Name: _____

Exam Conditions:

1) This is an open-book test. You can use any information source *except* another person.

2) HONOR SYSTEM- you are to take this exam independently. No collaborative efforts.

1. Ohm's law, developed by the German physicist Georg Simon Ohm, relates current, voltage, and resistance in circuits. The equation is:

   A. resistance = current / voltage
   B. voltage = current / resistance
   C. resistance = voltage / current
   D. none of the above

2. A backpack shocker is a series circuit. The anode resistance (R_a) is 142 ohms (Ω) and the cathode resistance (R_c) is 115 Ω. 350V pulsed direct current is applied. Determine the total electrode resistance and circuit current:

   A. 64 Ω & 5.5 amps
   B. 64 Ω & 0.18 amps
   C. 257 Ω & 1.4 amps
   D. 257 Ω & 0.73 amps

3. An electrofishing boat has 400V direct current power supply with two boom electrodes, each with a resistance of 57 Ω (in 100 μS/cm water conductivity). Hull resistance measures 15 Ω. Determine total electrode resistance and resulting circuit current.

   A. 0.02 Ω & 5,000 amps
   B. 129 Ω & 3.1 amps
   C. 72 Ω & 5.6 amps
   D. 44 Ω & 9.1 amps

4. Measuring electrode resistance for an electrofishing unit provides information to:

   A. improve electrode design
   B. determine power, voltage, and current output across water conductivities
   C. determine allocation of available power among electrodes
   D. all of the above

5. An electrofishing boat has two boom electrodes and the hull wired as the cathode. In 300 µS/cm water conductivity, the peak voltage meter reads 285 V and the peak current meter reads 14.3 amps. What is the total electrode resistance in 300 µS/cm water conductivity?

   A. 20 Ω
   B. 60 Ω
   C. 4,500 Ω
   D. Cannot calculate because only AC can be used to determine electrode resistance

6. You are electrofishing with one anode and one cathode. The applied voltage is 500V pulsed direct current, the anode measures 200 ohms and the cathode measures 152 ohms. Equivalent resistance is 352 ohms and circuit current is 1.42 amps. Determine power demand on the system.

   A. 357 watts
   B. 710 watts
   C. 790 watts
   D. 825 watts

7. Your electrofishing unit has an anode resistance of 183 Ω and a cathode resistance of 107 Ω. What percent of the power allocation goes to the anode?

   A. 63%
   B. 58%
   C. 37%
   D. Varies, depends upon applied voltage

8. Electrofishing boats designed with two anode booms and a non-painted hull as the cathode typically have total electrode resistance in the range of 40 – 60 Ω (at 100 µS/cm water conductivity). However, boat electrode resistance values near 100 Ω and as low as 32 Ω have been measured. A boat with _____ electrode resistance would have greater power output, and potentially be more effective, in low conductivity water:

   A. higher
   B. lower

9. Increasing the surface area of an electrode:

   A. decreases the resistance
   B. increases the resistance
   C. helps alleviate power limitations in high conductivity water
   D. has no effect on system power demand

10. A primary resistivity factor in electrofishing is:

   A. electrode metal type
   B. conductor metal type
   C. temperature
   D. water conductivity

11. Ambient water conductivity results from:

   A. turbidity and temperature
   B. turbidity, substratum type, and temperature
   C. ionic concentration only
   D. ionic concentration and temperature

12. You are electrofishing with pulsed direct current having a pulse width of 8 ms and a frequency of 30 H_z. Determine the duty cycle of this setting:

   A. 2.4 %
   B. 8 %
   C. 16 %
   D. 24 %

13. You are electrofishing with pulsed direct current. The peak reading meters on your pulsator show voltage = 145 V and current = 3 amps. The duty cycle is set at 40%. Determine the average power requirement.

