilating (breathing quickly and deeply) with eyes closed;
   d) Relaxed with eyes open.
2) To examine differences in the level of alpha rhythm activity during mental arithmetic and hyperventilation compared to the control condition of eyes closed and relaxed.

III. MATERIALS

- BIOPAC Electrode Lead Set (SS2L)
- BIOPAC Disposable Electrodes (EL503,) 3 electrodes per subject
- BIOPAC Electrode Gel (GEL1) and Abrasive Pad (ELPAD) *or* Skin cleanser or alcohol prep
- Lycra® swim cap (such as Speedo® brand) *or* supportive wrap (such as 3M Coban™ Self-adhering Support Wrap) to press electrodes against head for improved contact
- Biopac Student Lab System: BSL 4 software, MP36, MP35 or MP45 hardware
- Computer system (Windows 8, 7, Vista, XP, Mac OS X 10.5 – 10.8)

IV. EXPERIMENTAL METHODS

A. SETUP

FAST TRACK Setup

1. Turn the computer **ON**.
   - If using an MP36/35 unit, turn it **OFF**.
   - If using an MP45, make sure USB cable is connected and "Ready" light is **ON**.
2. **Plug the equipment in** as follows:
   Electrode Lead Set (SS2L)—CH 1
3. Turn ON the BIOPAC MP3X unit.

Setup continues…

Detailed Explanation of Setup Steps

Fig. 4.2 MP3X (top) and MP45 (bottom) hardware connections

4. Position electrodes on the scalp.
   Fig. 4.3 shows a sample configuration.

IMPORTANT
Good electrode contact with the scalp is crucial for obtaining a meaningful EEG recording.

Fig. 4.3

Guidelines for electrode placement:

- The placement of the scalp electrodes can vary (within limits) depending on your instructor's or **Subject's** preference.
- Keep the electrodes on one side (right or left) of the head.
- Apply some gel to the electrode. *(A fair amount of gel must be used to obtain a good electrode to scalp connection.)*
- The third electrode is the *ground* electrode and is placed over the Mastoid region (behind the ear).

Hints for obtaining optimal data:

- As much as possible, move (part) the hair away from the electrode adhesion area to ensure the electrode makes contact with the scalp.
- Gently abrade skin at the electrode sites.
- Apply a drop of gel to the electrode.
- Apply pressure to the electrodes for about one minute after the initial placement.
- **Subject** must remain still. Blinking and other movement will affect the recordings of all four rhythms.
- Despite your best efforts, electrode adhesion may not be strong enough to record data; try another **Subject** or different electrode placement.

5. **Clip** the Electrode Lead Set following the color code in Fig. 4.3.

The pinch connectors work like a small clothespin, but only latch onto the nipple of the electrode from one side of the connector.

6. Place cap/wrap on **Subject's** head to press electrodes into scalp (Fig. 4.4).

Drape the electrode cables over the head so that they are not pulling on the electrodes.

The cap or wrap should be snug but not uncomfortably tight.

Setup continues…

7. Get **Subject** in proper seating position (Fig. 4.5).
8. Wait five minutes to allow **Subject** to relax, and for electrodes to establish proper contact.

Place a Lycra® swim cap or supportive wrap on **Subject's** head to press electrodes against the scalp with a constant pressure. **Subject** should not press electrodes against scalp.

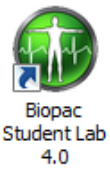
Fig. 4.4

Subject should be seated and relaxed. Ideally, the room should be *reasonably quiet* to help **Subject** mentally relax.

Fig. 4.5 Positioning

9. **Start** the Biopac Student Lab Program.
10. Choose lesson **"L04 – Electroencephalography (EEG) II"** and click **OK**.

Start Biopac Student Lab by double-clicking the Desktop shortcut.



11. Type in a unique **filename** and click **OK**.

No two people can have the same filename, so use a unique identifier, such as **Subject's** nickname or student ID#.

A folder will be created using the filename. This same filename can be used in other lessons to place the **Subject's** data in a common folder.

12. ***Optional***: Set Preferences.
    - Choose File > **Lesson Preferences**.
    - Select an option.
    - Select the desired setting and click **OK**.

This lesson has optional Preferences for data and display while recording. Per your Lab Instructor's guidelines, you may set:

Grids: Show or hide gridlines.

Lesson Recordings: Specific data recordings may be omitted based on instructor preferences.

