H01 Safety and Lab Practice

Student worksheet | Protected low-voltage circuits

Technology Commons

2026-10-04

Student: _____ **Date:** _____ **Class:** _____

Required: Questions 1 to 5. Optional Level 4 evidence: Questions 6 to 10. Calculate before simulation or building. Use protected extra-low voltage only.

Document role: This worksheet contains calculations, predictions, schematic work, and written reasoning. Use the separate Tinkercad guide for simulator construction and screenshots, and the lab handout for physical equipment, procedure, faults, and cleanup.

Evidence cycle: Predict, calculate using GUESS, draw, verify, build where approved, compare, diagnose, and reflect.

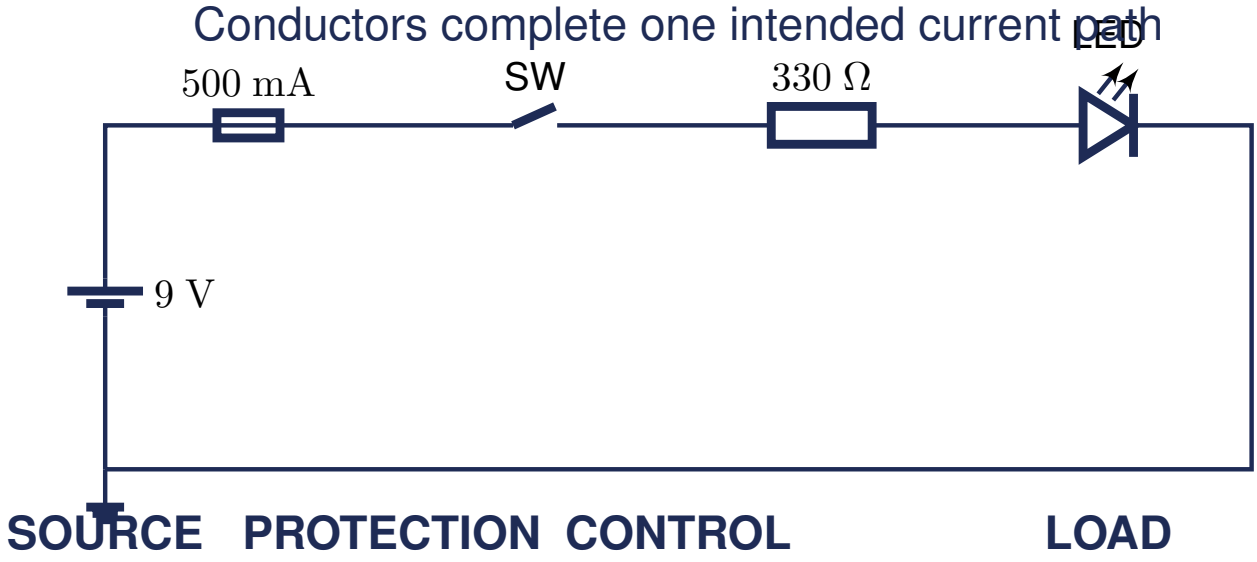


Figure 1: A protected low-voltage series circuit with source, fuse, switch, resistor, and LED.

Question 1: Predict LED current

Required | GUESS hand calculation Context: A 9.0 V battery supplies a red LED with $V_F = 2.0$ V through $330\ \Omega$.

Given	Symbol	Value	Unit
Source voltage	V_S	9.0	V
LED forward voltage	V_F	2.0	V
Series resistance	R	330	Ω

Unknowns: LED current I, resistor power P_R, and whether a 0.25 W resistor is acceptable. **Precision:** Two significant figures. Use a sensible metric prefix. **Calculator expectation:** Enter $(V_S - V_F)/R$, then reuse Ans for I^2R. **Tinkercad:** Calculate first; verification is Question 2.

Final answer: _____

Front photo submission	Back photo submission
Clear, upright, complete.	Submit even if blank.

Question 2: Verify the protected circuit

Required | Tinkercad verification Context: Recreate the H01 source, switch, 500 mA fuse, $330\ \Omega$ resistor, and LED.

Record	Calculated	Simulated	Percent difference
LED current			
Resistor voltage			
LED voltage			

Meter rules: Ammeter in series; voltmeter in parallel. **Unknowns:** Readings, percent difference, one discrepancy, and one limitation. **Calculator expectation:** Show the percent-difference entry. **Tinkercad requirement:** Include a screenshot showing meter placement and component values.

