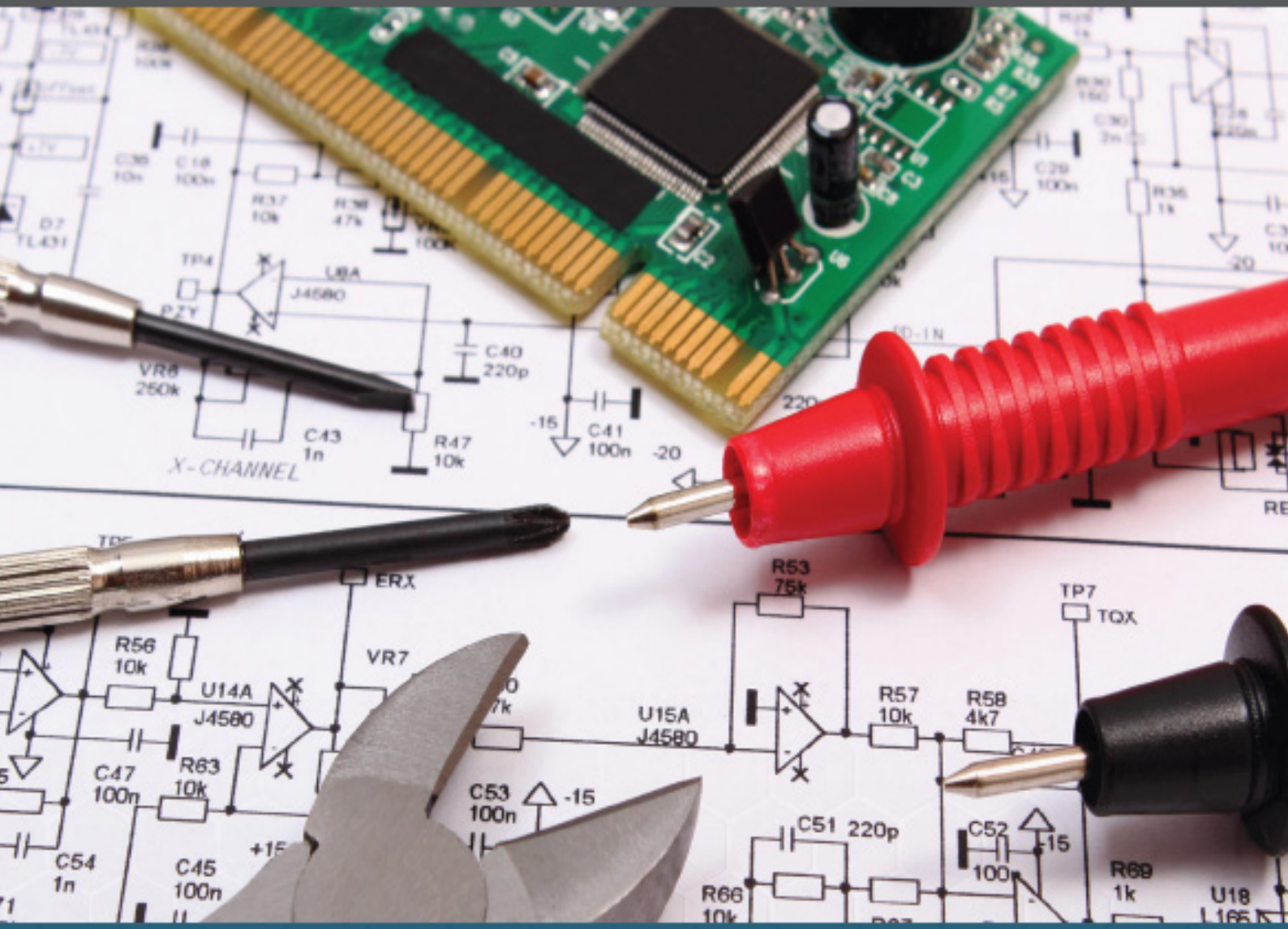


STUDENT RECORD BOOK

CP3878 - Electrical Essentials

Inspiring The Next Generation Of Engineers

www.matrixtsl.com

Contents

Student Record Book

Use this booklet alongside the worksheet diagrams and practical instructions. Record every measurement before carrying out calculations, and write clear answers to each question. Where a table has more rows than you need, leave the spare rows blank.

