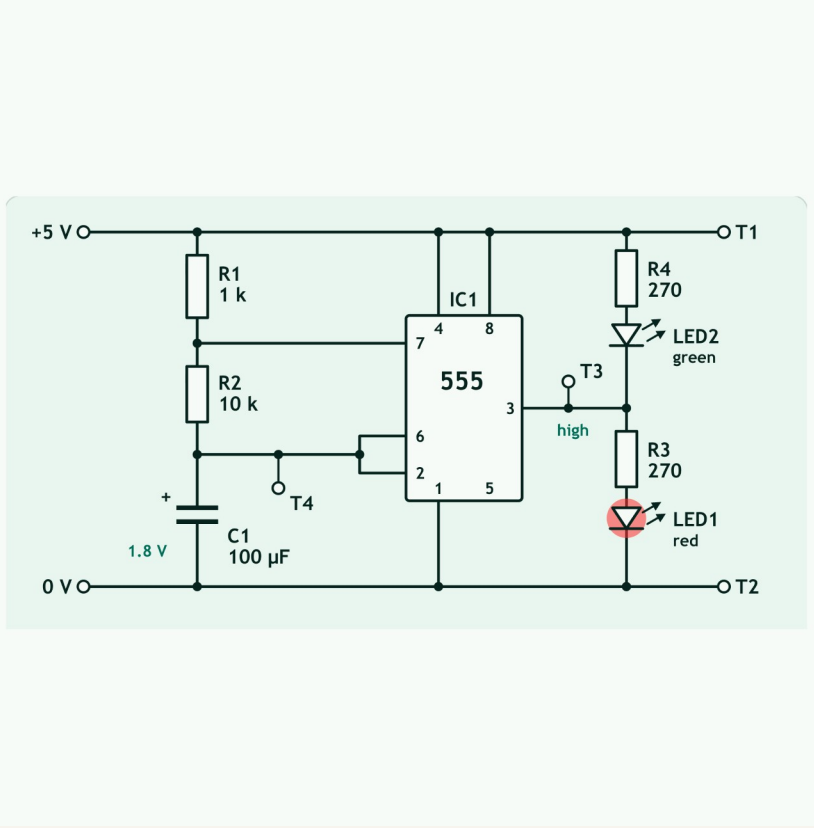
The 555 Astable

How does a circuit keep flashing with nobody pressing anything?



National 5 Practical Electronics

Daily Review



1	**State** the **pin** that **triggers** a 555.	Pin 2
2	**State** when a monostable **pulse ends**.	C1 reaches ⅔
3	Breadboard: **state** which holes are **joined**.	A column of 5
4	**Identify** the largest: 220R, 22, 2.2 mΩ, 2M2	2M2
5	5 Ω and 5 Ω in **series**. **Calculate** R_T.	10 Ω

PART 1

The 555 Astable

We are learning how a 555 astable keeps switching, and how to read its frequency.

By the end of this part…



1. I can **simulate** an **astable** in Yenka and **measure** how **fast** it flashes
2. I can **calculate frequency** from an **oscilloscope** trace

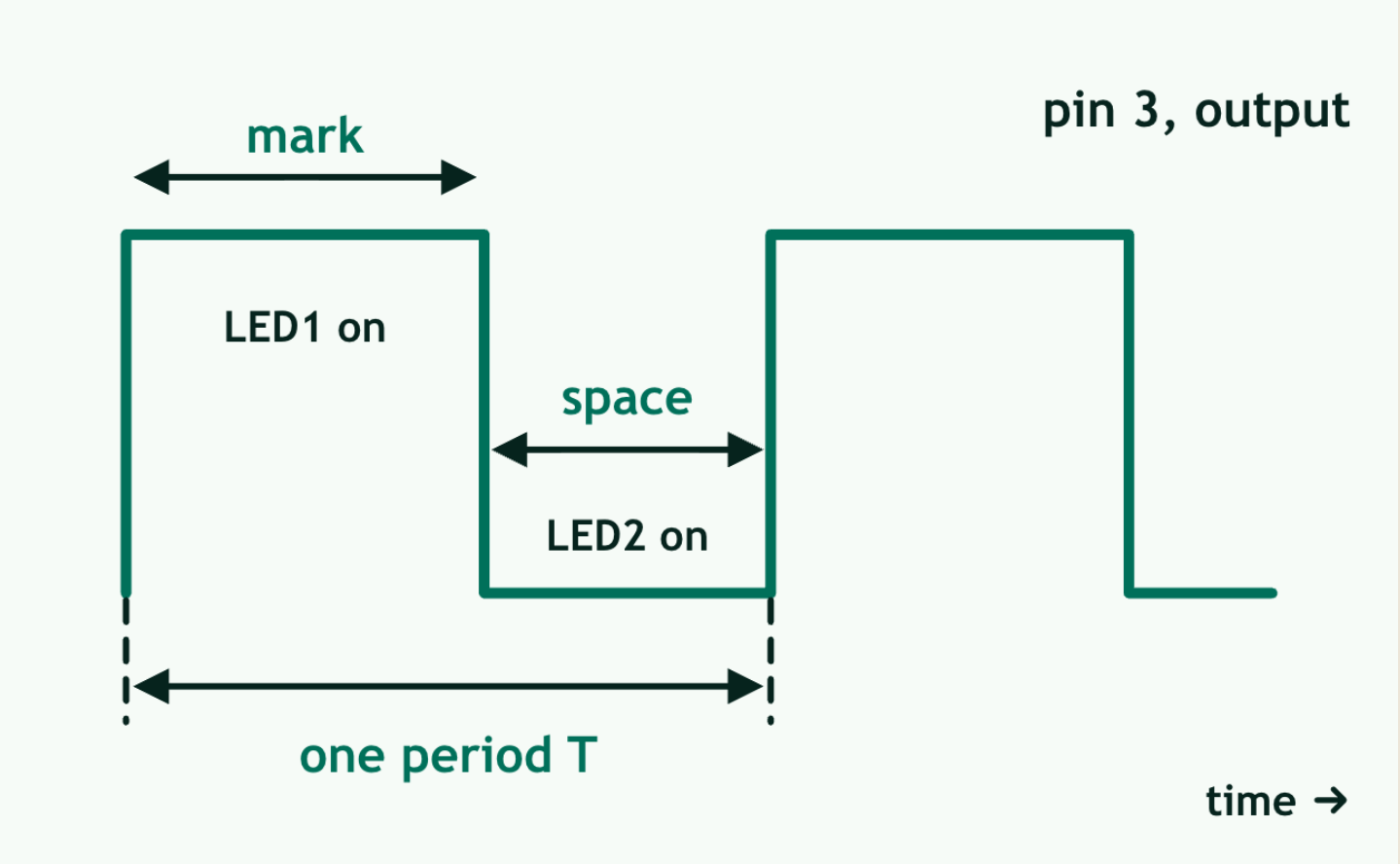
What an Astable Does

No stable state: on, off, **again and again**.

Mark: pin 3 **high**.

Space: pin 3 **low**.

Mark + space = one **period**, T.

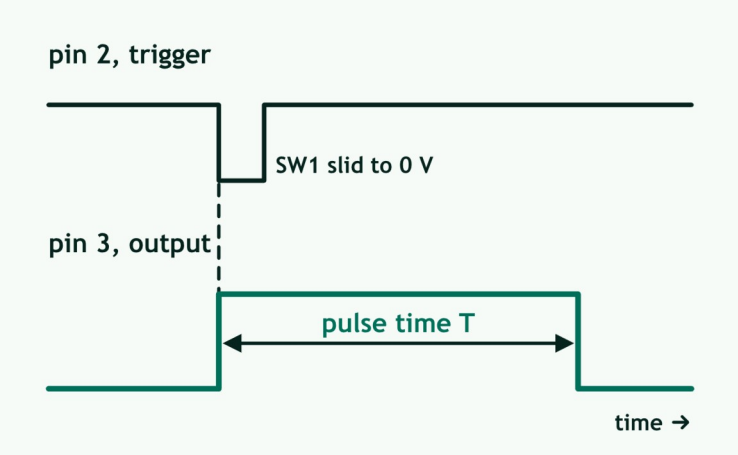


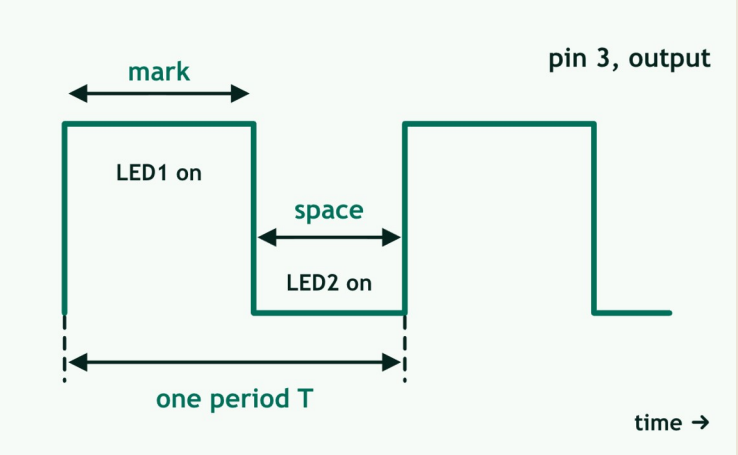
Monostable or Astable?

Monostable: **one** press, **one** pulse.

Astable: keeps **going**.

Same chip, **different** wiring.





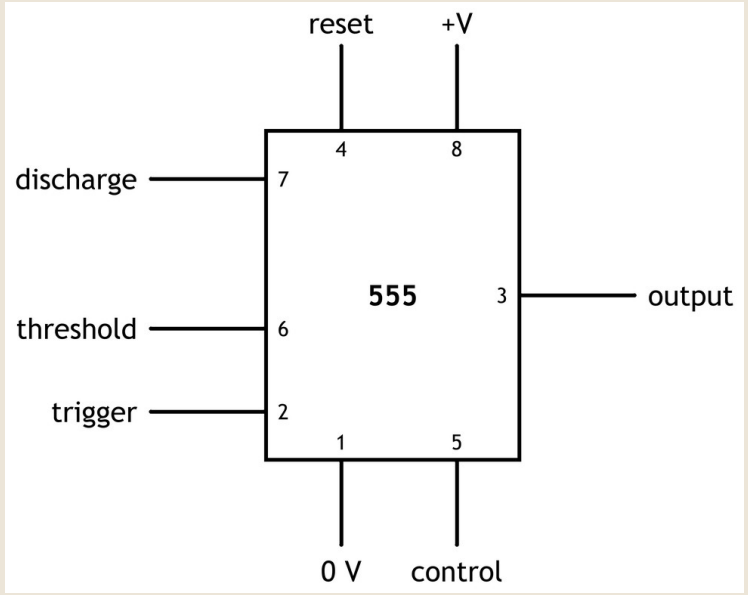
The 555 Timer (Recap)

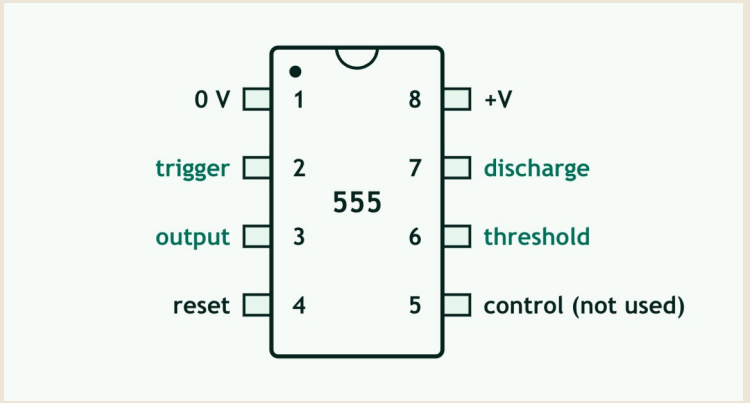
Pins **2** and **6** **joined.**

Pin **7 empties** C1.

