Short Answer Questions:

1. What happens to the current flowing through a resistor if its resistance is doubled, assuming the voltage remains constant?
    a. The current doubles
    b. The current halves [When the resistance of a resistor is doubled while the voltage remains constant, according to Ohm's Law (V = IR), the current flowing through the resistor halves.]
    c. The current quadruples
    d. The current remains the same

2. Which of the following is not a microcontroller?
    a. Arduino UNO
    b. ESP8266
    c. GPU [GPU stands for Graphics Processing Unit, which is not a microcontroller. GPUs are specialized electronic circuits designed to rapidly manipulate and alter memory to accelerate the creation of images in a frame buffer intended for output to a display device.]
    d. ATmega328

3. Which of the following statements is incorrect?
    a. The strength of the electrostatic force between 2 particles is proportional to product of their charges
    b. **The strength of the electrostatic force between 2 particles is proportional to the distance between them [FALSE - it should be inversely proportional]**
    c. Electromagnetism can be modeled by equations known as Maxwell equations
    d. There are 4 fundamental forces: the strong force, the weak force, the electromagnetic force and the gravitational force

4. Which of the following statements is incorrect?
    a. The prefix giga denotes a metric that is 10^3 times greater than the corresponding metric with the prefix mega
    b. The prefix mega denotes a metric that is 10^9 times greater than the corresponding metric with the prefix milli
    c. **The prefix tera denotes a metric that is 10^15 times greater than the corresponding metric with the prefix micro [FALSE it should be 10^18]**
    d. The prefix pico denotes a metric that is a 1000th times smaller than the corresponding metric with the prefix nano

5. Which of the following statements is incorrect?

- "Decision Trees" refers to a class of learning algorithms
- Using a training data set where each entry is represented by a collection of features and a label, it is possible to learn a classifier which, given a new entry with a set of features, will predict the label for that new entry
- **One risk when training Decision Trees is underfitting [FALSE: it should be "overfitting", namely building a decision tree that is overly specialized based on the specific data set used to train it]**
- As one travels down the branch of a decision tree, the entropy of the cases covered by the branch goes down

Long Answer Questions:

1. Explain the basic principles of transistor operation, including the functions of the emitter, base, and collector regions in both NPN and PNP transistor configurations.

Transistors are semiconductor devices that regulate the flow of electrical current, serving as amplifiers or switches in electronic circuits. In both NPN and PNP configurations, they consist of three regions: emitter, base, and collector, with the names derived from layers of positive and negative "doped" semiconductor material. NPN Transistors act as amplifiers. A small current applied to the base allows a larger current to flow between the collector and emitter. Reducing current on the base reduces the flow of current from collector to emitter. Eliminating current on the base stops the flow of current from collector to emitter. These transistors are primarily used as switches or relays, allowing a small current to control the flow of a larger current that cannot be directly handled.

Similarly, PNP transistors also act as amplifiers, allowing a small current on the base to control a larger current between the collector and emitter. Reducing current on the base reduces the flow of current from collector to emitter. They are used in the same way as NPN transistors for switching or relay purposes.

2. How do microcontrollers contribute to the implementation of IoT (Internet of Things) devices and smart systems? Provide a couple of examples in your answer.

Microcontrollers provide the computational power and control necessary to make IoT devices and smart systems intelligent and responsive to their environments, enabling them to gather data from sensors, process information, and execute tasks based on predefined logic. They automate processes, enhance efficiency, and improve user experiences.

For instance, in a smart home security system, a microcontroller can receive input from motion sensors or door/window sensors, analyze the data to determine if there's any suspicious activity, and trigger an alarm or send a notification to the homeowner's smartphone if an intrusion is detected.

Another example is in environmental monitoring applications, where microcontrollers can collect data from sensors measuring factors like temperature, humidity, air quality, or soil moisture. The microcontroller can then process this data, perform local analysis, and control actuators such as fans, heaters, or irrigation systems to maintain optimal environmental conditions.