Student name	
Group / class	
Course / unit	
Teacher / assessor	
Academic year	

Course target / personal learning goal:

Practical safety and measurement rules

- Switch the power supply is removed before rebuilding a circuit or moving an ammeter connection.
- Measure voltage in parallel with a component or supply.
- Measure current by breaking the circuit and inserting the meter in series.
- Never connect an ammeter directly across a power supply.
- Measure resistance only when the component or circuit is disconnected from the power supply.
- Begin current measurements on the highest suitable range unless instructed otherwise.
- Check polarity on LEDs, diodes and electrolytic capacitors before applying power.
- Discharge capacitors before rebuilding or repeating timing measurements.
- Report hot components, damaged leads, blown meter fuses or unexpected results to your teacher.

Meter setup check

Measurement	Meter mode	Meter connection	Initial range
DC voltage	V DC	Parallel	Above expected voltage
AC voltage	V AC	Parallel	Above expected RMS voltage
DC current	A DC	Series	Start high; correct socket
AC current	A AC	Series	Start high; correct socket
Resistance	Ohm/resistance	Across isolated component	Does not matter but ensure that the power is disconnected

WORKSHEETS

WORKSHEETS

Worksheet 1 - Understand Concepts of Voltage, Current and Power

Learning objective: Observe simple lamp circuits and relate brightness, current, voltage and power.

Lamp circuit observations

Circuit	Bulb arrangement / description	Brightness of each bulb	What happened when one bulb was removed?	Power use: high/medium/low
A	Single bulb			
B	Two bulbs in series			
C	Two bulbs in parallel			

Which circuit appears to use the most power? Explain why.

Which circuit appears to use the least power? Explain your choice.

If the circuits were powered by batteries, which battery would last longest and which would go flat first?

For the circuits with two bulbs, what did removing one bulb show about the way the circuit is connected?

Think of real examples that resemble each circuit arrangement. What are the advantages and disadvantages of each?

Purpose: Investigate toggle and push switches in various arrangements.

Circuit A Observations: -

Circuit B

Toggle Switch	Push Switch	Lamp
Open	Open	
Open	Closed	
Closed	Open	
Closed	Closed	

Circuit C

Toggle Switch	Push Switch	Lamp
Open	Open	
Open	Closed	
Closed	Open	
Closed	Closed	

WORKSHEETS

Worksheet 3 - Measuring Voltage

Learning objective: Use a multimeter to measure DC voltage in various circuits.

Circuit A. Voltage across bulb.

Circuit B. Voltage readings:

Measurement	Reading (V DC)
Top Bulb, Points 1 & 2	
Middle Bulb, Point 2 & 3	
Bottom Bulb, Points 3 & 4	
Total of all three bulbs	
Power supply, Points 5 & 6	

Notes

Circuit C. Voltage readings:

Measurement	Reading (V DC)
Left Bulb, Points 1 & 2	
Middle Bulb, Point 3 & 4	
Right Bulb, Points 5 & 6	
Power supply, Points 7 & 8	

Notes

Circuit D. Voltage readings:

Measurement	Reading (V DC)
Left Bulb, Points 1 & 2	
Top Bulb, Point 3 & 4	
Bottom Bulb, Points 4 & 5	
Total of Top & Bottom Bulbs	
Power supply, Points 6 & 7	

Notes

Worksheet 4 - Measuring Current

Learning objective: Use a multimeter as an ammeter and record current in series, parallel and mixed lamp circuits.

Circuit A. Single-lamp circuit

Measurement point / link removed	Current / A DC
First link position	
Second link position	

Does the current reading change when the ammeter is inserted at another point in the same simple circuit?

_____

_____

What connection gives a negative sign in the reading? Explain why.

_____

_____

Circuit B. Series lamp circuit current readings

Point	Current / A DC
P	
Q	
R	
S	

What do you notice about all the current readings in the series circuit?

_____

_____

Circuit C. Parallel lamp circuit current readings

Point	Current / A DC
P	
Q	
R	
S	
T (Predicted)	
T (Measured)	

What relationship is shown between the current at point T and the other measurements?

Circuit D. Mixed series/parallel current readings

Point	Current (A or mA DC)	Notes
P		
Q		
R		
S		
T		

Explain why the current readings at points P and T are equal.

Explain why the current readings at points Q and S are equal. What does this imply for the brightness of the two bulbs between these points?

Compare these readings with the current at point R. What does this mean for the brightness of the bulb above it?