Pin **3** output.

Pins **8**, **4** to **+V**; **1** to **0 V**.





The Booklet Circuit

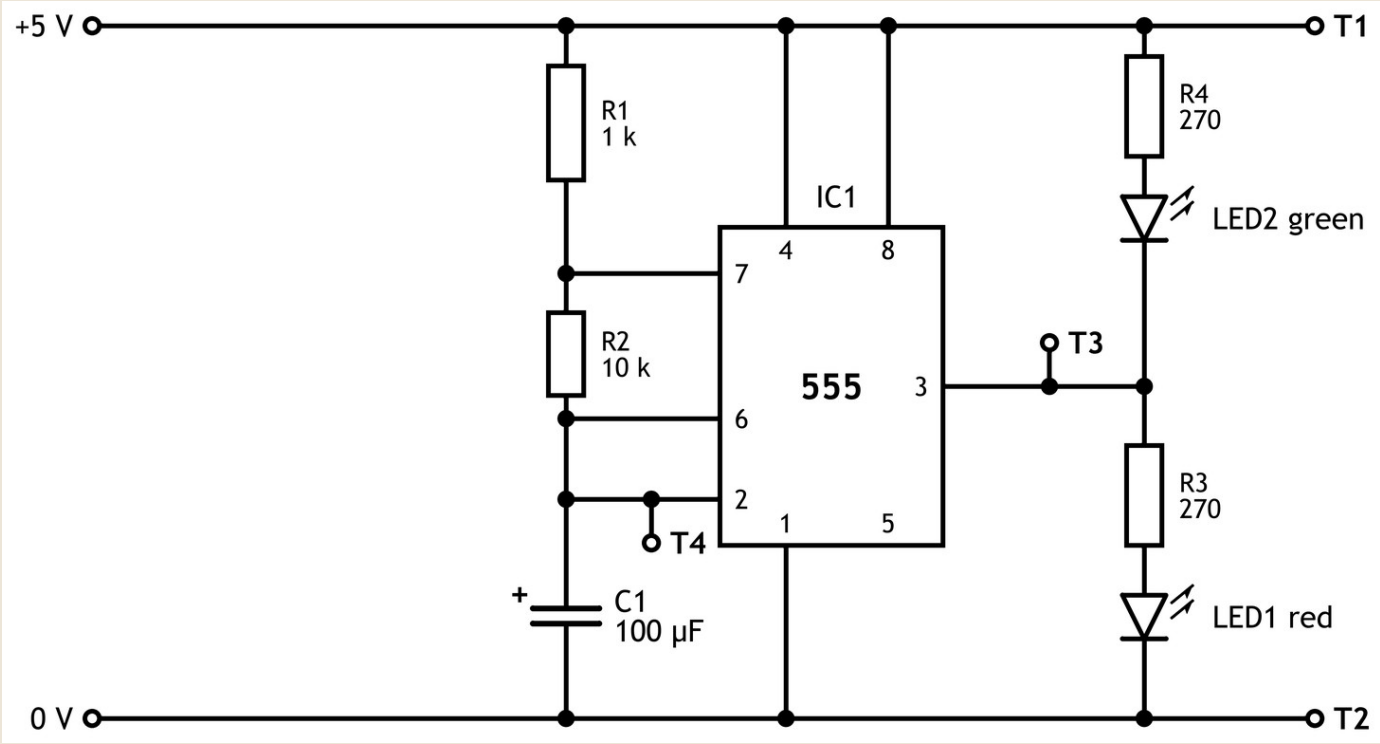
R1, **R2**, **C1**: the **timing.**

LED1 on: pin 3 **high.**

LED2 on: pin 3 **low.**

R3, **R4** protect the LEDs.

T3 pin 3, **T4** C1.



How It Works

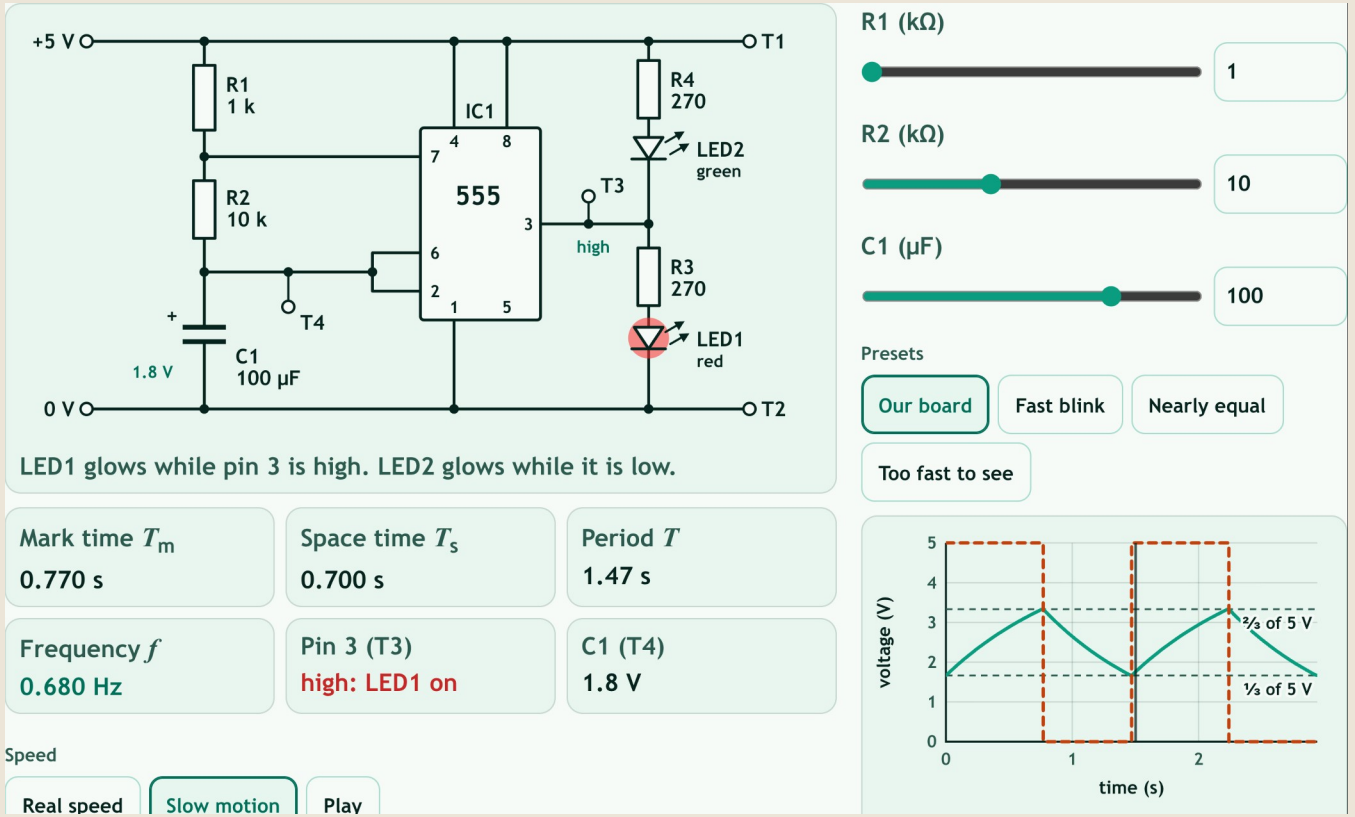
Pin 3 **high**: LED1 **on**.

C1 **charges**: R1 and R2.

At ⅔: pin 3 **low**.

Pin **7 empties** C1.

At ⅓: pin 3 **high** again.



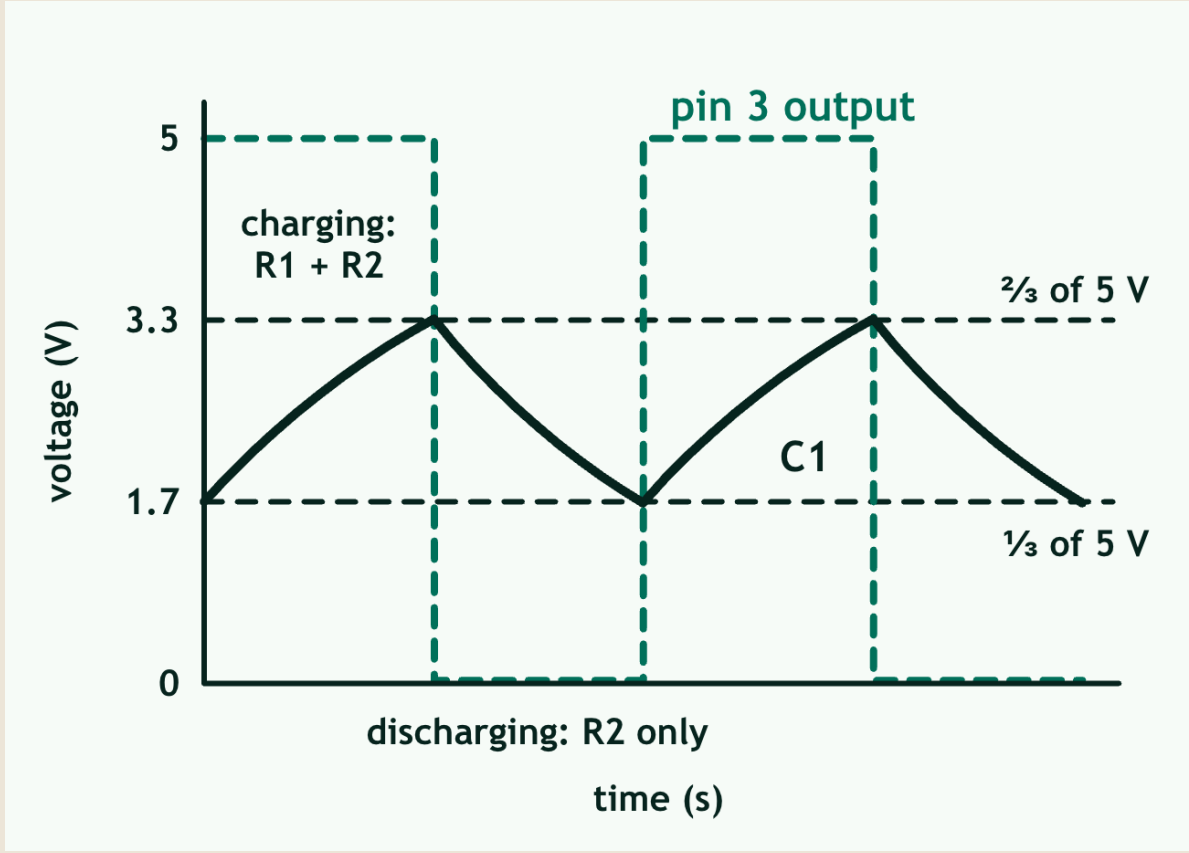
The Astable

Pin 3 **high**: C1 **charges** through R1 and R2.

At **two thirds**: pin 3 **low**, C1 **empties**.

At **one third**: pin 3 **high** again.

Draw the **graph** beside your notes.



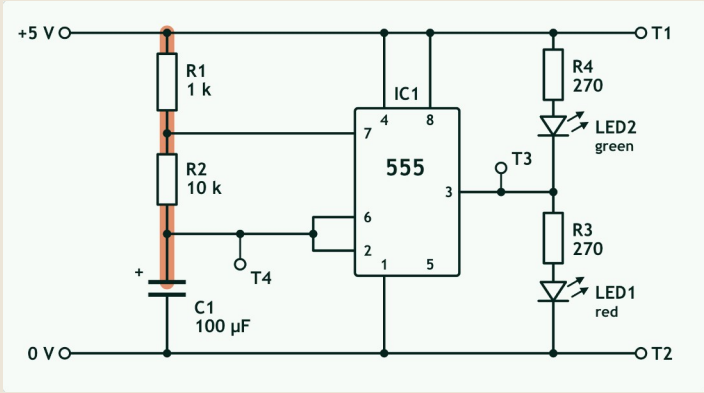
Watch Out: R1

Charging: R1 and R2.

