Electricity Block 2

Electronics

Knowledge Organizer

Key: [PHY] = National 5 **Physics (Electricity)** - **[PE]** = National 5 **Practical Electronics** - **[BOTH]** = appears in **both**

TABLE OF CONTENTS

CORE ELECTRICAL IDEAS (B2 FOCUS)

1) KEY QUANTITIES AND UNITS

Idea	Definition	Unit	Course link
Electric current (I)	The **rate of flow of electric charge** in a circuit.	**ampere (A)**	[BOTH]
Electric charge (Q)	The amount of electric charge transferred.	**coulomb (C)**	[BOTH]
Potential difference / voltage (V)	The **energy transferred per coulomb of charge** between two points in a circuit.	**volt (V)**	[BOTH]
Resistance (R)	A measure of how much a component **opposes the flow of current.**	**ohm (Ω)**	[BOTH]

Note: Power and energy are covered in **Block 3**, so they are not included here.

2) ESSENTIAL EQUATIONS (B2)

Equation (SQA notation)	What it's for	Notes	Course link
Q = I t	Charge transferred in time *t*	*t* in seconds (s)	[BOTH]
V = I R	Ohm's law calculations	Valid for **ohmic** components (straight-line V-I graph)	[BOTH]
$V_2 = \frac{R_2}{R_1 + R_2} V_s$	**Potential divider output voltage** across **R2**	R1 and R2 in series; **V2 is across R2**	[BOTH]
$\frac{V_1}{V_2} = \frac{R_1}{R_2}$	Divider relationship (ratio form)	Useful for comparing changes	[BOTH]

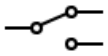
3) SERIES AND PARALLEL RECAP (FROM **BLOCK 1 - ELECTRICITY B1**)

Rule (B1 recap)	Summary	Course link
Series	**Current same** everywhere; **voltages add.**	[BOTH]
Parallel	**Voltage same** across branches; **current splits.**	[BOTH]

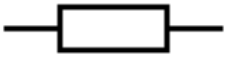
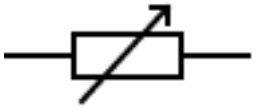
COMPONENTS YOU MUST RECOGNISE (B2 SET)

4) POWER CONNECTIONS AND SWITCHES

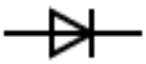
Component	Function (what it does)	Typical use / example	Symbol/diagram box	Course link
Voltage rails (V+ and 0 V/−)	The **supply connections** used to power a circuit (often shown as rails/lines on diagrams or breadboards).	Powering a breadboard or stripboard circuit		[BOTH] *(used heavily in [PE])*
Switch (SPST)	Single pole single throw: **ON/OFF** switch that opens or closes one path.	Simple on/off control		[BOTH]

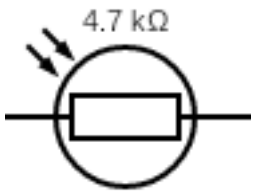
Switch (SPDT)	Single pole double throw: connects one input to **one of two outputs**.	Selecting between two paths (eg two control modes)		[BOTH] *(used heavily in [PE])*

5) RESISTORS, METERS AND OUTPUT DEVICES

Component	Function (what it does)	Typical use / example	Symbol box	Course link
Resistor (fixed)	Limits current / creates a voltage drop.	Current limiting, potential dividers		[BOTH]
Variable resistor	Adjustable resistance.	Sensitivity/threshold control in a divider		[BOTH] *(applications deeper in [PE])*
Ammeter	Measures current (connected **in series**).	Measuring circuit current		[BOTH]
Voltmeter	Measures potential difference (connected **in parallel**).	Measuring voltage across a component		[BOTH]
Lamp	Converts electrical energy to light (and heat).	Indicator / lighting		[BOTH]
Motor	Converts electrical energy to kinetic energy.	Fans, mechanisms		[BOTH]
Loudspeaker / buzzer	Converts electrical energy to sound.	Sound output / alarms		[BOTH] *(buzzer often used in [PE])*