Worksheet 5 - Understand Resistance and Apply Ohm's Law

Learning objective: Measure voltage and current for resistors, plot the relationship and understand Ohm's law.

100 ohm resistor: voltage and current readings

Target voltage across resistor	Actual voltage (V)	Current (A)
0.2 V		
0.4 V		
0.6 V		
0.8 V		
1.0 V		
1.2 V		
1.4 V		
1.6 V		
1.8 V		
2.0 V		

270 ohm resistor: voltage and current readings

Target voltage across resistor	Actual voltage (V)	Current (A)
0.2 V		
0.4 V		
0.6 V		
0.8 V		
1.0 V		
1.2 V		
1.4 V		
1.6 V		
1.8 V		
2.0 V		

560 ohm resistor: voltage and current readings

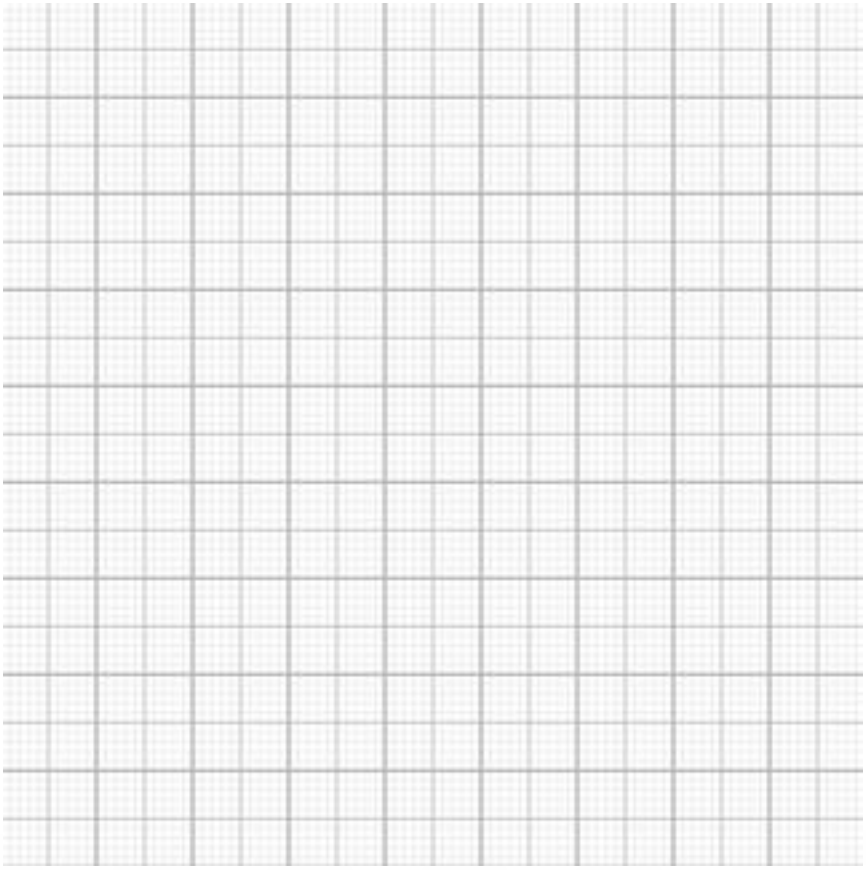
Target voltage across resistor	Actual voltage (V)	Current (A)
0.2 V		
0.4 V		
0.6 V		
0.8 V		
1.0 V		
1.2 V		
1.4 V		
1.6 V		
1.8 V		
2.0 V		

Resistance from graph slope

Component	Slope of graph (V/I)
100 ohm resistor	
270 ohm resistor	
560 ohm resistor	

What relationship did you find between voltage and current for each resistor?

Graph space / notes: plot current against voltage for the resistors, lamp and LED.



Challenge: non-ohmic components

Target voltage across lamp	Actual voltage (V)	Current (A)
0.5 V		
1.0 V		
1.5 V		
2.0 V		
2.5 V		
3.0 V		
3.5 V		
4.0 V		
4.5 V		
5.0 V		

Target voltage across lamp	Actual voltage (V)	Current (A)
0.5 V		
1.0 V		
1.5 V		
2.0 V		
2.5 V		
3.0 V		
3.5 V		
4.0 V		
4.5 V		
5.0 V		

Describe the shape of the graph for the lamp and LED.

What happens if you use volts, milliamps and kilo-ohms in Ohm's law? Explain why.