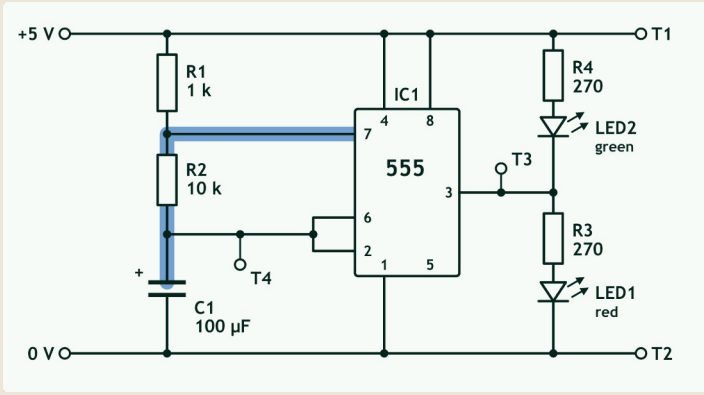
Emptying: R2 only.

Bigger R1: **longer mark** only.

Charging: R1 + R2



Emptying: R2 only



Calculate the Timing

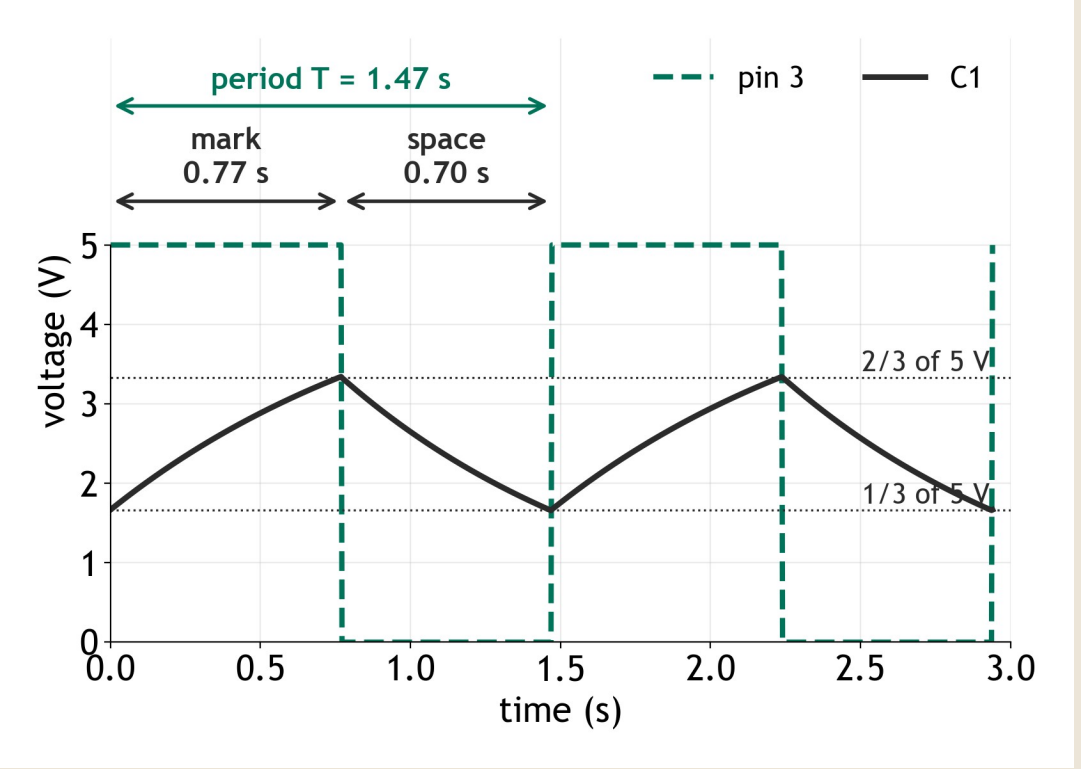
$$T_m = 0.7\,(R_1 + R_2)\,C_1$$

$$T_s = 0.7\,R_2\,C_1$$

$$T = T_m + T_s \qquad f = 1/T$$

kΩ to **Ω**, **µF** to **F**.

Need it for the **assignment**.



Worked Example: Astable Frequency

An astable has R_1 = 2.2 kΩ, R_2 = 47 kΩ and C_1 = 10 µF.

Calculate the **frequency** of its output.

$R_1 = 2200\ \Omega$

$R_2 = 47\ 000\ \Omega$

$C_1 = 0.000\ 01\ F$

$f = ?$

$T_m = 0.7 \times 49\ 200 \times 0.000\ 01 = 0.344\ s$

$T_s = 0.7 \times 47\ 000 \times 0.000\ 01 = 0.329\ s$

$T = 0.344 + 0.329 = 0.673\ s$

$\underline{f = 1 \div 0.673 = 1.49\ Hz}$

Show Me: Calculate the Frequency

1	R_1 4.7 kΩ, R_2 33 kΩ, C_1 22 µF. **Calculate** T_m.	0.58 s
2	**Calculate** the **space** time T_s.	0.51 s
3	**Calculate** the **period** T.	1.09 s
4	**Calculate** the **frequency** f.	0.92 Hz

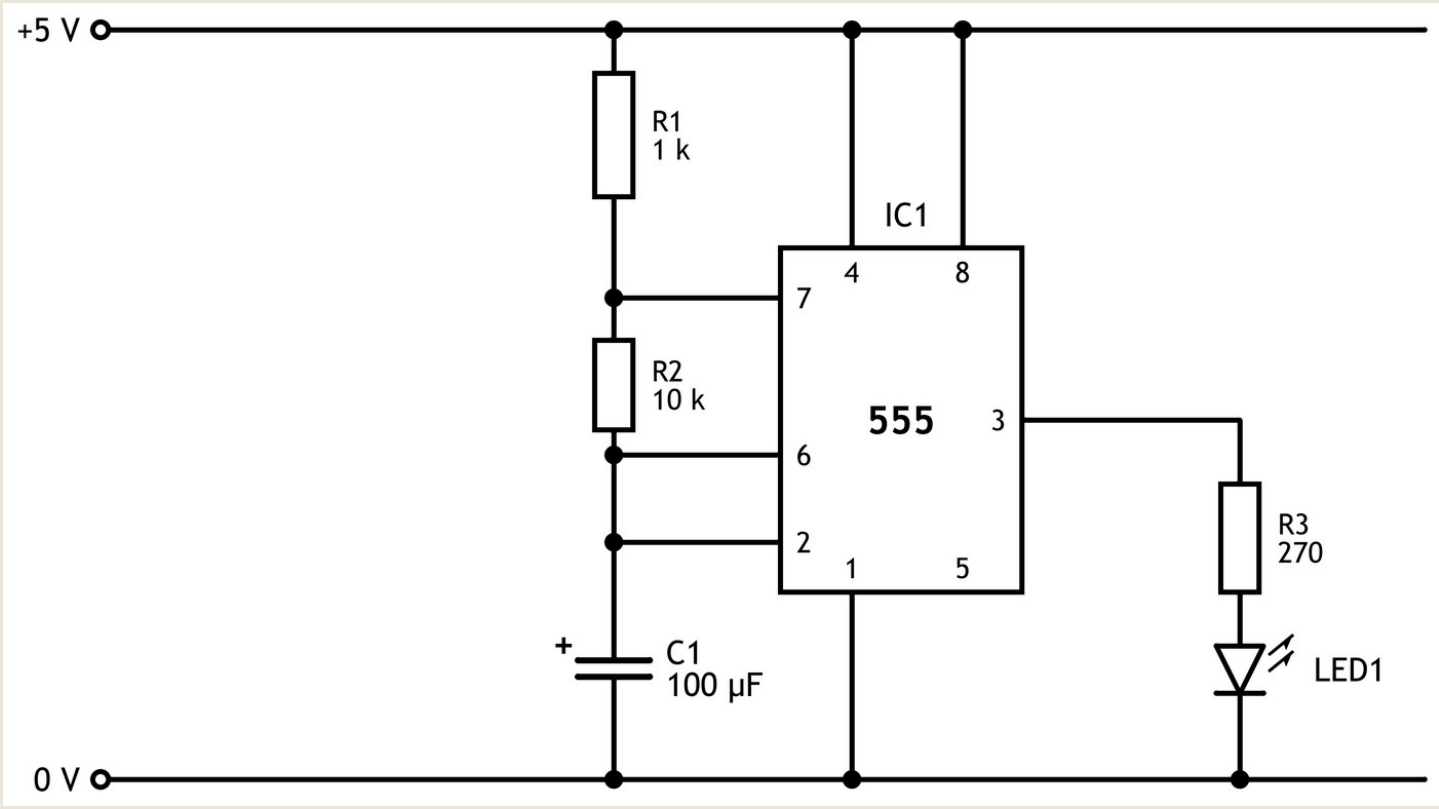
Another Way to Build It

One LED: pin 3 through **R3** to **0 V**.

On for the mark, **off** for the space.

Same rate.

Exam papers draw it **this way**.



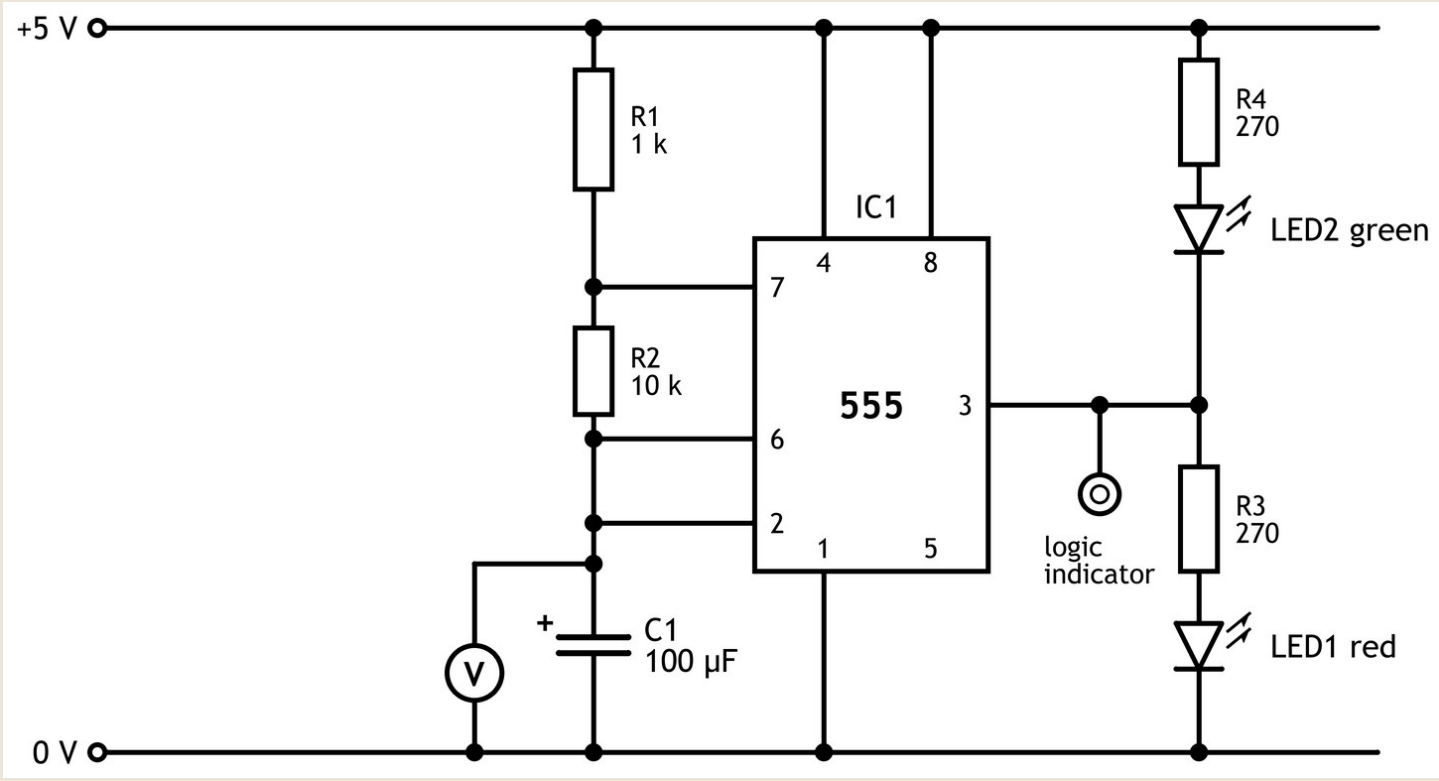
Simulate It in Yenka

Voltmeter across **C1**.