END OF SETUP

B. CALIBRATION

The Calibration procedure establishes the hardware's internal parameters (such as gain, offset, and scaling) and is critical for optimum performance. **Pay close attention to Calibration.**

FAST TRACK Calibration

1. **Subject** remains relaxed with eyes closed during Calibration.
2. Check Electrode Impedance. (Optional*)

***Only functional if your MP** hardware is compatible with the Electrode Check feature. If your MP hardware is not compatible, this feature will not be available. Please contact BIOPAC Technical Support for more information on how to enable Electrode Check functionality.

IMPORTANT
Certain subjects may not fall below the 10 K ohm reading. This reading is subject to individual variations in skin conductivity and electrode placement.

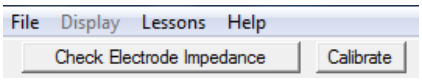
3. Click **Calibrate**.
4. During Calibration **Subject** must:
   - Remain seated, relaxed and still, with eyes closed.
   - Wait for Calibration to stop.
5. Verify recording resembles the example data.
   - If similar, click **Continue** and proceed to Data Recording.
   - If necessary, click **Redo Calibration**.

END OF CALIBRATION

Detailed Explanation of Calibration Steps

This step is optional and not applicable to MP45 hardware.

Use **Check Electrode Impedance** to check the **Subject's** skin conductivity. This opens the Electrode Checker panel and displays skin resistance in K ohms.



To use:

- Remove the Lead Set (SS2L) from CH1 and plug into the 'Electrode Check' input.
- Click 'Check Electrode Impedance' button.
- Ideally, both readings should be similar and below 10 k ohm. (See Fig. 4.6).
- When finished, be sure to remove the SS2L from the 'Electrode Check' input and plug into the CH 1 input before continuing.

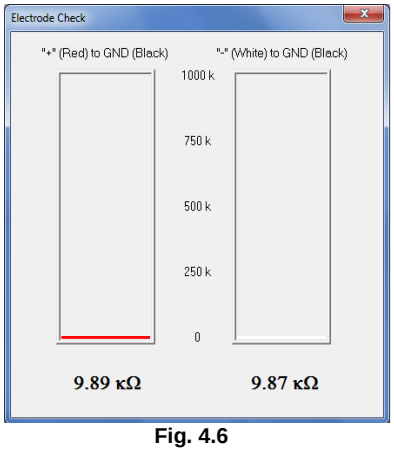


Fig. 4.6

Calibration lasts eight seconds.

The baseline should be relatively stable around 0 uV.

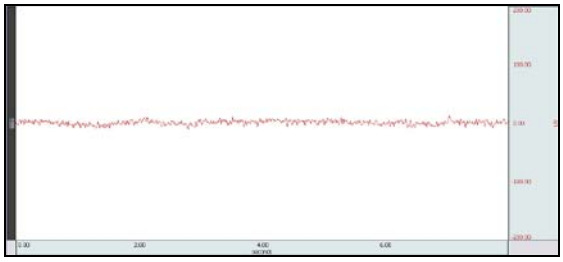


Fig. 4.7 Example Calibration data

If the data shows excessive baseline drift or large spikes, make sure the electrodes are making good contact with the scalp and that the cables are not pulling on the electrodes.

Click **Redo Calibration** and repeat Steps 3 – 5 if necessary.

C. DATA RECORDING

FAST TRACK Recording

1. Prepare for the recording.
   - **Subject** remains seated, relaxed, and still, with eyes closed.
   - **Review** recording steps.

Relaxed with eyes closed (Control)

2. Click **Record**.
   - **Subject** remains seated, relaxed and still, with eyes closed.

3. Record for 10 seconds.
4. Click **Suspend**.

Recording continues…

Detailed Explanation of Recording Steps

Subject will perform four tasks*; **Subject** will perform tasks in the intervals between recordings.

Recording 1: Relaxed with eyes closed

Recording 2: Performing mental math with eyes closed

Recording 3: Recovering from hyperventilation with eyes closed

Recording 4: Relaxed with eyes open

To work efficiently, read this entire section before recording, or review onscreen **Tasks** to preview recording steps in advance.

***IMPORTANT**

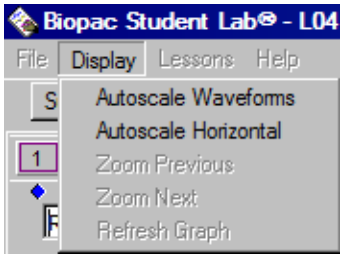
This procedure assumes that all lesson recordings are enabled in Lesson Preferences, which may not be the case for your lab. Always match the recording title to the recording reference in the journal and disregard any references to excluded recordings.