Screenshot or share link: _____

Front photo submission	Back photo submission
Calculation and comparison.	Submit even if blank.

Question 3: Source, protection, control, and load

Required | Circuit anatomy Context: Compare a USB power bank circuit with a vehicle fuse-panel branch.

Label the source, conductors, control, protection, and load on the H01 schematic. Explain why the fuse belongs close to the source. Calculate normal current for a 12.0 V, 2.2 W lamp, then select the smallest listed fuse above normal current from 0.10, 0.25, 0.50, and 1.0 A when the wire is rated for 1.0 A.

Unknowns: Lamp current, selected fuse, and two-sentence justification. **Precision:** Two significant figures. **Calculator expectation:** Show $I = P/V$. **Tinkercad:** No destructive short test.

Final answer: _____

Front photo submission	Back photo submission
Labelled diagram and GUESS.	Submit even if blank.

Question 4: Place the meters correctly

Required | Measurement planning Context: You need the LED voltage and total circuit current before a physical build.

Draw a voltmeter across the LED and an ammeter in the main series path. State the lead jacks, meter functions, starting ranges, and power state for each measurement. Explain why resistance and continuity measurements require power off.

Measurement	Connection	Power state	Expected magnitude
LED voltage			
Total current			
Resistor resistance			

Calculator expectation: Record the expected values from Questions 1 and 2. **Tinkercad:** Optional meter-placement rehearsal.

Final answer: _____

Front photo submission	Back photo submission
Meter sketch and table.	Submit even if blank.

Question 5: Diagnose an open switch

Required | Troubleshooting Context: The LED is off even though the 9.0 V source is present.

Predict total current, voltage across the open switch, and voltage across the resistor when the switch is open. Give a safe sequence that distinguishes an open switch from a dead source.

Unknowns: Three predicted readings and a safe diagnostic sequence. **Precision:** Two significant figures. **Calculator expectation:** No calculator is needed for zero-current voltage drop; explain the physics. **Tinkercad:** Verify only after writing the predictions.

Final answer: _____

Front photo submission	Back photo submission
Predictions and diagnosis.	Submit even if blank.

Question 6: Hazard hunt redesign

Optional Level 4 | Design Identify at least six hazards in a proposed bench setup with loose metal, long stripped wires, no current limit, an unprotected source, a damaged lead, food beside the circuit, and a charged capacitor. Redesign the setup and justify the order of controls.

Required evidence: Hazard, consequence, control, and verification table. **Calculator expectation:** None. **Tinkercad:** State why a simulation cannot prove physical bench safety.

Front photo submission	Back photo submission
Hazard table and redesign.	Submit even if blank.