Logic indicator on **pin 3**.

Count red flashes in **30 s**.

f = flashes ÷ **30**.



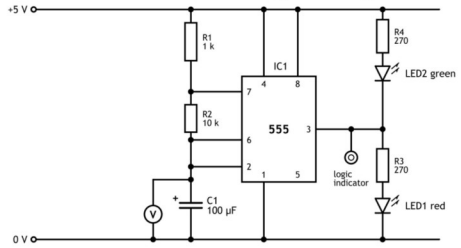
Your Turn: Yenka

Task 1 (B6-L4-p25)

Build the circuit in **Yenka**.
Count the flashes in 30 s. **Record** C1's lowest and highest voltage.

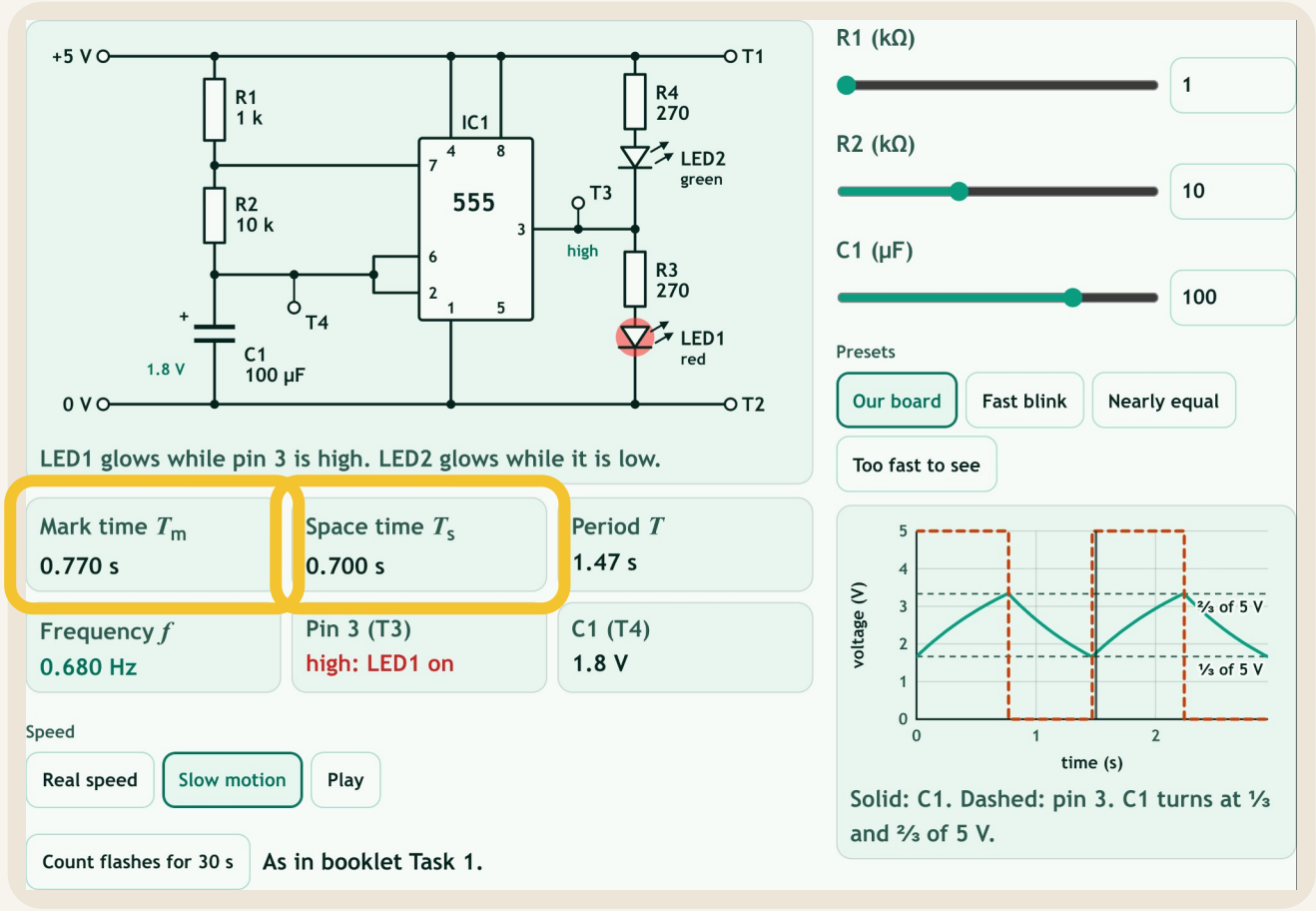
TASK 1 — Yenka: simulate it first

1. **Open** Yenka (Electronics). **Build** the circuit above.
2. **Add** a voltmeter across C1 and a logic indicator on pin 3, as in the diagram below.
3. **Count** how many times the logic indicator turns red in 30 seconds.
4. Watch the voltmeter. **Record** C1's lowest and highest voltage.



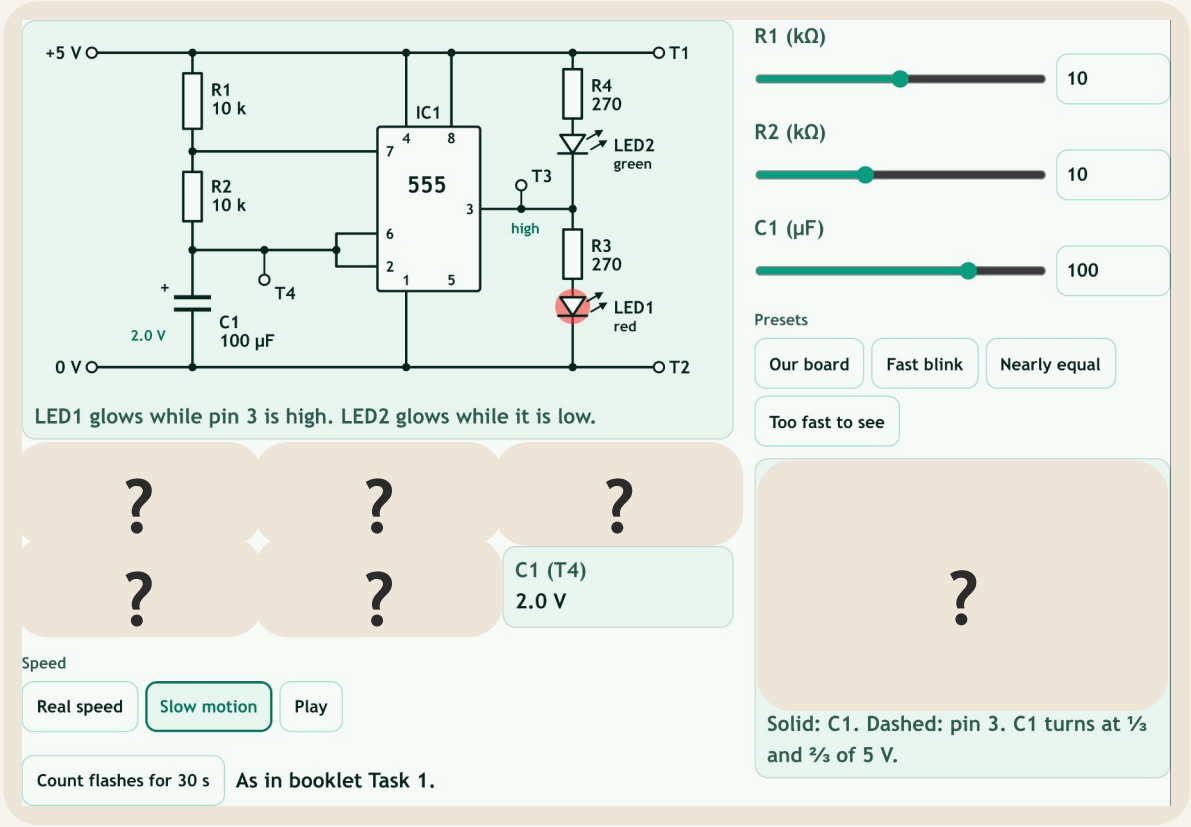
Flashes in 30 s	Frequency = flashes ÷ 30 (Hz)	C1 lowest (V)	C1 highest (V)

Astable Bench: Our Board



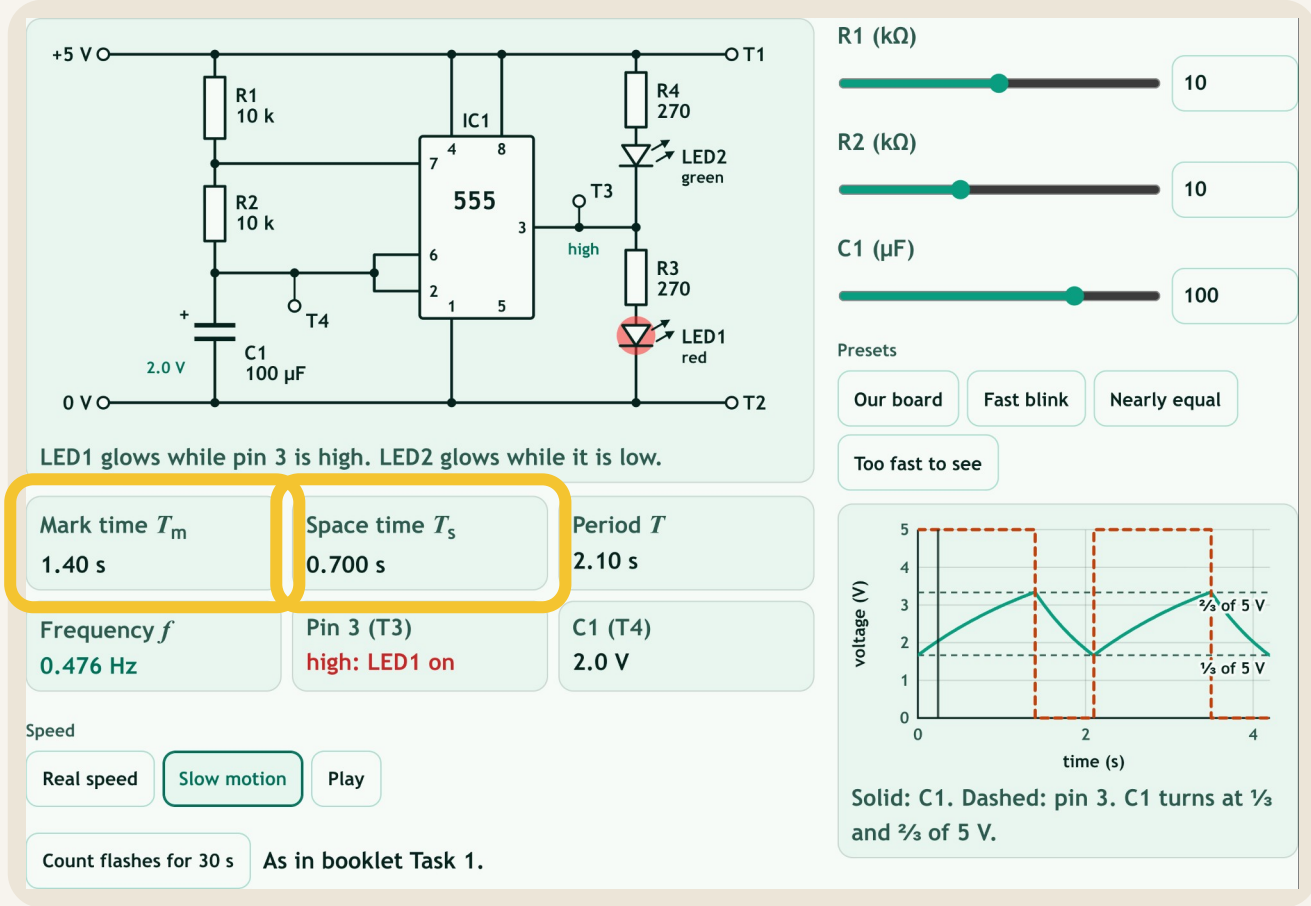
R1 **1 kΩ**, R2 **10 kΩ**, C1 **100 µF**: mark **0.77 s**, space **0.70 s**.