Hints for obtaining optimal data:

- **Subject** must try not to blink during "Eyes Open" portion of recording.
- **Subject** should not talk during any of the recordings, and should not verbalize answers to the mental arithmetic.
- The alpha signal will be increased during the relaxation recording if **Subject** relaxes mentally; i.e. thinks of a relaxing place.

Subject should try to relax mentally; i.e. think of a relaxing place.

Note: **Display** > **Autoscale Waveforms** and **Autoscale Horizontal** are available DURING recordings to allow scale changes if necessary.



Note The graph window will reduce to fit the **Input values** window on the right side of the display. The **Input values** window shows the alpha-RMS value in a thermometer-like bar display, and can be used as a visual aid to determine fluctuations in alpha-RMS activity. It is only updated during the recording.

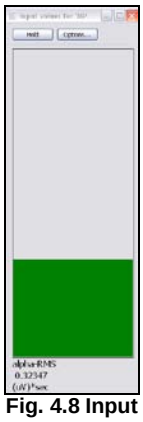


Fig. 4.8 Input Values

5. Verify recording resembles the example data.
   - If similar, click **Continue** and proceed to the next recording.
   - If necessary, click **Redo**.
   - If all required recordings have been completed, click **Done**.

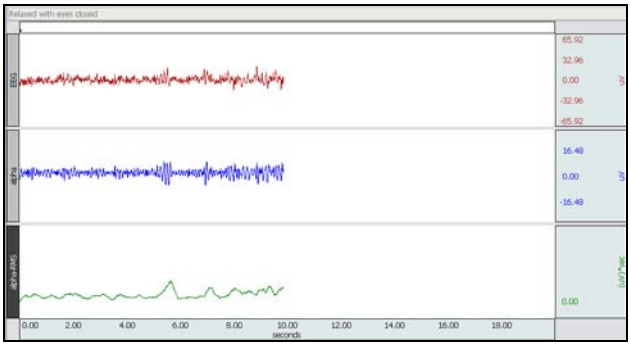


Fig. 4.9 Example Relaxed, Eyes Closed data

If recording does not resemble the Example Data

- If the data is noisy or flatline, check all connections to the MP unit.
- If there is excessive baseline drift or large spikes:
  - Check that electrodes are making good contact with the scalp, cap or wrap is snug and that the cables are not pulling on the electrodes.
  - **Subject** must remain as still as possible.
  - Try relaxation techniques, such as slow breathing or relaxing muscles.

Click **Redo** and repeat Steps 2 – 5 if necessary. Note that once **Redo** is clicked, the most recent recording will be erased.

Mental Arithmetic

6. **Director** prepares a math problem.
   - **Subject** remains seated and relaxed, with eyes closed.
   - **Review** recording steps.
7. Click **Record**.
8. **Director** verbalizes math problem to **Subject**.
   - **Subject** solves the problem silently with eyes closed.
   - Record for 20 seconds.
9. Click **Suspend**.
10. If the **Subject** indicates the math problem was given too quickly, **Redo** the recording.
11. Verify recording resembles the example data.
    - If similar, click **Continue** and proceed to the next recording.
    - If necessary, click **Redo**.
    - If all required recordings have been completed, click **Done**.

Recording continues…

Subject remains relaxed with eyes closed. **Director** prepares a math problem. The problem should be challenging but not too difficult—the point is to make **Subject** really work for the answer, not to stump **Subject**. For example:

2 minus 4…times 3…plus 9…double that…double again…divide by 4...

Director provides arithmetic problem at a rate that the **Subject** can solve silently.

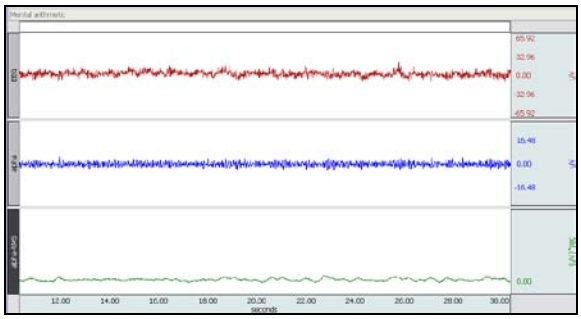


Fig. 4.10 Mental Arithmetic, Eyes Closed

The data may be different for the reasons outlined in Step 5.