Learning objective: Use a multimeter as an ohmmeter and compare direct resistance measurements with values found experimentally.

Resistance measurements

Component	Printed / nominal value	Experimental value from Worksheet 5	Multimeter reading
100 ohm resistor			
270 ohm resistor			
560 ohm resistor			
Lamp			

What do you notice when comparing the printed value, experimental value and multimeter reading?

Why might it be useful to measure the resistance of a non-ohmic component such as a lamp?

Challenge: Resistors in series measured with an ohmmeter

Combination	Predicted resistance	Measured resistance
100 ohm + 270 ohm		
100 ohm + 560 ohm		
270 ohm + 560 ohm		
100 ohm + 270 ohm + 560 ohm		

WORKSHEETS

Worksheet 7 - Series and Parallel Circuits

Learning objective: Measure voltage, current and power in series and parallel resistor circuits.

Series circuit: voltage, current and power

Item	Voltage (V)	Calculated current (mA)	Measured current (mA)	Power (mW)
Power Supply (Total)				
100 ohm resistor				
270 ohm resistor				
560 ohm resistor				

What do you notice about the calculated current through each resistor in the series circuit?

Does it make a difference where the ammeter is placed in the series circuit?

What happened when one resistor was removed? Did it matter which resistor was removed?

Did swapping the positions of components affect the current or the voltage across each resistor?

Resistor combination	Total voltage (V)	Total resistance (ohm)	Calculated current (mA)	Measured current (mA)
100 ohm + 270 ohm				
100 ohm + 560 ohm				
270 ohm + 560 ohm				
100 ohm + 270 ohm + 560 ohm				

Write a general rule for resistors connected in series.

Parallel circuit: voltage, current and power

Item	Resistor	Voltage (V)	Current (mA)	Power (mW)
Supply / total				
100 ohm branch	100Ω			
270 ohm branch	270Ω			
560 ohm branch	560Ω			

What do you notice about the total current compared with the branch currents?

What happened to the total current when one resistor branch was removed?

Parallel challenge: equivalent resistance

Combination	Measured total current	Calculated equivalent resistance	Measured resistance with power removed
100 ohm || 270 ohm			
100 ohm || 560 ohm			
270 ohm || 560 ohm			
100 ohm || 270 ohm || 560 ohm			

Can you find a general rule for resistors connected in parallel?

Worksheet 8 - Kirchoff's Laws

Learning objective: Use measured currents and voltages to check Kirchhoff's current law and voltage law.

Kirchhoff's current law: node readings

Current	Direction, positive or negative	Measured value (mA)
I1		
I2		
I3		
	Sum:	

Do the signed currents add up to zero? Explain any small difference.

Challenge: four-connection node

Current	Direction, positive or negative	Measured value (mA)
I1		
I2		
I3		
I4		
	Sum:	

Kirchhoff's current law: node readings

Voltages	Loop 1	Loop 2	Loop 3
Voltage 1 (V)			
Voltage 2 (V)			
Voltage 3 (V)			
Sum:			

Notes:

Challenge: LED carrier voltage deduction

Measurement / calculation	Value
Supply voltage / V	
Circuit current/ mA	
Series resistor value in LED carrier	470Ω

Measurement / calculation	Value
Calculated voltage across series resistor / V	
Calculated LED voltage / V	

Describe how you used Ohm's law and Kirchhoff's voltage law to deduce the LED voltage.

WORKSHEETS

Worksheet 9 - AC Versus DC

Learning objective: Compare direct current with alternating current and use RMS voltage when comparing lamp brightness.

Reversing the DC supply

Currents at a node: -

Current	Direction, positive or negative	Measured value (mA)	Value from previous worksheet (mA)
I1			
I2			
I3			
	Sum:		

Kirchhoff's voltage law: loop readings

Voltages	Loop	Value from previous worksheet
Voltage 1 (V)		
Voltage 2 (V)		
Voltage 3 (V)		
Sum:		

Power dissipated by 100Ω resistor

Measurement	This experiment	Previous worksheet
Voltage across resistor		
Current through resistor		
Power dissipated		

What is the effect of reversing the DC power supply?

Can you tell, just by looking at a lamp, which way round the DC power supply is connected? What about an LED?

AC and DC lamp comparison

Measurement / observation	Value / comment
AC voltage across right-hand lamp (RMS)	
DC voltage across left-hand lamp	
Do they appear equally bright?	