R1 is changed to **10 kΩ**. **Predict** which LED stays on **longer**.



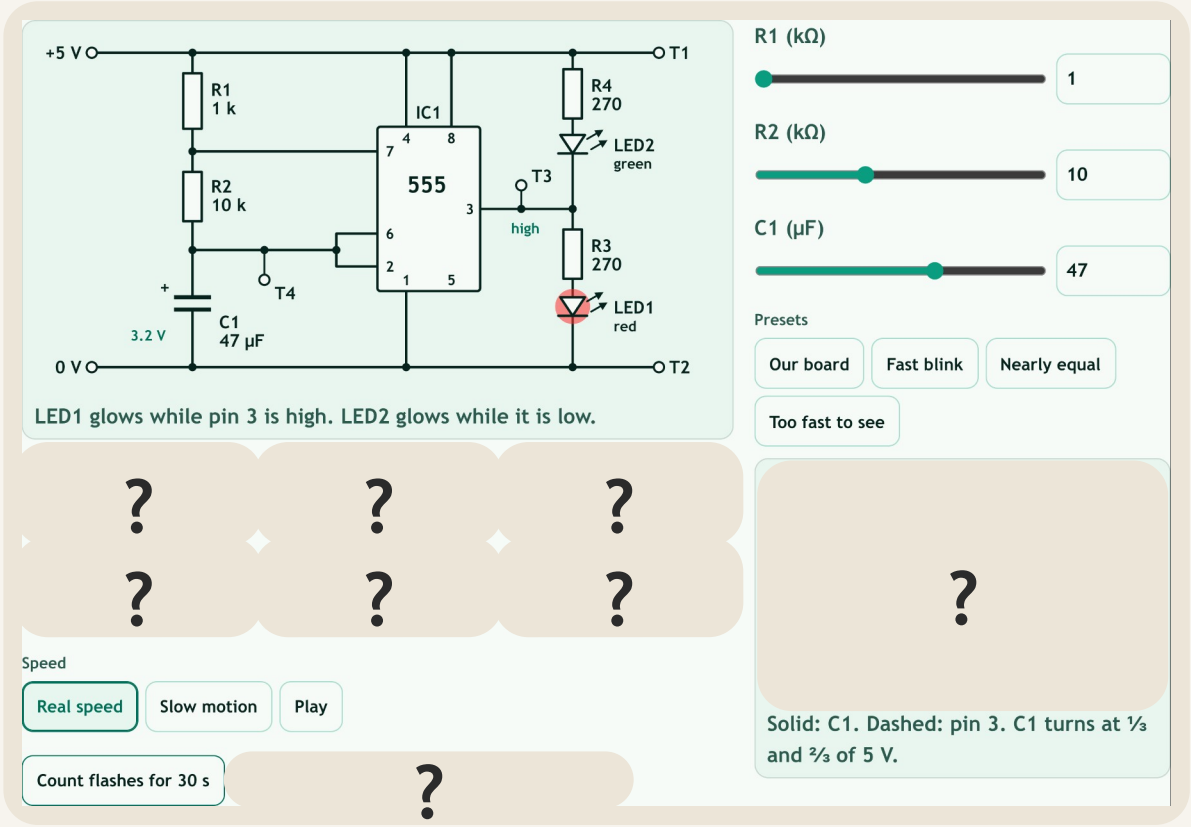
LED1: the mark gets longer, the space stays 0.70 s

Reveal: R1 at 10 kΩ



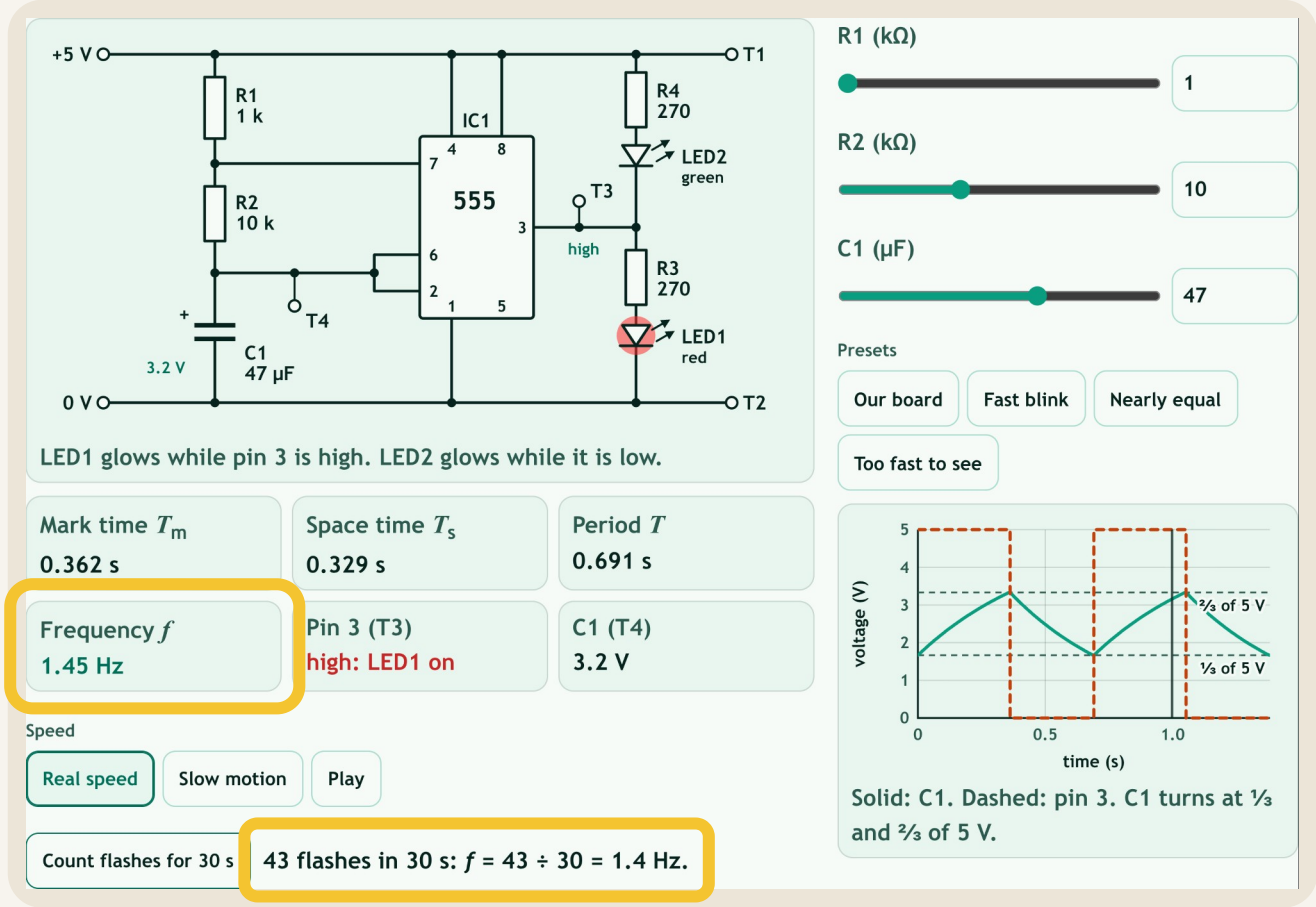
Mark **1.40 s**, space **still 0.70 s**: only **LED1's** time changed.

Back to 1 kΩ. C1 is changed to **47 µF**. **Predict** the **flashes** in **30 s**.



About 43: smaller C1, faster flashing

Reveal: C1 at 47 µF



C1 **smaller: 43** flashes in 30 s, about **1.45 Hz.**

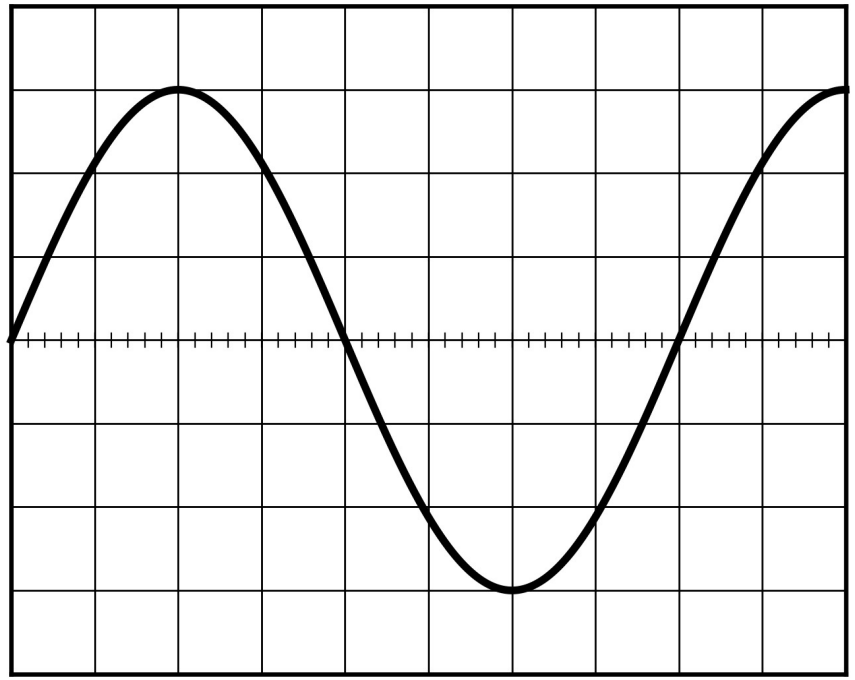
Reading an Oscilloscope

Peak: 3 div × 2 V/div = **6 V**.

Period: 8 div × 10 ms/div = **80 ms**.

f = 1 ÷ 0.08 s = **12.5 Hz**.

Smooth wave: **analogue**.
Square: **digital**.



Y-gain: 2 V/div timebase: 10 ms/div

2024 Question 8

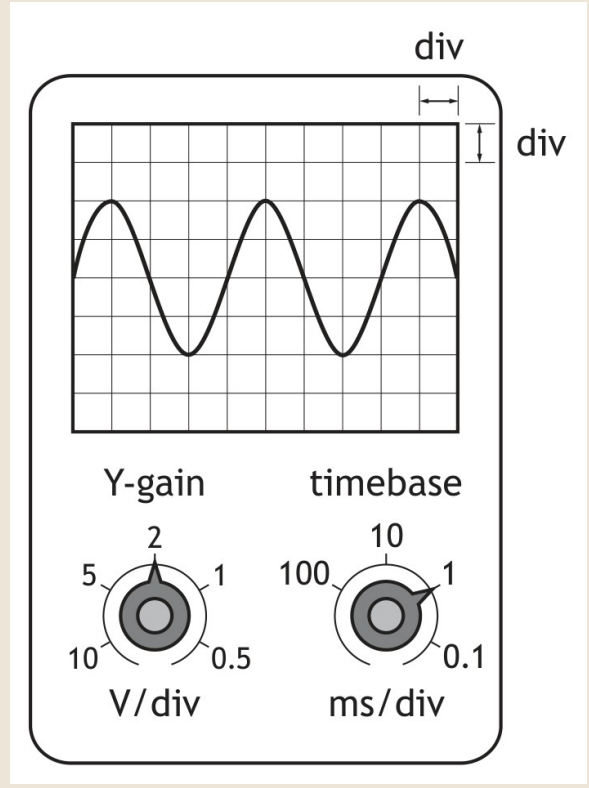
8. The output from a signal generator is connected to the input terminals of an oscilloscope.