Click **Redo** and repeat Steps 7 – 11 if necessary. Note that once **Redo** is clicked, the most recent recording will be erased.

After Hyperventilation

12. **Subject** is seated.
    - **Review** recording steps.
    - **Subject** hyperventilates for two minutes with eyes closed.

> **WARNING**
> Hyperventilation can make **Subject** dizzy and light headed. **Subject** should be seated with **Director** watching. Stop the procedure if **Subject** starts to feel sick or dizzy.

13. As soon as **Subject** stops hyperventilating and is sitting still, Click **Record** immediately.
14. Record for 10 seconds.
15. Click **Suspend**.
16. Verify recording resembles the example data.
    - If similar, click **Continue** and proceed to the next recording.
    - If necessary, click **Redo**.
    - If all required recordings have been completed, click **Done**.

Eyes Open recording

17. **Subject** remains seated and relaxed.
    - **Review** recording steps.
    - **Subject** opens eyes and avoids blinking during recording.
18. Click **Record**.
19. Record for 10 seconds.
20. Click **Suspend**.

Recording continues…

Subject hyperventilates (by breathing rapidly and deeply through mouth) for two minutes with eyes closed.

It is important that recording be resumed as quickly as possible after **Subject** has hyperventilated. However, to avoid EMG artifact, make sure **Subject** has stopped hyperventilating prior to clicking **Record**.

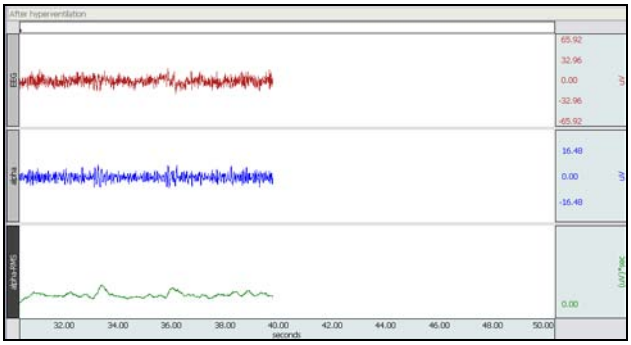


Fig. 4.11 Example after Hyperventilation, Eyes Closed data

The data may be different for the reasons outlined in Step 5, with the following exception:

- It is normal to have some baseline drift after hyperventilation.

Click **Redo** and repeat Steps 12 – 16 if necessary. Note that once **Redo** is clicked, the most recent recording will be erased.

Director instructs **Subject** to open eyes.

21. Verify recording resembles the example data.
    - If similar, click **Continue** and proceed to optional recording section, or click **Done** to finish.
    - If necessary, click **Redo**.

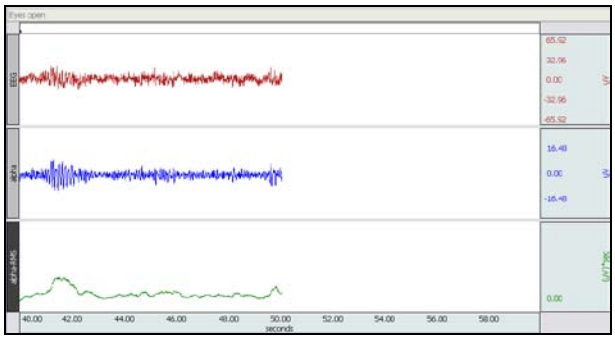


Fig. 4.12 Example Relaxed, Eyes Open data

The data may be different for the reasons outlined in Step 5, with the following exception:

- If the **Subject** blinked, it may have created a large spike in the data. If excessive, consider redoing the recording.

Click **Redo** and repeat Steps 17 – 21 if necessary. Note that once **Redo** is clicked, the most recent recording will be erased.

OPTIONAL ACTIVE LEARNING PORTION

With this lesson you may record additional data by clicking **Continue** following the last recording. Design an experiment to test or verify a scientific principle(s) related to topics covered in this lesson. Although you are limited to this lesson's channel assignments, the electrodes may be moved to different locations on the **Subject**.

Design Your Experiment

Use a separate sheet to detail your experiment design, and be sure to address these main points:

A. ***Hypothesis***

Describe the scientific principle to be tested or verified.

B. ***Materials***

List the materials you will use to complete your investigation.

C. ***Method***

Describe the experimental procedure—be sure to number each step to make it easy to follow during recording.