   A. 148 watts
   B. 174 watts
   C. 261 watts
   D. 435 watts

14. You are electrofishing with 60 H_z alternating current. The pulsator voltmeter reads 255 V_{rms}. Determine peak voltage:

    A. 85 V
    B. 180 V
    C. 361 V
    D. 510 V

15. You have defined (mapped) an electric field by voltage gradients at an applied voltage of 200 volts. Ambient water conductivity is 150 µS/cm. You wish to convert the electric field from one defined by voltage gradients to one defined by power densities (holding applied voltage at 200V). Thus, the 0.5 V/cm electric field contour would become approximately:

    A. 38 µwatts/cm^3
    B. 75 µwatts/cm^3
    C. 100 µwatts/cm^3
    D. 375 µwatts/cm^3

16. The parameters of voltage gradient and current density when plotted against the separation distance (X-axis) of two electrodes in a heterogeneous field are _____ curves.

    A. linear
    B. S-shaped
    C. U-shaped
    D. logarithmic

17. A rule-of-thumb for a first approximation of effective field size for an electrofishing unit states that the edge of the effective range is approximately 0.1 V/cm. This rule-of-thumb is approximate because we fish with power (not just voltage) and the rule breaks down in _____ conductivity waters.

    A. low (<100 µS/cm)
    B. medium (100-400 µS/cm)
    C. high (400-1,000 µS/cm)
    D. extremely high (>1,000 µS/cm)

18. Rotation of a voltage gradient probe in an electric field will:

A. produce a maximum and minimum reading
B. produce no change
C. A or B depending whether water conductivity is high or low, respectively
D. none of the above

19. In electrofishing, we must transfer energy from the water to fish to cause a behavioral response that can be exploited to capture fish. Thus we electrofish with:

A. current
B. power
C. resistance
D. voltage

20. In power transfer theory, threshold is:

A. induced movement of the fish toward the anode
B. induced movement without orientation
C. maximum power needed to capture a fish
D. the minimum level of an electrical stimulus required to achieve a particular fish response

21. The lowest point on the applied power curve (that is, the least amount of power required) for a given fish reaction corresponds to where?

A. fish effective conductivity less than water conductivity
B. fish effective conductivity greater than water conductivity
C. fish effective conductivity equals water conductivity
D. the product of current density and voltage gradient is maximum

22. Electrofishing generally is selective for:

A. larger fish
B. smaller fish
C. pelagic fish
D. benthic fish

23. Water temperature can affect electrofishing efficiency through:

    A. changes in conductivity
    B. changes in fish flotation rate
    C. changes in fish behavior
    D. all of the above

24. Catch-per-unit-effort (CPUE) can be used as an index of abundance for assessing differences among sampling sites if capture efficiency, q, is:

    A. relatively constant among sites
    B. variable among sites
    C. unknown
    D. B & C

25. An important reason for standardization is:

    A. consistency of work protocols
    B. safety
    C. reducing variance in capture efficiency
    D. estimating capture efficiency

26. Using a capture efficiency model allows the biologist to estimate capture efficiency at a sampling site and then to adjust the CPUE index to an estimate of true abundance:

    A. True
    B. False

27. When conductivity readings are less than 50 µS/cm:

    A. DC is usually best
    B. pulsed DC is usually best
    C. higher voltage gradients are required
    D. wait for better conditions

28. Narcosis is:

A. induced swimming toward the anode by an unconscious, belly-up fish
B. a state of electrically induced immobility with rigid muscles
C. a state of electrically induced immobility with slack muscles
D. a thrashing movement by fish

29. The difference between tetany and narcosis can be seen in the:

A. stiffness of body
B. opercles of the fish
C. body curvature
D. all of the above

30. The rule-of-thumb order of the three waveform categories in causing injury rates in salmonids, from lowest to highest, is:

A. continuous DC, pulsed DC, AC
B. pulsed DC, continuous DC, AC
C. AC, continuous DC, pulsed DC
D. not known

31. For warmwater fishes, as centrarchids (sunfishes), selection of pulsed direct current attributes should strive for:

A. low duty cycles (10% or less) and high power levels
B. a range of duty cycles between 10 – 50% and power levels just sufficient to cause capture-prone response as immobilization
C. highest frequencies sustainable by the equipment
D. highest power levels sustainable by the equipment