The trace is shown on the screen. The Y-gain and timebase settings are also shown below.

(a) State whether this signal is analogue or digital. **1**

(b) Determine the peak voltage of this signal. **1**

(c) Calculate the frequency of this signal. **3**



Marking: 2024 Question 8 (1 of 3)

Question	Expected response	Max mark	Additional guidance
8. (a)	Analogue (signal)	1	
(b)	4 V	1	Must include unit.

Marking: 2024 Question 8 (2 of 3)

Question	Expected response	Max mark	Additional guidance
8. (c)	T = (4 × 1 ms) = 4 ms or 4 × 10^{-3} s or 0.004 s (1 mark) f = 1/T (1 mark) f = 250 Hz (1 mark)	3	If incorrect setting chosen from oscilloscope award a maximum of 1 mark for the formula If period incorrect then award a maximum of 1 mark for the formula

Marking: 2024 Question 8 (3 of 3)

Question	Expected response	Max mark	Additional guidance
8. (c)	(continued)		If milli omitted from the period of the wave, treat as a unit error and award a maximum of 2 marks, unless final answer is then quoted as 0·25 kHz, in which case 3 marks may be awarded Accept f=N/t

Look back — by the end of this part…



1. I can **simulate** an **astable** in Yenka and **measure** how **fast** it flashes
2. I can **calculate frequency** from an **oscilloscope** trace

Daily Review

1	**State** the **pin** that **empties** C1.	Pin 7
2	Bigger R1. **State** what **changes**.	Longer mark only
3	T = 0.25 s. **Calculate** f.	4 Hz
4	9 V across 36 Ω. **Calculate** the **current**.	0.25 A
5	Gold band. **State** the **tolerance**.	±5 %

PART 2

Build and Test

We are learning to build an astable on stripboard and test it.

By the end of this part…



1. I can **plan** an astable on the **Stripboard Builder**, with **track cuts** and **test points**
2. I can **build** and **test** an astable with a **meter** and a **logic probe**

Why Stripboard Now

Stripboard: soldered, **finished** circuit.

A **track** joins its whole **row**.

Cut every track **under the chip**.

Solder a **DIL socket**, not the chip.

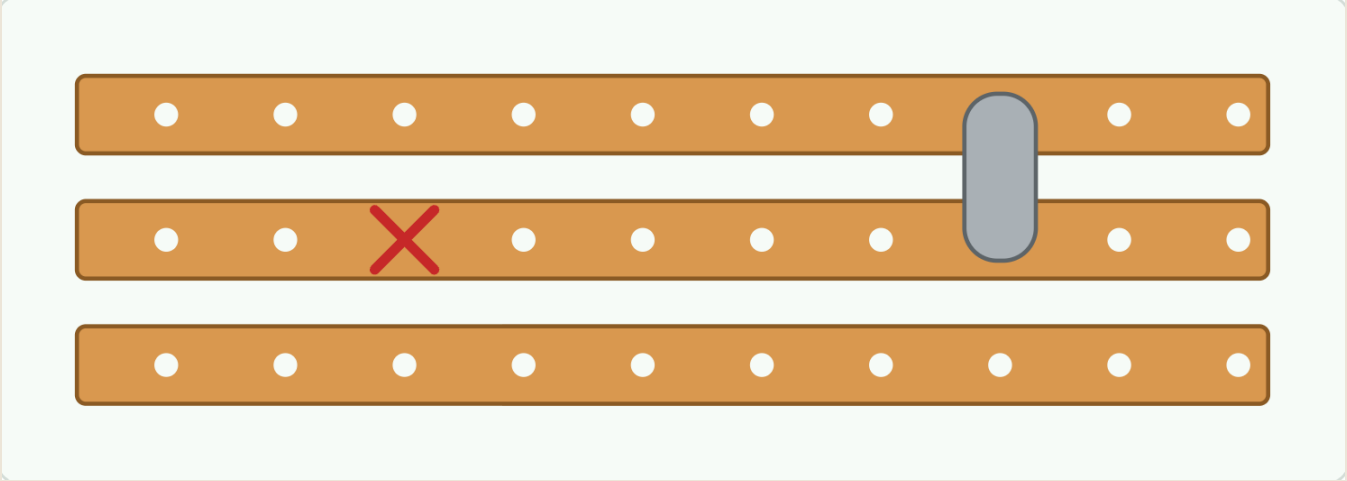
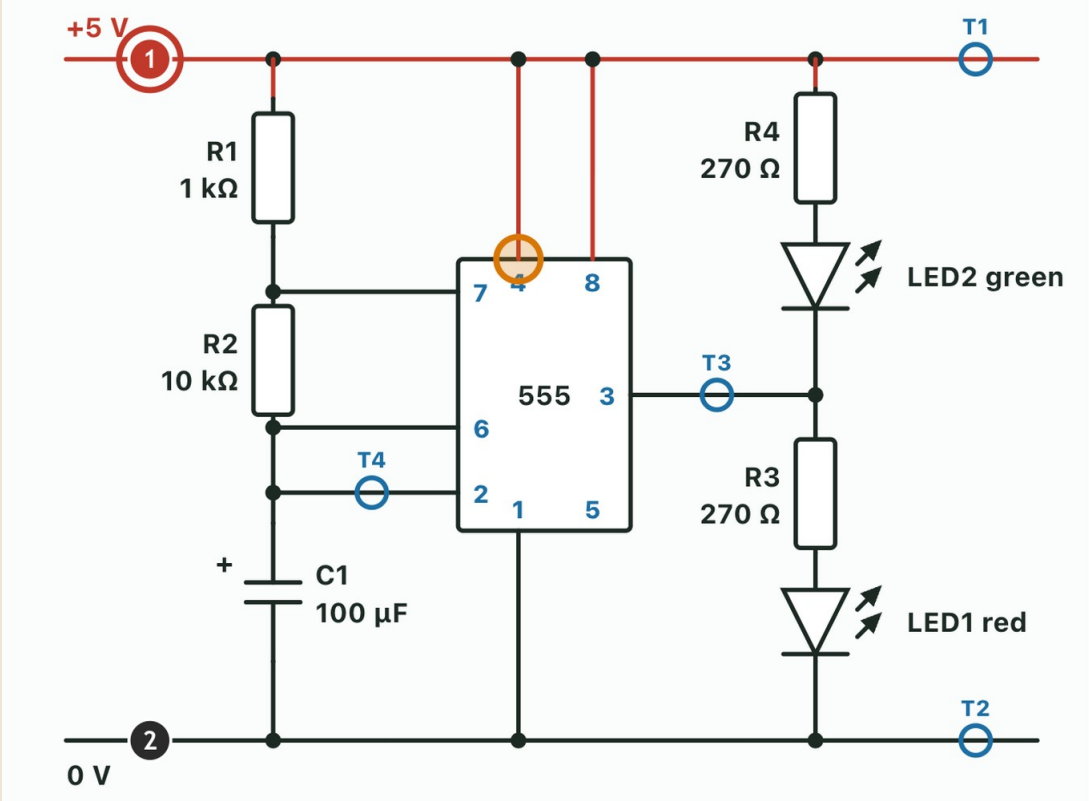
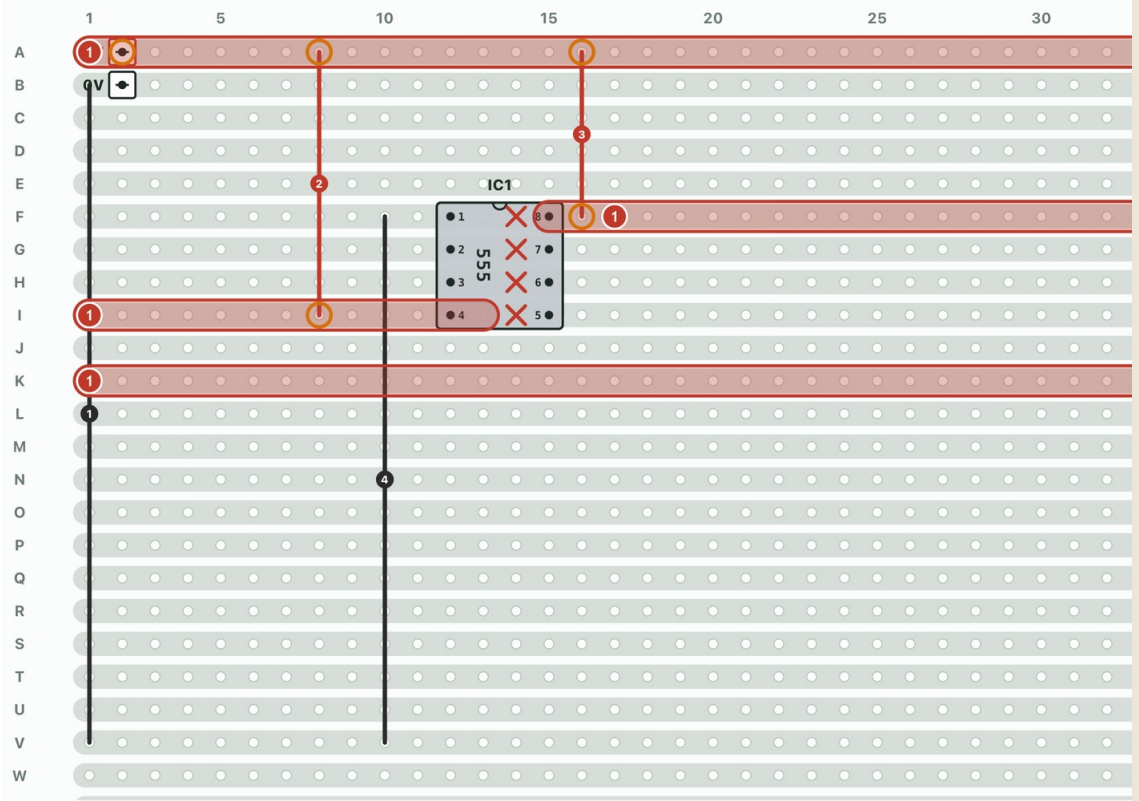