Run Your Experiment

D. ***Set Up***

Set up the equipment and prepare the subject for your experiment.

E. ***Record***

Use the **Continue**, **Record** and **Suspend** buttons to record as much data as necessary for your experiment.

Click **Done** when you have completed all of the recordings required for your experiment.

Analyze Your Experiment

F. Set measurements relevant to your experiment and record the results in a Data Report.

22. After clicking **Done**, choose an option and click **OK**.

After clicking **Done**, dialog with options will be generated. Make a selection, and continue as directed.

If choosing the **Record from another Subject** option:

- Repeat Setup Steps 5 – 9, and then proceed to Calibration.

23. Remove electrodes.

Remove cap or wrap, the electrode cable pinch connectors, and peel off all electrodes. Discard the electrodes. (BIOPAC electrodes are not reusable.) Wash the electrode gel residue from the skin, using soap and water. The area around the electrode sites may remain red for a few hours, which is quite normal.

END OF RECORDING

V. DATA ANALYSIS

FAST TRACK Data Analysis

1. Enter the **Review Saved Data** mode.

   - Note Channel Number (CH) designations:

Channel	*Displays*
CH 1	**EEG**
CH 40	**alpha**
CH 41	**alpha RMS**

   - Note measurement box settings:

Channel	*Measurement*
CH 1	**Stddev**
CH 40	**Stddev**
CH 41	**Mean**
CH 40	**Freq**

2. Set up your display window for optimal viewing of the entire recording.

3. Use the I-Beam cursor to select the first data recording.

   A

4. Repeat the measurements for each of the data recordings.

   A

Data Analysis continues…

Detailed Explanation of Data Analysis Steps

If entering **Review Saved Data** mode from the Startup dialog or lessons menu, make sure to choose the correct file.

The data should resemble Fig. 4.13.

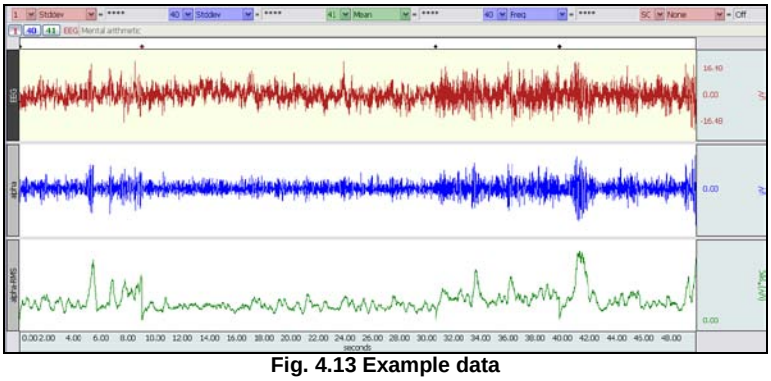


Fig. 4.13 Example data

The measurement boxes are above the marker region in the data window. Each measurement has three sections: channel number, measurement type, and result. The first two sections are pull-down menus that are activated when you click them.

Brief definition of measurements:

Stddev: Standard deviation is a measure of the variability of data points. The advantage of the Stddev measurement is that extreme values or artifacts do not unduly influence the measurement.

Mean: Displays the average value in the selected area.

Freq: Converts the time segment of the selected area to frequency in cycles per second

The "selected area" is the area selected by the **I-beam** tool (including endpoints).

Note: The append event markers mark the beginning of each recording. Click on (activate) the event marker to display its label.

Useful tools for changing view:

Display menu: Autoscale Horizontal, Autoscale Waveforms, Zoom Back, Zoom Forward

Scroll Bars: Time (Horizontal); Amplitude (Vertical)

Cursor Tools: Zoom Tool

Buttons: Overlap, Split, Show Grid, Hide Grid, -, +

Hide/Show Channel: "Alt + click" (Windows) or "Option + click" (Mac) the channel number box to toggle channel display.