Challenge: What DC voltage makes the LED appear as bright as the AC power supply?

WORKSHEETS

Worksheet 10 - AC Behaviour of Resistors

Learning objective: Check Ohm's law and Kirchhoff's laws in AC resistor circuits.

AC measurements for 100 ohm resistor

Measurement	AC voltage (V RMS)	AC current (mA RMS)	Peak voltage (challenge)	Peak current (challenge)
1				
2				
3				
4				
5				
6				

AC measurements for 270 ohm resistor

Measurement	AC voltage (V RMS)	AC current (mA RMS)	Peak voltage (challenge)	Peak current (challenge)
1				
2				
3				
4				
5				
6				

DC positive and negative measurements for 100 ohm resistor

	Power Supply Positive		Power Supply Negative	
Measurement	Voltage (V DC)	Current (mA DC)	Voltage (V DC)	Current (mA DC)
1				
2				
3				
4				
5				
6				

DC positive and negative measurements for 270 ohm resistor

	Power Supply Positive		Power Supply Negative	
Measurement	Voltage (V DC)	Current (mA DC)	Voltage (V DC)	Current (mA DC)
1				
2				
3				
4				
5				
6				

What does your graph show about applying Ohm's law to positive, negative and AC voltages?

Graph space / notes: plot AC and DC current against voltage, continuing the line through zero.

AC Kirchhoff current law check at node N

Current	RMS measurement (mA)	Sign taken from equivalent DC circuit	Signed value (mA)
I1			
I2			
I3			
		Sum:	

AC Kirchhoff current law check at node N

Voltage	RMS measurement (V)	Sign taken from equivalent DC circuit	Signed value (V)
V1			
V2			
V3			
		Sum:	

Compare these results with the DC Kirchhoff activity. What do you notice?

WORKSHEETS

Worksheet 11 - Combinations of Resistors

Learning objective: Find the equivalent resistance of series, parallel and mixed resistor networks.

Series resistor combination

Measurement / calculation	Value
100Ω resistor measured resistance	
270 Ω resistor measured resistance	
560 Ω resistor measured resistance	
Total resistance measured between A and B	
Circuit voltage between A and B	
Circuit current	
Total resistance calculated from V/I	

How does the V/I resistance compare with the ohmmeter resistance?

_____

_____

Did changing the order of the resistors make any difference?

_____

_____

Series challenge combinations

Combination	Calculated total resistance	Measured total resistance
Two resistors		
Four or more resistors		

Parallel resitor combination

Measurement / calculation	Value	Units
100Ω resistor measured resistance		ohm
270Ω resistor measured resistance		ohm
560Ω resistor measured resistance		ohm
Total resistance measured between A and B		ohm
Circuit voltage between A and B		V
Total current from power supply		mA
Current in 100Ω resistor		mA
Current in 270 Ω resistor		mA
Current in 560 Ω resistor		mA
Total resistance calculated from V/I		ohm

Do the branch currents add up to the total current?

Did changing the order of the resistors make any difference?

Mixed series/parallel circuit

Part of circuit	Calculated resistance (ohm)	Measured resistance (ohm)
Series combination		
Parallel combination		
Total circuit		

WORKSHEETS

Worksheet 12 - Voltage Dividers

Learning objective: Calculate and measure voltage divider outputs and investigate the effect of loading the output.

Basic voltage divider with R1 = 100 ohm

R2 value	Measured R2	Total resistance	Supply voltage	Calculated current	Measured current	Calculated V2	Measured V2
560 Ω				3 V			
				6 V			
				12 V			
270 Ω				3 V			
				6 V			
				12 V			

Thermistor voltage divider challenge

What happens to the output voltage as the thermistor is heated?

_____

_____

Phototransistor voltage divider challenge

Condition	Output voltage (V)
Covered / Dark	
Room lighting	
Bright light shone at it	

What happens to the output voltage as the phototransistor is covered and then lit?

_____

_____

Loaded voltage divider with lamp

Measurement	Value
Voltage across lamp with lamp connected	
Current through lamp	
Voltage at divider output with lamp removed	

Why does connecting the lamp change the output voltage of the divider?

Challenge: variable resistor equivalent circuit

Measurement	Value
Current through lamp matched to previous activity	
Voltage across lamp	
Measured resistance of variable resistor	

Could you tell which circuit was inside a hidden box by measuring only the lamp voltage and current? Explain.