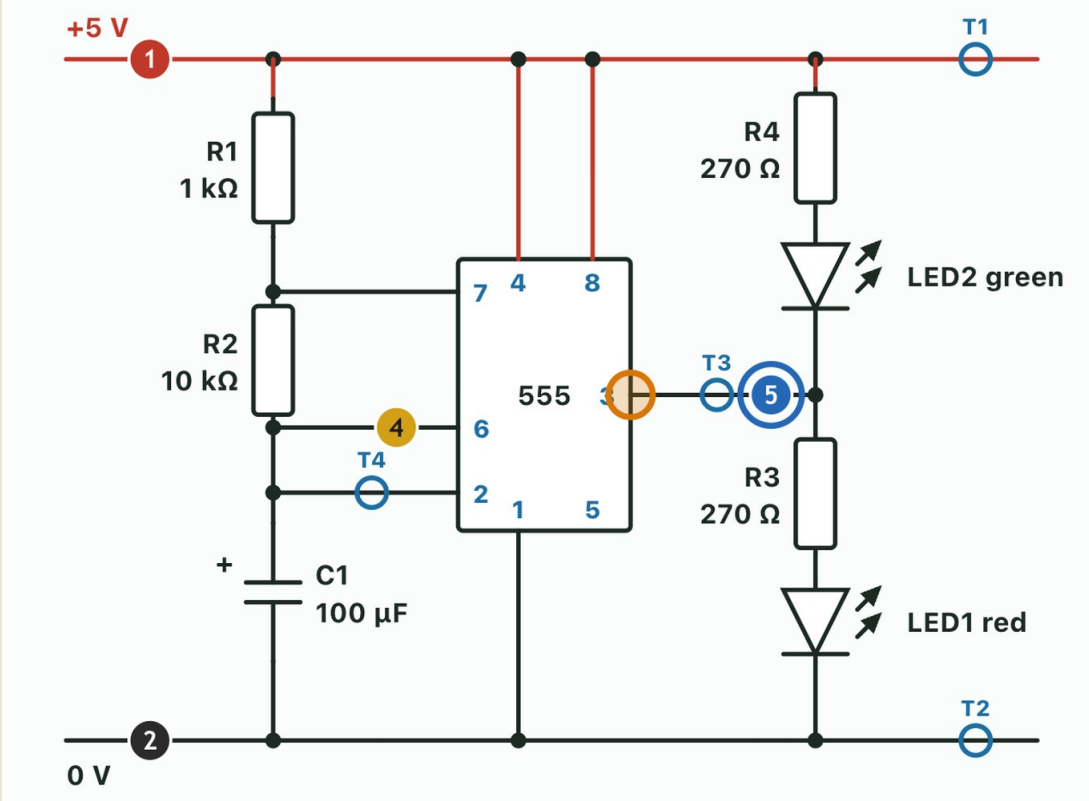
Diagram to Stripboard: 1 of 3

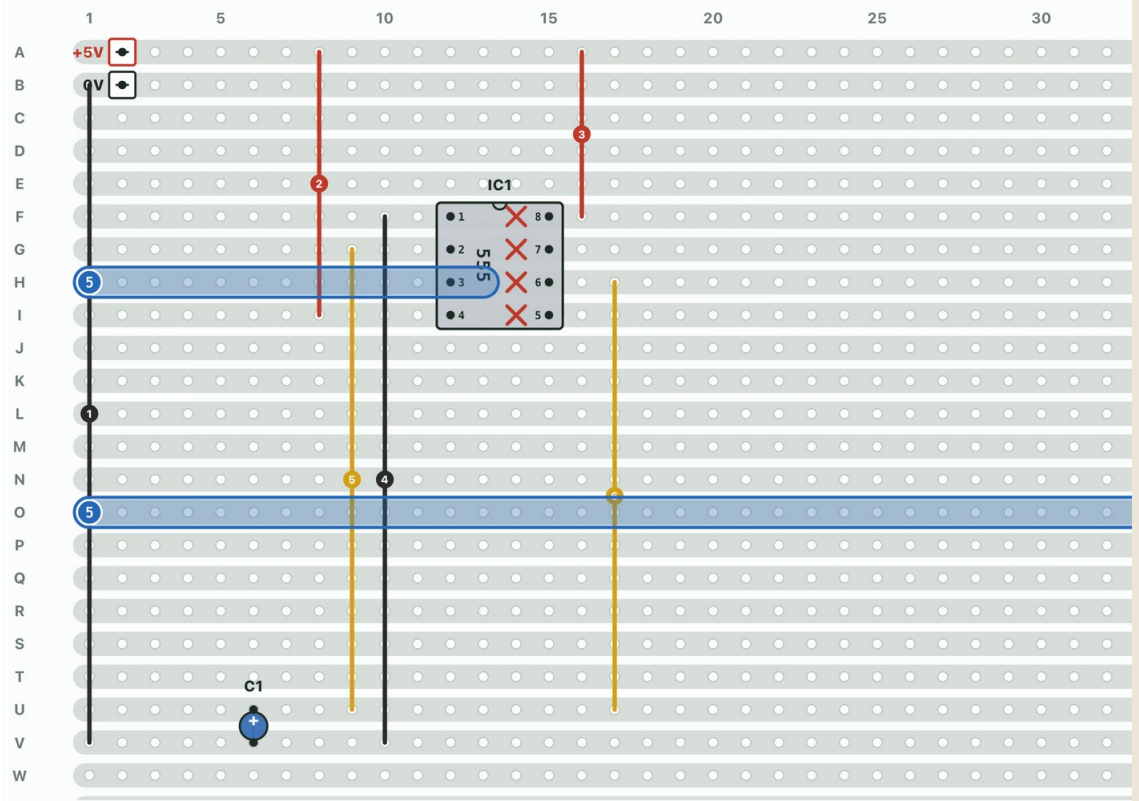




Net **1**, **+5 V**: red links to pins **8** and **4**.

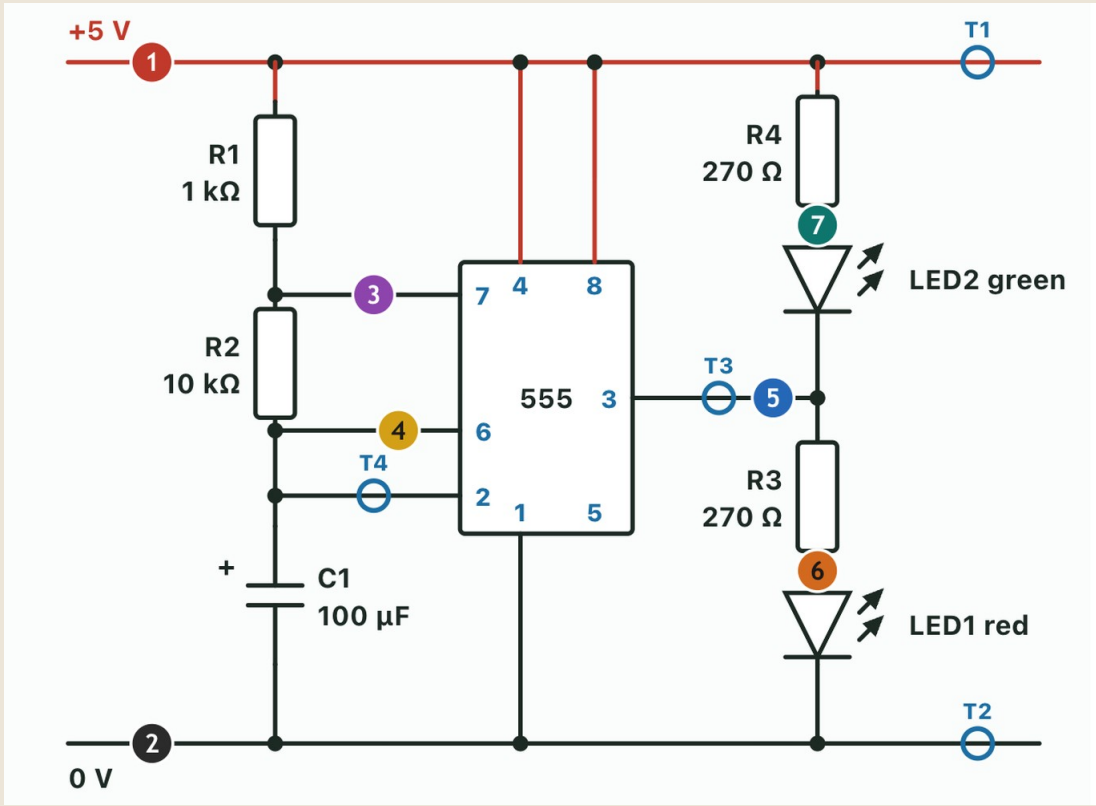
Diagram to Stripboard: 2 of 3

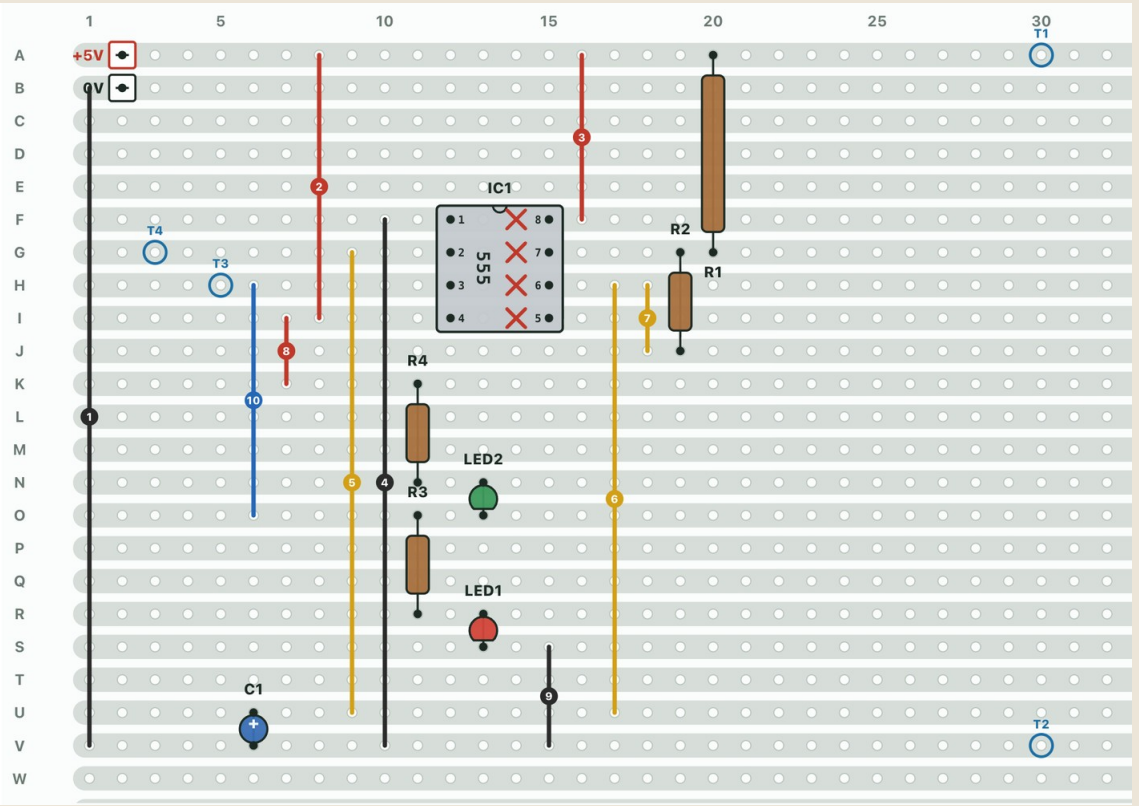




Net **5**, **pin 3**: the **output**.

Diagram to Stripboard: 3 of 3





Check: the **finished** board.

Your Turn: Plan It

Task 2 (B6-L4-p27)

Follow the guide on the Lesson 4 page.
Plan it on the **Stripboard Builder**.
Fill in the **wiring schedule** and the **checklist**.