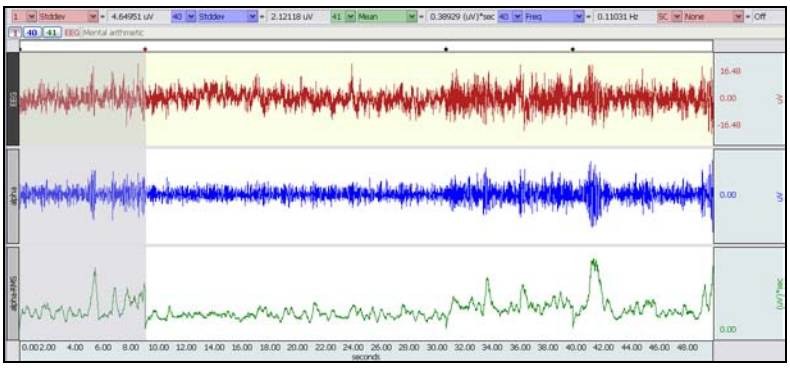


Fig. 4.14 First data recording selected

5. Zoom in on a small section of the Recording 1 data.
6. Use the I-Beam cursor to select an area from one peak to the next in the **alpha** band (CH 40).

   B

Be sure to zoom in far enough so that you can easily measure the frequency of the **alpha** wave.

Fig. 4.15 shows a sample setup for measuring the frequency in the **alpha** band (CH 40).

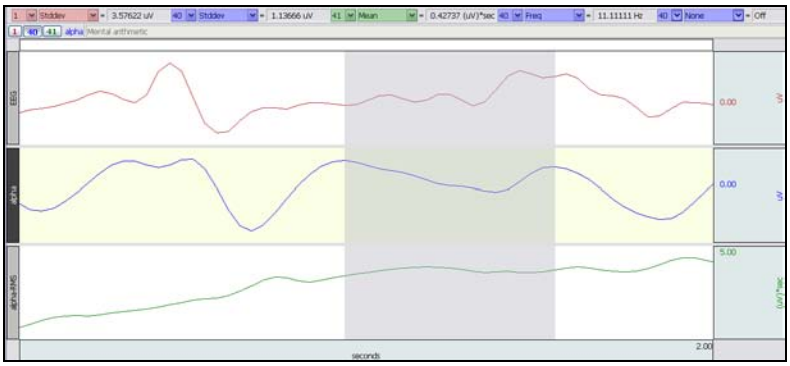


Fig. 4.15 Alpha wave frequency measurement

7. Answer the questions at the end of the Data Report.
8. **Save** or **Print** the Data Report.
9. **Quit** the program.

END OF DATA ANALYSIS

An electronically editable **Data Report** is located in the journal (following the lesson summary,) or immediately following this Data Analysis section. Your instructor will recommend the preferred format for your lab.

END OF LESSON 4

Complete the Lesson 4 Data Report that follows.

ELECTROENCEPHALOGRAPHY II

- *EEG II*

DATA REPORT

Student's Name: _____

Lab Section: _____

Date: _____

I. Data and Calculations

Subject Profile

Name:_____ Height:_____

Age:_____ Gender: Male / Female Weight:_____

Amplitudes

A. **Complete Table 4.1 with the amplitudes of the recorded data** in the control and experimental conditions. Calculate the difference for the Alpha-RMS Mean between the Experimental Conditions and the Control, and then summarize whether the Experimental Mean was larger (+,) smaller (–,) or the same (=) as the Control Mean.

For example: To calculate Alpha-RMS Difference for the "Mental Arithmetic" recording, subtract the "Eyes Closed (Control)" Alpha-RMS value from the measured "Mental Arithmetic" Alpha-RMS value.

Table 4.1

Condition	EEG 1 Stddev	Alpha 40 Stddev	Alpha-RMS 41 Mean	Alpha-RMS Difference (Exp. - Control)	Alpha-RMS Summary (+, –, =)
Eyes closed (**Control**)					
Mental arithmetic					
Recovering from hyperventilation					
Eyes open					

Frequency

B. **What is the frequency of an alpha rhythm from "Eyes closed" data?** 40 Freq =_____Hz

Does this agree with the expected values? Yes No

II. Questions

C. Refer to Table 4.1: When was the general amplitude of the EEG highest?

_____

_____

_____

D. Refer to Table 4.1: When were the alpha wave levels highest?

_____

_____

_____

E. Refer to Table 4.1: How do your results compare with the information presented in the Introduction?

F. Did Subject need to concentrate during math problems? Yes No
How would the level of concentration required affect the data?

G. What might account for the amplitude difference of waves recorded from a subject tested alone, in a darkened room, and subjects tested in a lab full of students?

H. Which conditions produced the lowest alpha activity?

III. OPTIONAL Active Learning Portion

A. ***Hypothesis***

B. ***Materials***

C. ***Method***

D. ***Set Up***

E. ***Experimental Results***

End of Lesson 4 Data Report