Solderless Breadboards

Power bus (red)
Ground bus (blue)
Component bus

Note that the two sides are not connected
Wiring Standards

When possible, use wire colors for different types of signals:

- Black: ground
- Red: power
- Other: various signals
Clean Wiring

A clean breadboard will make debugging easier – and it makes circuits more robust.
Care with Power

• Only insert components and wires into the breadboard when power is disconnected
• “Wire, check-twice, then power”
  – Never reverse power and ground (this is a very common mistake)
• Most chips that we will use expect +5V
  – More can destroy the chips
  – We will use DC/DC converters to step battery voltages down to +5V
Care of Chips

• Use insertion and extraction tools: never your fingers
• Minimize your contact with pins: static electricity can destroy a chip
• Use a wrist strap when you handle chips

www.a7vtroubleshooting.com

www.chantronics.com.au

www.hvwtech.com
TTL Chips: 2-Input AND Gates

Chip number: 7408

Pin 1 is marked on the chip

Power

Ground

www.dcs.warwick.ac.uk

www2.117.ne.jp
Wiring Procedure (Suggested)

• Power supply
• Power/ground buses
• Insert primary components
• Wire power/ground for components
• Add signals and remaining components
• Test incrementally
Debugging Techniques

• Multimeter:
  – Use *voltage mode* to check logic levels
  – Use *continuity mode* to confirm connections
    (but never with power turned on!)

• Oscilloscope:
  – View voltage as a function of time on 2 channels

• Test incrementally

• Test intermediate sub-circuits
A Basic Circuit

(Projects 2-4)
A Basic Circuit

• Connect through adapter to AVR ISP

• Do not reverse the pins!
A Basic Circuit

Extra LED allows you to see when a program is being downloaded.
A Basic Circuit

16 MHz crystal
• (generally optional)
• Without it, your processor will run at 1MHz (we want the 16MHz clock)
Lab Procedures

• No food or drink are allowed in the lab.

• Before leaving the lab, please be sure to clean up your workspace.

• Because some equipment may be in short supply, please coordinate with others who will need these resources.

• Never place dead components back into the stock (instead – place them in the ‘graveyard’).
Lab Procedures

• No equipment or supplies may leave the lab without the permission of the monitor.

• No books may leave the lab.

• Please clear all guests with the lab monitor.

• Unless you have prior permission, please do not handle the projects of other class members.
Lab Procedures

• Always check your wiring before you power up your circuit (especially your power and ground connections).

• When removing chips from breadboards, always use an appropriate tool (not your fingers!).

• If you break something, please report it (don't just put it away).

• You are expected to supply and configure your own laptop computers for project use.