NeuroTrace Study Guide

Domain: Domain I – Basic Concepts & Principles
Section: Basic EEG Physics & Instrumentation
Style: Conceptual, simplified, ABRET-focused

---

1. Core Principles (Must Know)

EEG Measures Electrical Voltage Differences

- **EEG measures electrical voltage differences:** Voltage, not current
- Voltage = electrical potential difference
- Measured between two points (electrodes)
- Very small signals (microvolts)
- Essential concept

Signals Are in the Microvolt (μV) Range

- **Signals are in the microvolt (μV) range:** Very small
- Typical EEG: 10–100 μV
- Much smaller than ECG (millivolts)
- Requires amplification
- Sensitive to noise

Instrumentation Must Amplify Brain Signals While Minimizing Noise

- **Instrumentation must amplify brain signals while minimizing noise:** Dual function
- Amplify weak signals
- Reject environmental noise
- Balance amplification and noise rejection
- Essential for quality recording

Key Principle

- **EEG is a measurement system, not a power delivery system**
- EEG measures, does not deliver
- No current passes into brain
- Passive recording only
- Safety principle

Practical Application

- Understand voltage measurement
- Know signal size (μV range)
- Recognize amplification needs
- Understand noise rejection

---

2. Voltage vs Current

Voltage

Electrical Potential Difference

- **Electrical potential difference:** Voltage definition
- Difference in electrical potential

- Measured in volts (V) or microvolts (μV)
- What EEG records
- Essential concept

What EEG Records

- **What EEG records:** Voltage differences
- EEG measures voltage
- Between electrodes
- Not current
- Critical distinction

Current

Flow of Electrons

- **Flow of electrons:** Current definition
- Movement of electrical charge
- Measured in amperes (A)
- NOT measured by EEG
- Important distinction

NOT Measured by EEG

- **NOT measured by EEG:** Critical point
- EEG does not measure current
- EEG does not pass current
- EEG only measures voltage
- Safety and understanding

ABRET Emphasis

- **EEG does not pass current into the brain**
- EEG is passive recording
- No electrical current delivered
- Safe measurement only
- Must understand this

Best Practice

- Memorize: EEG measures voltage, not current
- Understand: EEG is passive, not active
- Know: No current passes into brain
- Apply: Safety and interpretation

---

3. Polarity & Waveform Deflection

Negative Deflection

Indicates Relative Negativity at the Active Electrode

- **Indicates relative negativity at the active electrode:** Polarity meaning
- Negative deflection = active electrode more negative
- Relative to reference electrode
- Not absolute, but relative
- Important for interpretation

Polarity Depends On

Electrode Orientation

- **Electrode orientation:** Physical orientation
- How electrode is placed
- Orientation affects polarity
- Must be consistent
- Standard placement

Montage Selection

- **Montage selection:** Reference choice
- Which electrode is reference
- Bipolar vs referential
- Affects polarity appearance
- Must consider montage

Positive Deflection

- **Positive deflection:** Opposite of negative
- Active electrode more positive
- Relative to reference
- Depends on montage
- Context-dependent

Best Practice

- Understand relative polarity
- Consider montage effects
- Know polarity is relative
- Apply to interpretation

---

4. EEG Signal Pathway (Simplified)

Cortical Neurons Generate Electrical Potentials

- **Cortical neurons generate electrical potentials:** Signal origin
- Neurons create electrical activity
- Postsynaptic potentials
- Synchronized activity
- Source of EEG signals

Potentials Reach Scalp Electrodes

- **Potentials reach scalp electrodes:** Signal detection
- Electrical activity travels to scalp
- Through skull and scalp
- Attenuated by distance
- Detected by electrodes

Amplifiers Increase Signal Strength

- **Amplifiers increase signal strength:** Signal amplification
- Weak signals amplified
- Made visible on display
- Essential for recording

- Increases signal size

Filters Shape Frequency Content

- **Filters shape frequency content:** Signal filtering
- Remove unwanted frequencies
- Low-frequency filter (LFF)
- High-frequency filter (HFF)
- Shape final appearance

Signals Are Displayed and Stored

- **Signals are displayed and stored:** Final output
- Displayed on screen
- Stored digitally
- Available for review
- Permanent record

Best Practice

- Understand signal pathway
- Know each step
- Recognize where problems occur
- Apply to troubleshooting

---

5. Core EEG Hardware Components

Component	Function
Electrodes	Detect voltage
Amplifiers	Increase signal
Filters	Shape waveform
Computer	Display/store data

Electrodes

- **Detect voltage:** Primary function
- Contact with scalp
- Detect electrical potentials
- Convert to electrical signal
- First step in pathway

Amplifiers

- **Increase signal:** Amplification
- Make weak signals visible
- Differential amplification
- Common-mode rejection
- Essential component

Filters

- **Shape waveform:** Frequency control
- Remove unwanted frequencies

- Low-frequency filter
- High-frequency filter
- Shape final appearance

Computer

- **Display/store data:** Output
- Visual display
- Digital storage
- Analysis capability
- Permanent record

Best Practice

- Know each component function
- Understand signal pathway
- Recognize component roles
- Apply to troubleshooting