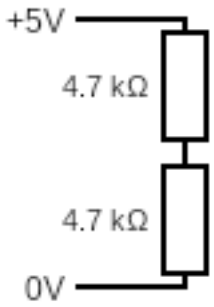
6) DIODES, LEDS, CAPACITORS AND SENSORS

Component	Definition / key idea	What to remember	Symbol box	Course link
Diode	Allows current to flow **in one direction only**.	**Forward bias** conducts; **reverse bias** blocks.		[BOTH]
LED (light emitting diode)	A diode that emits light when current flows forward.	Needs a **protective resistor** to limit current.		[BOTH]
Capacitor	Stores electric charge and energy.	Used for **timing** and **smoothing** (applications emphasised in [PE]).		[BOTH]

LDR (light dependent resistor)	Resistance depends on light level.	**More light → lower resistance** (typical).		[BOTH]
Thermistor (NTC)	Resistance depends on temperature.	**Higher temperature → lower resistance** (typical NTC).		[BOTH]

POTENTIAL DIVIDERS, LEDS AND CONTROL CIRCUITS

7) POTENTIAL DIVIDER (CORE B2 IDEA)

Topic	Student-ready notes	Diagram box	Course link
What is a potential divider?	Two (or more) resistors in **series** used to create an **output voltage** that is a **fraction of the supply voltage**.		[BOTH]
Naming	**Vs** = supply voltage. **R1 and R2** are the series resistors. **V2** is the output voltage **across R2**.		
Why do we use it?	To make a **variable voltage signal**. Using an LDR/thermistor/variable resistor makes the output voltage change with **light/temperature/setting**.		
Divider equation	$V_2 = \frac{R_2}{R_1 + R_2} V_s$		
Key understanding	The resistor with the **bigger share of total resistance** gets the **bigger share of the supply voltage**.		

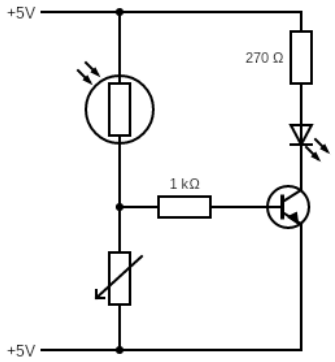
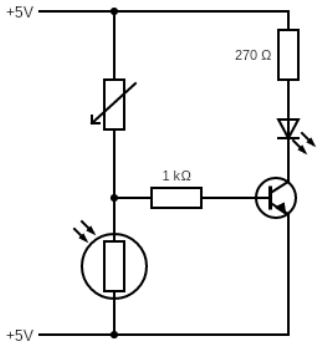
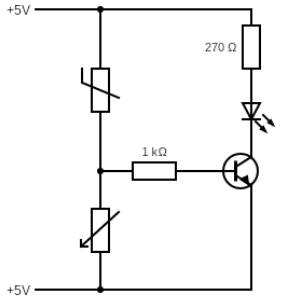
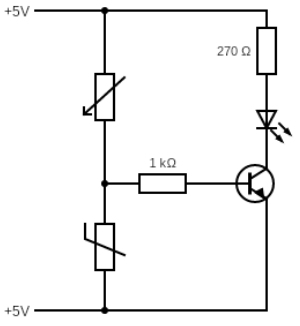
8) QUICK RULES (IF…THEN…)

Quick rule	Meaning in words	Course link
If R2 increases → V2 increases	A bigger R2 gives a bigger fraction of Vs across R2.	[BOTH]
If R1 increases → V2 decreases	More of Vs is "used up" across R1, leaving less across R2.	[BOTH]
LDR: light level increases → resistance decreases	Bright light makes an LDR's resistance drop.	[BOTH]
NTC thermistor: temperature increases → resistance decreases	Hotter thermistor → lower resistance (NTC).	[BOTH]

9) LED PROTECTIVE RESISTOR (CURRENT LIMITING)