WORKSHEETS

Worksheet 13 - Potentiometers

Learning objective: Measure a potentiometer and compare its use as a variable resistor, voltage divider and fixed resistor.

Potentiometer resistance measurements

Control knob position	Resistance A-C (ohm)	Resistance B-C (ohm)
Fully anti-clockwise		
1/4 turn		
Half-way		
3/4 turn		
Fully clockwise		

Does the resistance between A and B change as the control knob is turned?

_____

_____

Circuit A: Potentiometer as variable resistor

Control knob position	Voltage across lamp (V)
Fully anti-clockwise	
1/4 turn	
Half-way	
3/4 turn	
Fully clockwise	

Circuit B: Potentiometer as voltage divider

Control knob position	Voltage across lamp (V)
Fully anti-clockwise	
1/4 turn	
Half-way	
3/4 turn	
Fully clockwise	

Circuit C: End connections

Control knob position	Voltage across lamp (V)
Fully anti-clockwise	
1/4 turn	
Half-way	
3/4 turn	
Fully clockwise	

Does rotating the control knob have any effect in Circuit C? Explain why.

Challenge: replacing 250 ohm potentiometer with 10k ohm potentiometer

Circuit A: Potentiometer as variable resistor

Control knob position	Voltage across lamp (V)
Fully anti-clockwise	
1/4 turn	
Half-way	
3/4 turn	
Fully clockwise	

Circuit B: Potentiometer as voltage divider

Control knob position	Voltage across lamp (V)
Fully anti-clockwise	
1/4 turn	
Half-way	
3/4 turn	
Fully clockwise	

Circuit C: End connections

Control knob position	Voltage across lamp (V)
Fully anti-clockwise	
1/4 turn	
Half-way	
3/4 turn	
Fully clockwise	

Which arrangement and potentiometer value is best for controlling lamp brightness? Explain.

WORKSHEETS

Worksheet 14 - Capacitor Charge and Discharge

Learning objective: Time capacitor charging and discharging, then relate the results to capacitance, resistance and time constant.

Quick capacitor charge/discharge observations

Capacitor value	Time to reach 4 V	LED lit time / observation
22000 microfarad		
4700 microfarad		
33 microfarad		

What effect does the value of the capacitor have on charging time and LED discharge time?

_____

_____

Detailed charge measurements

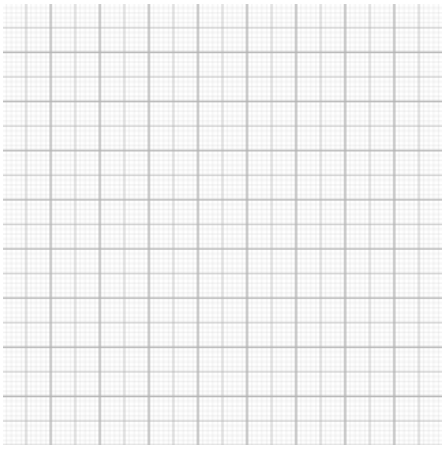
Resistor measurement: _____

Time (s)	Capacitor voltage (V)	Current measured or calculated (mA)
0		
30		
60		
90		
120		
150		
180		
210		
240		
270		
300		
330		
360		
390		
420		
450		
480		
510		
540		
570		
600		

Detailed discharge measurements

Time after shorting link fitted (s)	Capacitor voltage (V)	Current measured or calculated (mA)
0		
30		
60		
90		
120		
150		
180		
210		
240		
270		
300		
330		
360		
390		
420		
450		
480		
510		
540		
570		
600		

Graph space / notes: plot capacitor voltage and current against time for charging and discharging.



Time constant challenge

Capacitor value	Calculated time constant (s)	Measured time to 4 V (s)	Difference / comment
22000 microfarad			
4700 microfarad			
33 microfarad			
Other capacitor / resistor combination			

Worksheet 15 - Capacitors in AC Circuits

Learning objective: Measure AC voltage and current in a capacitor circuit and calculate capacitive reactance.

AC capacitor measurements

Quantity	Measured value
AC voltage across capacitor (V rms)	
AC current in circuit (mA rms)	
Frequency (Hz)	

AC capacitor measurements

Method	Reactance (ohms)
Using Xc = V/I	
Using Xc = 1/(2*pi*f*C)	

Do the two reactance values agree? Comment on any difference.