---

6. Noise & Interference

Sources

Power Lines

- **Power lines:** 50/60 Hz noise
- Electrical power lines
- 50 Hz (Europe) or 60 Hz (US)
- Environmental interference
- Common noise source

Muscle Activity

- **Muscle activity:** EMG artifact
- Muscle contractions
- High-frequency artifact
- Patient-related
- Common artifact

Poor Electrode Contact

- **Poor electrode contact:** Technical issue
- High impedance
- Unstable contact
- Creates noise
- Technical problem

Controlled By

Impedance Balance

- **Impedance balance:** Technical control
- Balanced impedance reduces noise
- Unbalanced increases noise
- Technical factor
- Must maintain balance

Grounding

- **Grounding:** Electrical safety and noise reduction
- Ground electrode
- Reduces environmental noise
- Essential for quality
- Must verify

Differential Amplification

- **Differential amplification:** Noise rejection
- Rejects common noise
- Common-mode rejection ratio (CMRR)
- Essential for quality
- Technical principle

Best Practice

- Recognize noise sources
- Know control methods
- Apply noise reduction
- Maintain quality

---

7. Common ABRET Exam Traps

Trap 1: Confusing Voltage with Current

- **Reality:** EEG measures voltage, not current
- **Trap:** May think EEG measures current
- **Solution:** Memorize: EEG = voltage measurement
- **ABRET focus:** Voltage vs current distinction

Trap 2: Thinking EEG Delivers Electricity to the Brain

- **Reality:** EEG is passive recording only
- **Trap:** May think EEG delivers current
- **Solution:** Understand EEG is measurement only
- **ABRET focus:** Passive vs active distinction

Trap 3: Assuming Larger Waves Mean Stronger Brain Activity

- **Reality:** Wave size depends on multiple factors
- **Trap:** May equate size with strength
- **Solution:** Understand size depends on sensitivity, filters, etc.
- **ABRET focus:** Wave size interpretation

Trap 4: Ignoring the Role of Instrumentation

- **Reality:** Instrumentation affects appearance
- **Trap:** May not consider equipment effects
- **Solution:** Always consider instrumentation
- **ABRET focus:** Equipment effects on interpretation

Trap 5: Not Understanding Polarity

- **Reality:** Polarity is relative, not absolute
- **Trap:** May think polarity is absolute
- **Solution:** Understand relative polarity
- **ABRET focus:** Polarity interpretation

---

8. Case-Based Example

Scenario

Clinical Setting: Routine EEG recording
Problem: EEG shows excessive noise despite normal brain activity
Observation: Noise present in all channels
Question: What could cause this?

Interpretation

- **Instrumentation or impedance issue**
- Not brain activity problem
- Technical issue
- Equipment or impedance
- Must troubleshoot

Teaching Point

- **Signal appearance depends on equipment integrity**
- Good equipment = good signal
- Poor equipment = poor signal
- Must verify equipment
- Technical factors matter

ABRET Application

- Given noisy EEG → consider instrumentation
- Given signal quality → check equipment
- Given interpretation → verify equipment
- Must know troubleshooting

---

9. Exam Readiness Checklist

Use this checklist to verify your understanding:

- ☐ Can define voltage vs current (voltage = potential difference, current = electron flow)
- ☐ Can explain EEG signal measurement (voltage differences in μV range)
- ☐ Can identify core hardware components (electrodes, amplifiers, filters, computer)
- ☐ Can apply physics concepts correctly (voltage measurement, polarity, signal pathway)
- ☐ Understand that EEG measures voltage differences
- ☐ Know that signals are in microvolt range
- ☐ Recognize that instrumentation amplifies signals and rejects noise
- ☐ Know that EEG is a measurement system, not power delivery
- ☐ Can explain polarity and waveform deflection
- ☐ Understand signal pathway (neurons → electrodes → amplifiers → filters → display)
- ☐ Can identify noise sources and control methods
- ☐ Can identify common ABRET exam traps

---

10. Internal Cross-Links

Workflow

- **Amplifiers, Impedance & Grounding:** Detailed amplifier and impedance information
- **Filters & Sensitivity:** Detailed filter and sensitivity information

Patterns

- **Artifacts:** How instrumentation affects artifacts
- **Noise patterns:** Technical vs physiologic noise

Cases

- **Instrumentation troubleshooting cases:** Cases involving equipment issues
- **Signal quality cases:** Cases requiring equipment verification

Quizzes

- **EEG physics MCQs:** Questions on voltage, current, instrumentation
- **Polarity questions:** Questions on waveform polarity
- **Signal pathway questions:** Questions on signal flow

Study Tips

1. **Memorize key distinction:** EEG measures voltage, not current
2. **Learn signal pathway:** Neurons → electrodes → amplifiers → filters → display
3. **Understand components:** Electrodes (detect), Amplifiers (increase), Filters (shape), Computer (display/store)
4. **Know the principle:** EEG is measurement system, not power delivery
5. **Remember the traps:** Voltage vs current, passive vs active, size interpretation
6. **Know noise sources:** Power lines, muscle, poor contact
7. **ABRET focus:** Expect questions on voltage vs current, signal measurement, and instrumentation components

---

End of Study Guide

For additional practice, complete quiz questions tagged: voltage, current, instrumentation, polarity