MechBase Starter Kit — BOM & Setup Guide

Target Age: 7+ | **Platform:** Raspberry Pi 4 + Technic-Compatible Parts | **Goal:** Build 4 progressive mechatronics projects

🛒 1. Electronics Order (~$60)

Item	Qty	Notes
Adafruit 16-Channel PWM + Dual Motor Driver HAT	1	I2C control, powers motors/servos directly from LiPo
TT Gear Motor (90 RPM, 6V)	2	High torque, shaft fits Technic hubs/axles
SG90 Micro Servo	1	For crane winch, sorting gate, or steering
HC-SR04 Ultrasonic Sensor	1	Distance sensing for obstacle avoidance
TCRT5000 IR Reflective Sensor	2	Line tracking & object detection
Limit Switch (Micro)	2	Teaches "machine knows when it's done"
LiPo Battery 7.4V 2200mAh (2S)	1	Powers the motors (separate rail)
2S LiPo Charger (1A)	1	Safe, regulated charging
Mini Breadboard + Jumper Wire Kit	1	M-M, M-F, F-F mixed pack

🧱 2. BrickLink BOM (Technic-Compatible)

*Search these exact part numbers on **bricklink.com** to build your cart. Covers all 4 projects.*

Part #	Qty	Description
`6041`	2	Plate 32 × 32 (Car chassis & crane base)
`32064`	4	Beam 1 × 4
`32065`	4	Beam 1 × 6
`32066`	4	Beam 1 × 8
`32067`	4	Beam 1 × 10
`32436`	6	L Bracket (Motor & sensor mounts)
`32452`	4	T Bracket
`32001`	4	Axle 3L (Notched)

32002	6	Axle 4L (Smooth)
32013	2	Axle 7L (Smooth)
32014	2	Axle 10L (Smooth)
32043	10	Bushing 1/2" (Holds wheels to axles)
41676	2	Gear 12 Tooth
41677	2	Gear 20 Tooth
41678	2	Gear 40 Tooth
32202	2	Bevel Gear 12 Tooth
41679	4	Tire 1.25" (16x20)
41680	4	Rim 1.25" (16x20)

🔌 3. Wiring Map (Pi 4 + Adafruit HAT)

> **Power Architecture:** Plug the HAT directly onto the Pi 4 GPIO pins. Connect the 7.4V LiPo to the HAT `VIN` & `GND` terminals. The HAT powers the motors AND feeds 5V back to the Pi. Keep a separate USB-C power bank handy for initial boot/testing if needed.

- **DC Motors:** Plug TT Motor 1 into `M1` and Motor 2 into `M2` on the HAT.
- **Servo:** Plug SG90 servo into `PWM 0` on the HAT.
- **HC-SR04:** `VCC`(5V), `GND`, `Trig`(GPIO 17), `Echo`(GPIO 18).
- **IR Sensors:** `VCC`(5V), `GND`, `OUT`(GPIO 27 & 22).
- **Limit Switches:** `GND` & `NO` to `GND` & GPIO 23/24.

💻 4. Software Setup (Pi 4)

Step 1: Install Dependencies

```
sudo apt update && sudo apt install -y pigpio python3-pip
sudo systemctl enable pigpio
pip3 install flask gpiozero adafruit-circuitpython-motorkeeper adafruit-blinka
```

Step 2: Project Structure

Create the folder and files on your Pi:

```
mkdir ~/mechkit && cd ~/mechkit
# Create files: motors.py | sensors.py | logic.py | app.py
```

(Full code provided separately. Run `python3 app.py` to start the web dashboard on `http://<YOUR_PI_IP>:5000`)

🚀 5. Project Progression

#	Project	Concepts Learned
1	Rolling Chassis	Circuits, motor control, forward/reverse logic
2	Winch Crane	Servo control, limit switches, "machine knows when done"
3	Sorting Gate	IR sensing, IF/THEN logic, automated response
4	Obstacle Avoider	Ultrasonic distance, continuous feedback loops