Question 7: Blade-fuse cutaway

Optional Level 4 | Internal view and explanation

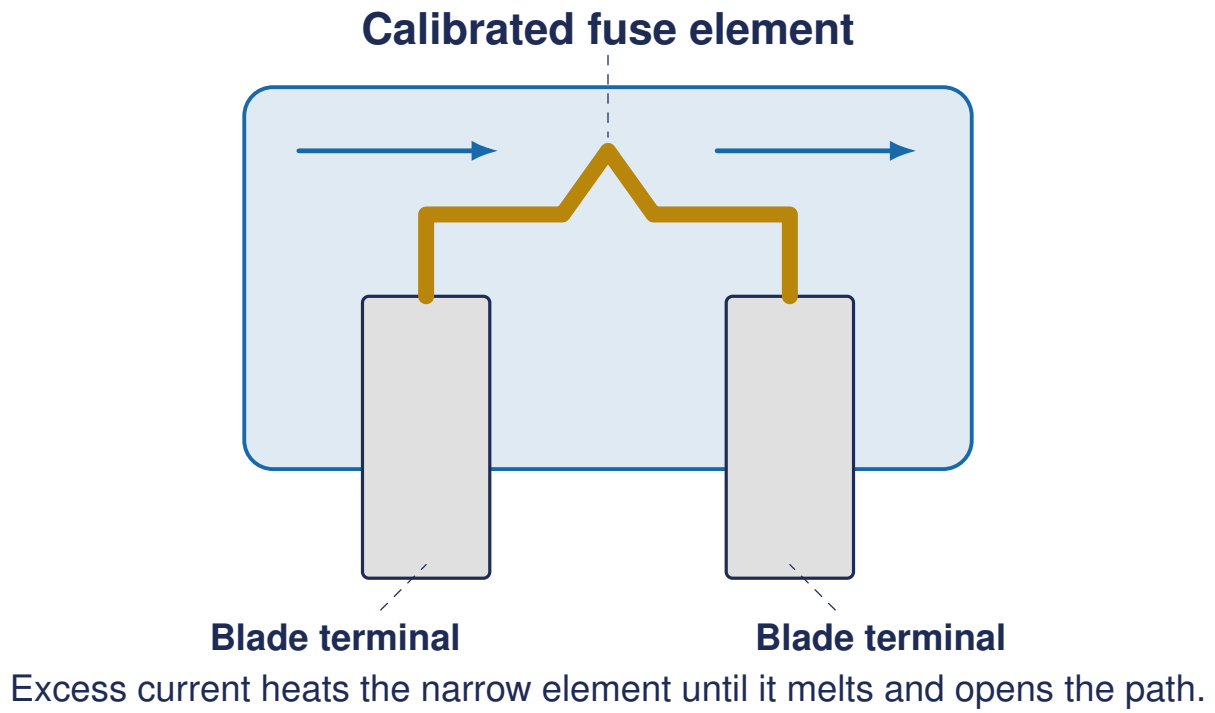


Figure 2: Simplified automotive blade fuse cutaway.

Explain how the narrow element changes an overload into an open circuit. Distinguish a blown fuse as evidence from the root cause of the fault. Compare fuse replacement with bypassing the fuse.

Unknowns: Energy pathway, protection action, and safe next step. **Calculator expectation:** None. **Tinkercad:** Do not simulate destructive heating.

Front photo submission	Back photo submission
Explanation and labels.	Submit even if blank.

Question 8: USB power-bank transfer

Optional Level 4 | Transfer A power bank is labelled 5.0 V, 2.0 A maximum. A load requests 7.5 W. Calculate requested current and decide whether the rating is exceeded. Explain why rated maximum current is not a promise that every cable and connector is safe at that current.

Unknowns: Requested current and justified decision. **Precision:** Two significant figures. **Calculator expectation:** Show $I = P/V$. **Tinkercad:** Optional current-limit model.

Front photo submission	Back photo submission
GUESS and decision.	Submit even if blank.

Question 9: Wrong meter jack

Optional Level 4 | Troubleshooting and prevention A student measures voltage while the red lead remains in the high-current jack. Describe the risk, stop-work response, inspection, correct setup, and a habit that prevents recurrence. Add a pre-measurement checklist that another student can follow.

Unknowns: Root cause, safe response, and prevention. **Calculator expectation:** None. **Tinkercad:** Explain why virtual meters may not reproduce real fuse, lead, and arc hazards.

Front photo submission	Back photo submission
Diagnosis and checklist.	Submit even if blank.

Question 10: Safety case and reflection

Optional Level 4 | Justification and reflection Create a one-page safety case for a low-voltage bicycle-light prototype. Include source limits, conductor and connector checks, control, protection, load ratings, meter plan, stop conditions, emergency response, simulation limits, and one lesson learned from troubleshooting.

Unknowns: A coherent, evidence-based safety argument. **Calculator expectation:** Include at least one rating calculation if your design uses numerical values. **Tinkercad:** Include one verification and one limitation.

Front photo submission	Back photo submission
Safety case.	Submit even if blank.

Common assessment rubric

Category	Level 1	Level 2	Level 3	Level 4
Mathematical reasoning and GUESS	limited setup or unit use	partly correct method	correct method and units	precise, efficient reasoning with independent checks
Schematic quality and conventions	major symbol or connection errors	mostly readable with some errors	correct, labelled, and readable	exceptionally clear with purposeful layout and complete references
Simulation or verification evidence	limited or incomplete evidence	some valid evidence and comparison	complete evidence with comparison	well-chosen evidence that tests assumptions and limitations
Physical construction and safe practice	frequent prompting required	generally safe with some prompting	safe, organized, and approved work	consistently anticipates hazards and supports team safety
Testing and troubleshooting	guesses without a test plan	partial plan using some evidence	logical tests identify the likely cause	efficient tests distinguish alternatives and verify the repair

Category	Level 1	Level 2	Level 3	Level 4
Design decisions	choice has limited justification	some criteria support the choice	clear criteria and trade-offs support the choice	constraints, evidence, and iteration produce a strong decision
Documentation and communication	incomplete or difficult to follow	understandable with gaps	clear tables, labels, results, and conclusion	concise, polished communication makes the evidence easy to audit

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