Learning objective: Measure a series RC circuit and use phase relationship to explain voltage and impedance measurements.

Series RC measurements

Quantity	Measurement
Voltage across resistor V_R (V RMS)	
Voltage across capacitor V_C (V RMS)	
Total voltage from AC inverter V_S (V RMS)	
Circuit current (mA RMS)	

Series RC calculations

Quantity	Measurement
Resistance, R = VR/I (Ω)	
Capacitive reactance, XC = VC/I (Ω)	
Equivalent resistance, Z = V total/I (Ω)	
Circuit current (mA RMS)	

Series RC calculations

Calculation	Working	Result
Pythagoras voltage: $\sqrt{(VR^2 + VC^2)}$		
Pythagoras impedance: $\sqrt{(R^2 + XC^2)}$		

WORKSHEETS

Worksheet 17 - Capacitor and Resistor in Parallel

Learning objective: Measure a parallel RC circuit and compare branch currents with total current.

Parallel RC measurements

Quantity	Measurement
AC inverter output voltage, V_S (V RMS)	
Total current supplied by AC inverter, I_S (mA RMS)	
Current in resistor branch, I_R (mA RMS)	
Current in capacitor branch, I_C (mA RMS)	

Parallel RC calculations

Calculation	Working	Result
Resistance R = V/IR (Ω)		
Capacitive reactance $X_C = V/I_C$ (Ω)		
Combined impedance $Z = V_S/I_S$ (Ω)		
Pythagoras Current $\sqrt{(I_R^2 + I_C^2)}$ (mA RMS)		
Pythagoras impedance		
$1 / \sqrt{(R^{-2} + XC^{-2})}$ (Ω)		

Do the branch currents add directly to the total current? Explain using phase difference.

Learning objective: Compare the DC and AC behaviour of capacitors and inductors.

Resistance-mode checks

Component	Resistance reading (Ω)
33 µF capacitor	
200 mH inductor	

DC circuit measurements

Component	Voltage (V DC)	Current (mA DC)	Calculated DC resistance (Ω)
Inductor			
Capacitor			

Is it possible to calculate a DC resistance for the capacitor? Explain.

DC circuit measurements

Component	Voltage (V RMS)	Current (mA RMS)	Calculated Reactance (Ω)
Inductor			
Capacitor			

Compare the AC and DC behaviour of the capacitor and inductor.

WORKSHEETS

Worksheet 19 - Inductor and Resistor in Series

Learning objective: Measure a series LR circuit and account for the resistance of a real inductor.

Series LR measurements

Quantity	Value
DC resistance of resistor, R (Ω)	
DC resistance of inductor, R_L (Ω)	
Voltage across resistor, V_R (V RMS)	
Voltage across inductor, V_L (V RMS)	
Circuit current, $I = V_R / R$	
Inductor impedance, $Z_L = V_L / I$	
Inductor reactance $X_L = \sqrt{(Z_L^2 - R_L^2)}$	

Learning objective: Observe the magnetic field produced by current in a wire and in a coil with different cores.

Single wire and compass observations

What happens when the single wire comes close to the compass?

What is the effect of making a loop?

How does adding another turn change the effect on the compass?

Challenge: What happened when the wire was folded back on itself? Why is this different to making a loop?

How does the coil compare to the wire?

What is the effect of the nail?

Worksheet 20 - Basic Principles of Electromagnetism

What is the effect of the ferrite core?

How are the nail and ferrite core different when the current is switched off?

Which end of the compass points towards the core? How could you reverse it?

What do you think would happen if the electromagnet were powered by AC?

If you wanted to make a more powerful electromagnet, what changes might you make?

Learning objective: Observe solenoid operation and back EMF when an inductive load is switched off.

Coil and solenoid observations

What happens in the coil circuit when the switch is released?

How does the solenoid circuit behave differently?

Since the switch interrupts the power supply current, where does the current to light the LED come from?

Challenge: solenoid current and power

Measurement / calculation	Value	Units
Solenoid current (A)		A or mA
Supply voltage (V DC)		V
Power P = V x I		W

Research notes: applications of solenoids and why solenoids are suitable for them.

WORKSHEETS

Worksheet 22 - Relays

Learning objective: Use a relay as an isolated switch, to operate a solenoid, and as a latch.

Basic Relay Circuit

What happens when the switch is pressed?

Solenoid Relay Circuit

What happens when the switch is pressed?

