Question 1:

Which of these arduino pin combinations are the most suitable for reading values from a potentiometer?

A) Ground, D6, 5V.

B) Ground, A0, 5V - The ground and 5V values are needed to provide power to the potentiometer, while an analogue pin (A0) is needed to read the range of voltages. Digital pins (D6) can only read high (5V) or low (0V) signals.

C) Ground, D6.

D) Ground, A0.

Question 2:

What is the purpose of a resistor in a basic arduino LED circuit?

A) To make the voltage more consistent.

B) To increase the brightness of the LED.

C) To change the color of the LED.

D) To decrease the current flowing through the LED - The current from an arduino is often higher than an LED can handle. Adding a resistor lowers the current flowing through the LED to an operating level.

Question 3:

What best describes the appearance of an ideal solder joint?

A) Rough and porous.

B) A smooth shiny cone - the smooth and shiny appearance indicates proper heating and solder application, ensuring good bonding. The cone shape suggests the optimal amount of solder, securing the component to the board.

C) A shiny ball.

D) Dull and speckled.

Question 4:

How many pins would a basic 4x4 LED Matrix have?

A) 4.

B) 8 – Each row of LEDs needs one pin for control, and each column needs one pin for control. With 4 rows and 4 columns, there's a total of 4 + 4 = 8 pins.

C) 16.

D) 32.

Question 5:

The voltage drop across a 500Ω resistor is 100V. What is the current through the resistor?

A) 200mA - rearranging V=IR, I=V/R=100/500=0.2A=200mA

B) 0.2mA

C) 500A

D) 5mA

Long Question 1)

Scott has accidentally spilled Coke Zero onto his 5V voltage regulator, and is trying to replace it with his spare parts:

- **A 180Ω resistor**
- **A rheostat (a variable resistor)**
- **A 9V battery**

He decides to construct a voltage divider circuit with the 180Ω resistor and rheostat.

a) To create a 5V drop over the rheostat, what resistance would he need to set it to? Show your calculations, and draw a diagram of the circuit.

To determine the voltage drop over the rheostat, we use R_1 as the 180Ω resistor, and R_2 as the rheostat. Rearranging the voltage divider equation for R_2:

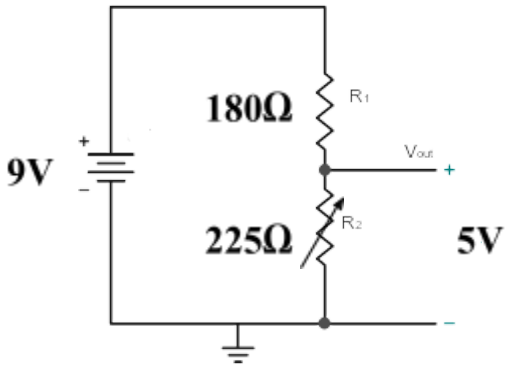
$$V_{out} = \frac{V_{in} R_2}{R_1 + R_2}$$

$$R_2 = \frac{V_{out} R_1}{V_{in} - V_{out}}$$

$$= \frac{5 \times 180}{9 - 5}$$

$$= 225$$

As such, the potentiometer would need to be set to 225Ω to get a voltage drop of 5V.



b) How will the performance of the voltage divider circuit you designed in part a) change as the battery drains, compared to a functioning 5V voltage regulator?

Unlike a voltage regulator, the output voltage of a voltage divider is directly proportional to the input voltage. This means as the 9V battery drains, its voltage will decrease, causing the output voltage across the rheostat to also decrease. This would lead to inconsistent power delivery to the rest of the circuit. Voltage regulators, on the other hand, are designed to actively maintain a constant output voltage, even as the input voltage varies within a specified range. Therefore, even if the 9V battery goes below 9V, a voltage regulator would still provide a stable 5V output.

Long Question 2)

Describe the behavior of a capacitor in the given situations, and provide an explanation for why the capacitor exhibits that behavior.

a) **Direct Current (DC)**
b) **High-frequency Alternating Current (AC)**
c) **Low-frequency Alternating Current (AC)**

a) When subjected to a direct current, a capacitor will initially act as a conductor, but quickly acts as an open circuit, blocking the current from passing. This is because initially, the current flows freely while the capacitor charges up. Once the capacitor is fully charged though, it resists further current flow. This means that the capacitor allows for initial charging but then blocks further current.

b) For high-frequency alternating current, a capacitor acts with very low resistance. This is due to the rapid changes in direction of the current causing the capacitor to not have enough time to significantly charge or discharge. With a low charge build-up, the capacitor presents minimal opposition and acts more like a short circuit (or low resistance) for high-frequency alternating current, letting the current through in either direction.

c) Under low-frequency alternating current, a capacitor acts with a high resistance, limiting the current. This is because the slower rate of current change allows the capacitor more time to charge before the direction of the current swaps. As the capacitor spends more time carrying higher charges, it slows the flow of current. This behavior makes the capacitor act as a higher resistance for low-frequency alternating current.