32. The behavioral response associated with highest injury rates:

A. Escape
B. Taxis
C. Narcosis
D. Tetany

33. "Branding" of fish by electrofishing is a:

A. burn from fish touching electrodes
B. hemorrhage of near-skin capillaries
C. dilation of pigment cells
D. torn muscle

34. Most electrofishing-induced severe spinal injuries in salmonids occur:

A. in nape (neck) region
B. in caudal region
C. in region of maximum girth
D. equally likely to occur anywhere along spinal cord

35. According to the fish injury risk model, a small fish with a low vertebral count (< 40 vertebrae), should have a _____ risk of injury due to electrofishing

A. higher
B. lower

36. The most hazardous electrofishing equipment category probably is:

A. boat electrofishing
B. shore-based
C. backpack
D. none of the above

37. The electrofishing equipment category wherein the operator can surround herself with equipotential surfaces:

A. boat electrofishing
B. shore-based
C. backpack
D. all of the above

38. Electrical continuity among metal surfaces in an electrofishing boat can be tested using a multimeter. If two metal surfaces are in electrical continuity, the multimeter should read:

A. zero voltage
B. less than one ohm
C. greater than one ohm
D. less than one amp

39. For an electrofishing boat with a metal hull, all metal in the boat should be electrically referenced (electrically connected) to the:

A. engine
B. holding tank
C. railings
D. hull

40. USFWS safety policy requires that the voltage for "power control" (safety switch) circuits on electrofishing boats not exceed:

A. 0 volts
B. 24 volts
C. generator capacity (usually 240 volts)
D. control box transformer capacity (varies)

41. USFWS safety policy requires that personal flotation devices are worn during boat electrofishing:

A. at all times
B. only when operating in waters that are deep, high velocity, or turbid
C. at all times during which the air temperature is less than 90° F
D. only during active fish netting

42. A safety inspection of electrofishing equipment should occur:

A. before each day's use
B. when problems arise
C. before each field season
D. A & C

43. Electrofishing equipment is often noisy and the crews should be prepared to:

A. protect their hearing with ear plugs or ear phones
B. communicate with hand signals or headset communicators
C. not rely on voice commands in an emergency
D. all of the above

44. The types of accidents possible in an electrofishing operation include:

A. electrical shock
B. burns
C. falling on slippery surfaces
D. all of the above

45. Rubber gloves should be standard equipment for:

A. shore-based operations
B. boat operations
C. backpack operations
D. all of the above

46. USFWS safety policy requires the use of rubber insulating ("linemans") gloves:

A. True
B. False

47. Refueling should:

A. never be attempted with equipment operating
B. not be attempted until hot surfaces are allowed to cool
C. when on land, be conducted with portable gas containers placed on the ground
D. all of the above

48. Electrodes should never be handled with the generator running or the battery connected. In fact, a waiting period of 5 minutes should be observed after shut-down to allow the capacitors to self-discharge in the control box before handling electrodes:

A. True
B. False

49. Electrofishing should be terminated during:

A. an electrical storm
B. a heavy rain
C. a failure of any safety switch
D. all of the above

50. You are generating an applied power goal table for your district. You found that, for successful electrofishing on Reynolds Lake, the minimum power requirement was 4,525 $watts_{RMS}$ (242 V_{RMS} and 18.7 A_{RMS} readings taken from pulsator metering). Ambient water conductivity was 445 µS/cm. From the literature, you assumed that effective fish conductivity was 115 µS/cm. This information was used to calculate the applied power goal of 2,954 watts at "matched conditions". Determine the applied power goal for district waters having 250 µS/cm conductivity.

A. 2965 watts
B. 3197 watts
C. 3422 watts
D. 6125 watts