Component	Voltage (V)	Current (mA)	Power (W)
Relay coil			
Solenoid			

What happens when the switch is pressed?

How is the circuit reset?

Explain why the relay circuit behaves as an electrical memory.

Research notes: relay contact configurations found from a supplier website.

Learning objective: Observe transformer action with changing current and measure step-up/step-down transformer ratios and efficiency.

DC transformer test: What happened to the LED when the switch was pressed several times? What does this tell you about transformer operation?

AC transformer LED test: What happened to the LED with the AC supply?

Transformer measurements: 2:1 step-down arrangement

Switch state	Secondary Load	Primary voltage (V AC)	Primary current (mA AC)	Secondary voltage (V AC)	Secondary current (mA AC)
Measurement Points:		**A - B**	**E**	**C - D**	**F**
Open	None				N/A
Closed	560Ω				

Switch state	Secondary Load	Primary Power (mW)	Secondary Power (mW)	Efficiency (%)
Open	None		N/A	N/A
Closed	560Ω			

Transformer measurements: 2:1 step-down arrangement

Switch state	Secondary Load	Primary voltage (V AC)	Primary current (mA AC)	Secondary voltage (V AC)	Secondary current (mA AC)
Measurement Points:		**A - B**	**E**	**C - D**	**F**
Open	None				N/A
Closed	560Ω				

Switch state	Secondary Load	Primary Power (mW)	Secondary Power (mW)	Efficiency (%)
Open	None		N/A	N/A
Closed	560Ω			

Learning objective: Observe the motor effect and measure current in a DC motor under different mechanical loads.

Motor-effect carrier observations

Test condition	Motion of rod / observation
Magnet in first orientation, 3 V supply	
Magnet flipped so South pole is on top	
Current reversed by rotating power supply carrier	
Supply increased to 6 V	

How did reversing the magnetic field or the current direction affect the motion?

Use Fleming's left-hand rule to describe the relationship between field, current and motion.

DC motor current measurements

Motor condition	Ammeter reading
Motor running freely	
Motor slowed by gentle pressure	
Motor stalled briefly	

What happened to the current as the motor was slowed or stopped?

Learning objective: Build and test a simple fuse, observe it operating under fault conditions, and estimate its blow current.

Fuse construction and initial measurements

Notes on fuse construction and comparison with other circuit components: -

Resistance of fuse (Ω):

Describe what happened when the lamp was short-circuited: -

Challenge: fuse blow current

Trial	Current when fuse blew (A)
1	
2	
3	

Worksheet 26 - Circuit Breaker and RCD

Learning objective: Compare resettable circuit breakers with residual current devices and identify which faults they detect.

Circuit breaker fault test

Describe the operation of the circuit breaker. How is it different from the fuse tested in the earlier worksheet?

RCD and circuit breaker fault test

Which device trips when a short-circuit occurs?

Which device trips when the potentiometer is rotated? At what current does it trip?

Does it make a difference whether the lamps are on or off?

Describe the difference between the two protection devices:

Learning objective: Use a hand-cranked generator and observe how load affects generated voltage and mechanical effort.

Generator voltage observations

Action	Voltage produced (V)	Polarity (Positive or Negative)
Turn handle clockwise		
Turn handle counter-clockwise		

Generator with loads

What happened as the switch was pushed and the LED was connected?

How did the lamp compare with the LED as a load?

WORKSHEETS

Worksheet 28 - Fault Finding

Learning objective: Apply a structured fault-finding process and document evidence, measurements and conclusions.

Circuit 1

Measurement	Lamp	LED
Current (A)		
Voltage (V)		
Calculated Resistance (Ω)		
Measured Resistance		

Explain the difference between calculated and measured resistance.

Circuit 2

Explain your fault-finding strategy.

Why is the LED not coming on?

What can be changed to make the LED come on?

1.

2.

Which change do you choose and why?

Circuit 3

Test	Current (A)
Circuit powered but switch not pressed.	
Switch pressed, circuit operating normally.	
Solenoid removed, relay operating alone.	
Relay bypassed, solenoid operating alone.	

Challenge: Why has the relay been failing recently? What should the technician do?

Circuit 4

Resistance Measurements (Ω)	D	C	B
A			
B			
C			

Wire	Post
A	
B	
C	
D	

Challenge: How could an operator in the plant room help solve this activity?

Notes

ELECTRICAL ESSENTIALS

CP3878

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