1. Identify Your Wires & Pins

1.1 GA25-370 Motor w/ Encoder

- **Thick Red** – Motor Positive
- **Thick Black** – Motor Negative
- **Thin Blue** – Encoder VCC (5 V)
- **Thin White** – Encoder GND
- **Thin Yellow** – Encoder Channel A
- **Thin Green** – Encoder Channel B

1.2 L298 H-Bridge Module

(As labeled on the PCB)

- **Power 1 (Vss)** – Logic supply (5 V)
- **Power 2 (Vms)** – Motor supply (up to 12 V)
- **Ground** × 2 – All tied to common GND
- **Enable 1&2** – PWM input for Motor A
- **Input 1**, **Input 2** – Direction bits for Motor A
- **Output 1**, **Output 2** – Motor A terminals
- (The "3&4" side is unused)

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2. Prepare Your Breadboard & Power

1. **Breadboard rails**
    - Tie the **+ rail** to your **12 V supply +**.
    - Tie the **– rail** to the supply **ground**.
2. **Arduino power**
    - We'll power the L298 logic and encoder from Arduino's 5 V/ GND later.

3. Mount & Power the L298

3.1. Place the L298 so its pins straddle the gutter.
3.2. **Motor Supply**:

- Jumper **12 V rail → Power 2 (Vms)** on L298
  3.3. **Logic Supply & Ground**:
- Jumper **Arduino 5 V → Power 1 (Vss)** on L298
- Jumper **Arduino GND → any L298 GND** pin
- Jumper **breadboard GND rail → the other L298 GND**

4. Wire the Motor to L298

4.1. **Motor Positive (red) → L298 Output 1**
4.2. **Motor Negative (black) → L298 Output 2**

If direction is reversed in software, swap these two.

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5. Wire Control Signals (Arduino → L298)

L298 Pin	Arduino Pin	Role
Enable 1&2	D5 (PWM)	Speed control (PWM)
Input 1	D2	Direction bit 1
Input 2	D3	Direction bit 2

- Use male-female jumpers: Arduino D2 → L298 Input1, D3 → Input2, D5 → Enable1&2.

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6. Add Encoder Pull-Ups

6.1. Place **two 10 kΩ resistors** on the breadboard:

- One end of each into the **Arduino 5 V rail**.
- The other ends reserved for Channel A & B lines.

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7. Wire the Encoder (Motor → Arduino)

Encoder Wire	Connection
Blue (VCC)	Arduino **5 V**
White (GND)	Arduino **GND** (and breadboard GND rail)
Yellow (Channel A)	Breadboard node → Arduino **D8** + pull-up resistor to 5 V
Green (Channel B)	Breadboard node → Arduino **D9** + pull-up resistor to 5 V

- At each encoder-signal node, tie the resistor's free lead to 5 V so A/B idle HIGH.

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8. Common-Ground Check

8.1. Ensure **all grounds** are tied together:

- Arduino GND
- L298 GND pins
- Encoder GND
- 12 V supply ground

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9. Final Inspection & Power-Up

9.1. Visually verify no loose or shorted wires.
9.2. With a multimeter, check continuity between Arduino GND and breadboard GND.
9.3. Upload your Arduino sketch.
9.4. Power the 12 V supply — the motor should spin at the PWM duty you set.
9.5. Open Serial Monitor at 115200 baud to see `time,voltage,RPM` streaming.