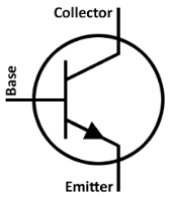
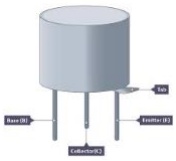
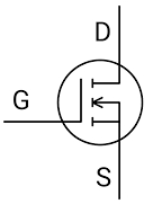
Topic	Student-ready notes	Course link
Why an LED needs a resistor	LEDs don't limit current well; without a resistor the current can be too large and **damage the LED**.	[BOTH]
Resistor calculation	**$R = (V_s - V_{LED}) / I_{LED}$**	

10) CONTROL CIRCUITS (USING LDR/THERMISTOR + DIVIDER + SWITCH STAGE)

Circuit type	What it means	What changes the output	Diagram box	Course link
High light control	Output turns **ON** at **high light level**.	LDR resistance changes → divider output voltage changes → switch stage changes output.		[PE]
Low light control	Output turns **ON** at **low light level**.	LDR resistance changes → divider output voltage changes → switch stage changes output.		[PE]
High temperature control	Output turns **ON** at **high temperature**.	Thermistor resistance changes → divider output voltage changes → switch stage changes output.		[PE]
Low temperature control	Output turns **ON** at **low temperature**.	Thermistor resistance changes → divider output voltage changes → switch stage changes output.		[PE]

SWITCHING, SIMULATION, TESTING AND SOLDERING

12) TRANSISTORS AND MOSFETS USED AS SWITCHES

Device	Definition	What to remember	Symbol box	Component	Course link
NPN transistor (BJT)	Semiconductor device that can act as an **electronic switch**.	A small **base current** controls a larger **collector current**. A silicon transistor typically begins to switch on when **VBE ≈ 0.7 V** (approx).			[BOTH] *(skills/building focus is [PE])*
n-channel enhancement MOSFET	Switch device controlled by **gate voltage**.	Very small gate current; turns on when the **gate voltage** is high enough (threshold behaviour).			[BOTH] *(skills/building focus is [PE])*

13) YENKA (SIMULATION) — QUICK PURPOSE

Yenka	**Test circuits safely** before building **Measure voltages/currents** without risk **Compare** results to your calculations Practice **fault finding** using “normal” readings as a reference	**Course link:** [PE]

14) TESTING MINDSET (ELECTRONICS)

Test stage	What it means	Examples	Course link
Pre-power-up checks	Checks done **before switching on** to avoid damage.	Correct component values; correct orientation (diode/LED/capacitor/transistor); no loose wires; no short circuits; correct power connections; tidy wiring.	[PE]
Functionality tests	Tests done **after switching on** to confirm the circuit works.	Measure supply voltage; measure key node voltages; confirm output turns on/off in the correct conditions; compare to simulation; check current isn’t excessive.	[PE]

15) COMMON MISTAKES (FAULT-FINDER BOX)

Common mistake	What you usually see	Quick fix	Course link
LED reversed	LED never lights	Flip LED orientation (check diode direction)	[PE]
No protective resistor	LED very bright then fails / gets hot	Add correct series resistor	[PE]
Measuring the wrong voltage	Numbers don't match expectation	Measure **V2 across R2** (parallel connection)	[BOTH]
Wrong rail / no 0 V reference	Circuit behaves unpredictably / no output	Check V+ and 0 V rails are correct and continuous	[PE]
Short circuit / solder bridge	Supply drops / components heat / output stuck	Inspect, rework solder, remove bridge with solder sucker	[PE]
Transistor/MOSFET pins mixed up	Switch stage doesn't work	Re-check pinout (E/B/C or G/D/S) before powering	[PE]

16) SOLDERING AND TOOLS (DEFINITIONS)

Item	Definition / purpose	Safety / good practice	Course link
Track cutter	Tool used on stripboard to **break a copper track** so parts of the circuit are electrically separated.	Double-check the correct hole/track before cutting.	[PE]
Heat sink	A clip/metal part used to **carry heat away** from a component while soldering.	Protects heat-sensitive components; don't overheat parts.	[PE]
Solder sucker	Tool used to **remove molten solder** to fix mistakes or clear holes.	Use carefully; keep iron tip clean and tinned.	[PE]
Good solder joint	A clean, shiny joint that securely connects component and pad/track.	Right amount of solder; heat the joint not the solder; keep parts still while cooling.	[PE]