COGS 160: Brain Waves
Final Exam: Due In Class Friday 6/9

Name:_______________________________________________________________________

1. Which of the following sentences would NOT elicit an N400? (2 points)
   A. I take my coffee with cream and socks.
   B. The table has four leg.
   C. A robin is not a vehicle.
   D. I still miss my ex-wife, but I am improving my aim.

2. Which of the following is likely to elicit a mismatch negativity (MMN)? (2 points):
   A. A repeated auditory stimulus at 40 Hz.
   B. A repeated auditory stimulus within a sequence of stimuli ascending in pitch.
   C. A repeated auditory stimulus occurring every 8 seconds.
   D. An auditory stimulus that is higher in pitch than subsequent stimuli.

3. Which of the following would NOT induce a steady state response (2 points)?
   A. A 380 Hz and 420 Hz tone presented together, creating beats at 40 Hz.
   B. A square that flickers on screen by alternating between black and white at 20 Hz.
   C. A vibration that increases in intensity at 5 Hz.
   D. A 1000 Hz tone that is presented at a constant amplitude.

4. The electroencephalogram (EEG) is most sensitive to current flow in which region (2 points)?

   A. The region between A and B
   B. The region between B and C
   C. The region between B and D
   D. The region between D and E

5. Name two features of event-related potential (ERP) components that are taken into account when they are named/defined (2 points):
6. A. One hundred pyramidal cells in a cortical gyrus receive an excitatory input at their
distal dendrites, resulting in synchronous excitatory postsynaptic potentials (EPSPs).
Draw the signal you would expect to record from an electrode placed on the surface of
the scalp, and indicate the direction (up or down) that corresponds to positive and
negative voltage (4 points):

B. The same one hundred pyramidal cells receive an excitatory input close to their cell
bodies, resulting again in synchronous EPSPs. Draw the signal you would expect to
record from an electrode placed on the surface of the scalp, and indicate the direction
(up or down) that corresponds to positive and negative voltage (4 points):

7. The EEG is thought to be preferentially sensitive to current flow along cortical pyramidal
neurons.
A. Explain why the EEG is thought to be more sensitive to current flow along pyramidal
cells than to current flow along other cell types in the cortex (2 points).

B. Explain why the EEG is thought to be more sensitive to current flow along cortical
neurons than to current flow along neurons in subcortical brain regions (e.g.
hippocampus) (2 points).

8. You observe an increase in the amplitude of an oscillation in the EEG signal.
A. List two possible changes in network activity that could result in the observed
increase in amplitude (4 points).
B. Describe the results of an experiment to support one of the possibilities listed above (4 points).

9. While chatting about neural oscillations at a party, someone tells you that they believe that neural oscillations are exhaust fumes of the brain. Write your response to them below, and provide an example from at least two experiments to support why you agree or disagree with their statement (8 points):

10. You are designing a brain-computer interface (BCI) that can help tetraplegic patients spell words by using features of the EEG signal to select letters on a screen.
   A. Describe a feature of the EEG signal that you will exploit for your device, and explain why you chose this feature (4 points).

   B. Describe the method you will use to induce the EEG feature you have chosen (4 points).
C. Explain how your device will interpret detection of the feature in order to select letters on a screen (4 points).

11. A single cortical region is capable of exhibiting multiple different rhythms (e.g. slow waves during one behavior, gamma during another behavior).
   A. Explain how a single cortical region can manifest distinct rhythms by describing one possible mechanism through which this can be accomplished (4 points).

   B. Name two rhythms, indicate their frequency ranges, and hypothesize the function that the cortical region is performing when it is engaged in each rhythm (6 points).

   C. Choose one of the rhythms above and describe the behavior of the animal/human and the activity of the cortical cells (e.g. bursts, ordered firing, silent) at times when the rhythm is prominent. (4 points).
12. Groups of pyramidal neurons in Region A exhibit neural resonance, but do not have the same resonant frequency. The resonant frequency of Group X is 7 Hz, the resonant frequency of Group Y is 15 Hz, and the resonant frequency of Group Z is 20 Hz.

A. Define neural resonance (2 points):

B. When excitatory neurons in Region B communicate with Region A, they exhibit action potentials at a rate of 15 Hz. Compare the responses of Groups X, Y, and Z to input from Region B (4 points).

C. When excitatory neurons in Region C communicate with Region A, they exhibit action potentials at a rate of 20 Hz. Compare the responses of Groups X, Y, and Z to input from Region C (4 points).

D. During some behavioral tasks, both Region B and Region C are often communicating with Region A at the same time. If Region A would like to process information from Regions B and C simultaneously and separately (in non-overlapping populations of neurons), how might it accomplish this given the resonance properties of its neurons (4 points)?
13. Course and professor evaluations will be used to make changes to the course and determine whether it will be offered again in the future. Please consider filling out a CAPE and commenting on your learning experience here: cape.ucsd.edu/students. Check one of the following (**1 point**).

- ___Yes, I filled out a CAPE.
- ___No, I did not fill out a CAPE because _______________________________.

14. **Extra credit (**4 points**): Identify a topic from this course that you found particularly interesting or a fact that really “resonated” with you, and describe why you will remember the topic/fact 10 years from now.