Scan me

PERIOD 2 STARTS HERE

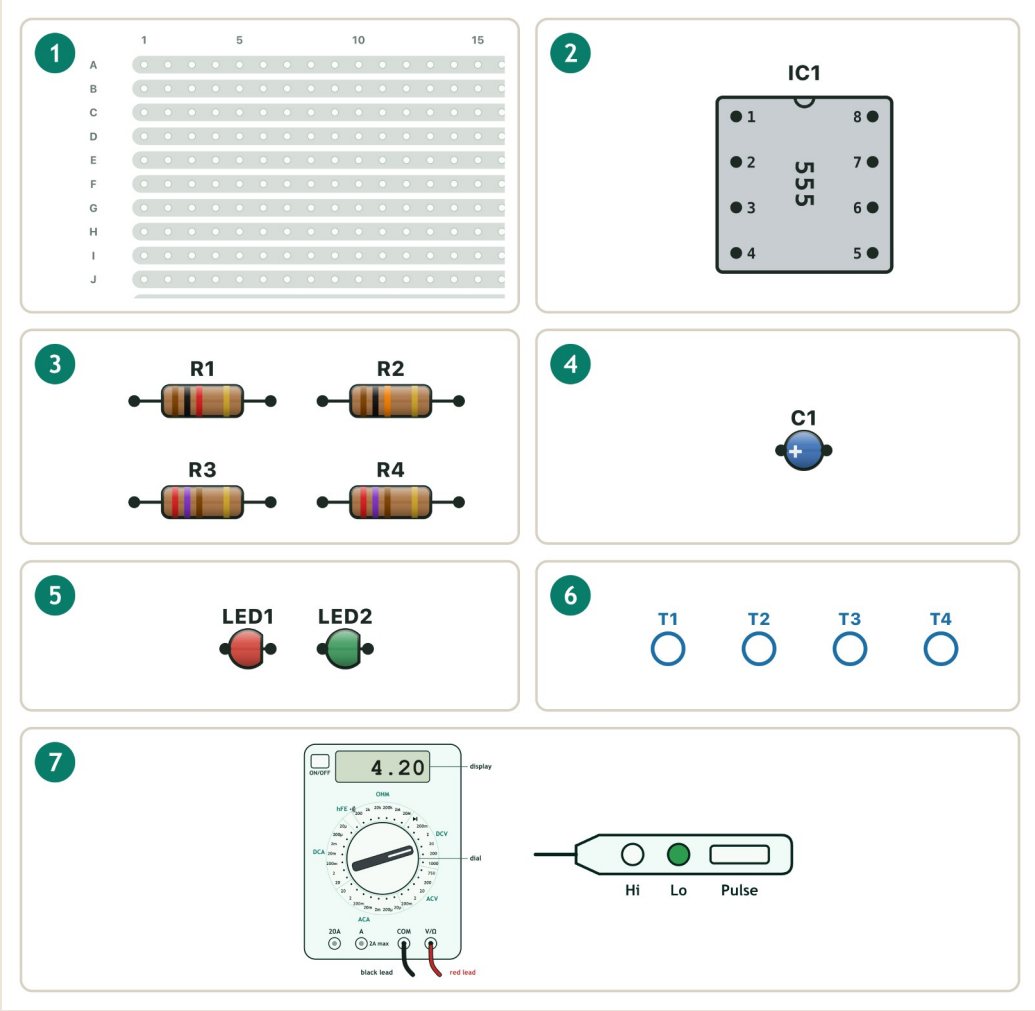
Collect and Check

Collect the kit, check every part, then the pre-power-up check.

What to Collect

Collect one set each.

1. **Stripboard**, cut to size
2. **8-pin DIL socket**, **555** (IC1)
3. **R1** 1 kΩ, **R2** 10 kΩ, **R3**, **R4** 270 Ω
4. **C1** 100 µF
5. **LED1** red, **LED2** green
6. **4 test pins** (T1 to T4)
7. **Multimeter**, **logic probe**



Your Turn: Check It

Tasks 3-4 (B6-L4-p28)

Check each part with the **meter**.
Build it, then the **pre-power-up** check: **every** row.

SAFETY Goggles on, iron in its **stand**.

TASK 3 — Check the parts
Check every part **before** it goes in. Use the Testing jobs table in section 1.

Part	Setting	Expected	Measured	OK?
R1	OHM 2k	1 kΩ: reads 0.95 to 1.05		
R2	OHM 20k	10 kΩ: reads 9.5 to 10.5		
R3, R4	OHM 2k	270 Ω: reads about 0.27		
LED1, LED2	diode check	a number one way round, 1 the other		

TASK 4 — Pre-power-up check
Fill this in **before** the supply is connected. Power on only when every row is done.

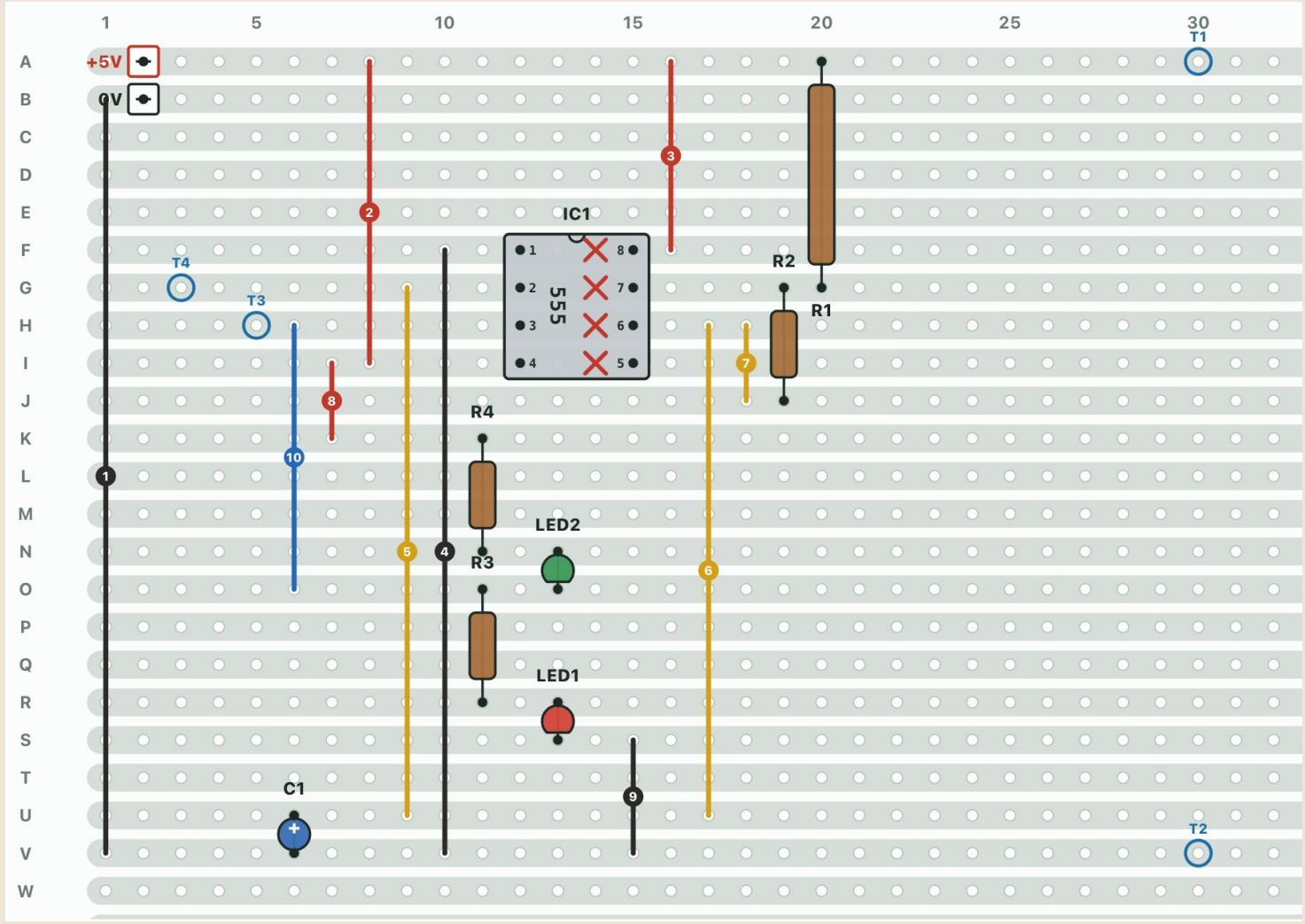
Date	Test point	Description of test	Result	Changes made
	T1 to T2	No short between the supply rails: continuity setting, no beep.		
	—	No solder bridges between tracks. Track cuts under IC1 are clean (continuity: no beep).		
	—	IC1 in its socket the right way round: notch and pin 1 at the marked end.		
	—	C1, LED1 and LED2 the right way round.		
	—	Every link matches the wiring schedule.		
	—	Supply set to 5 V before it is connected.		

PERIOD 3 STARTS HERE

Build It

Solder your board from your plan.

Build It: Bench Card 1

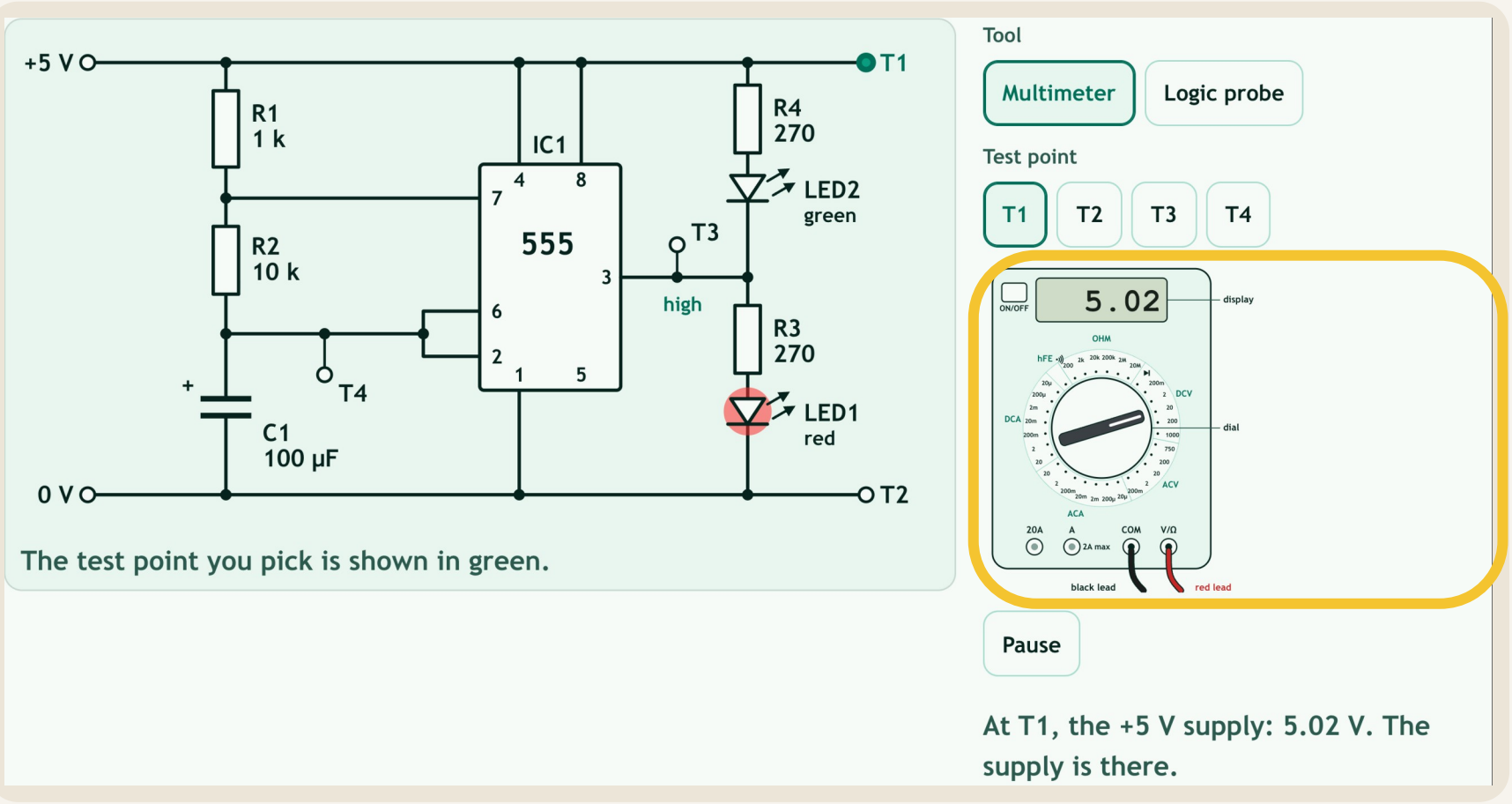


PERIOD 4 STARTS HERE

Test It

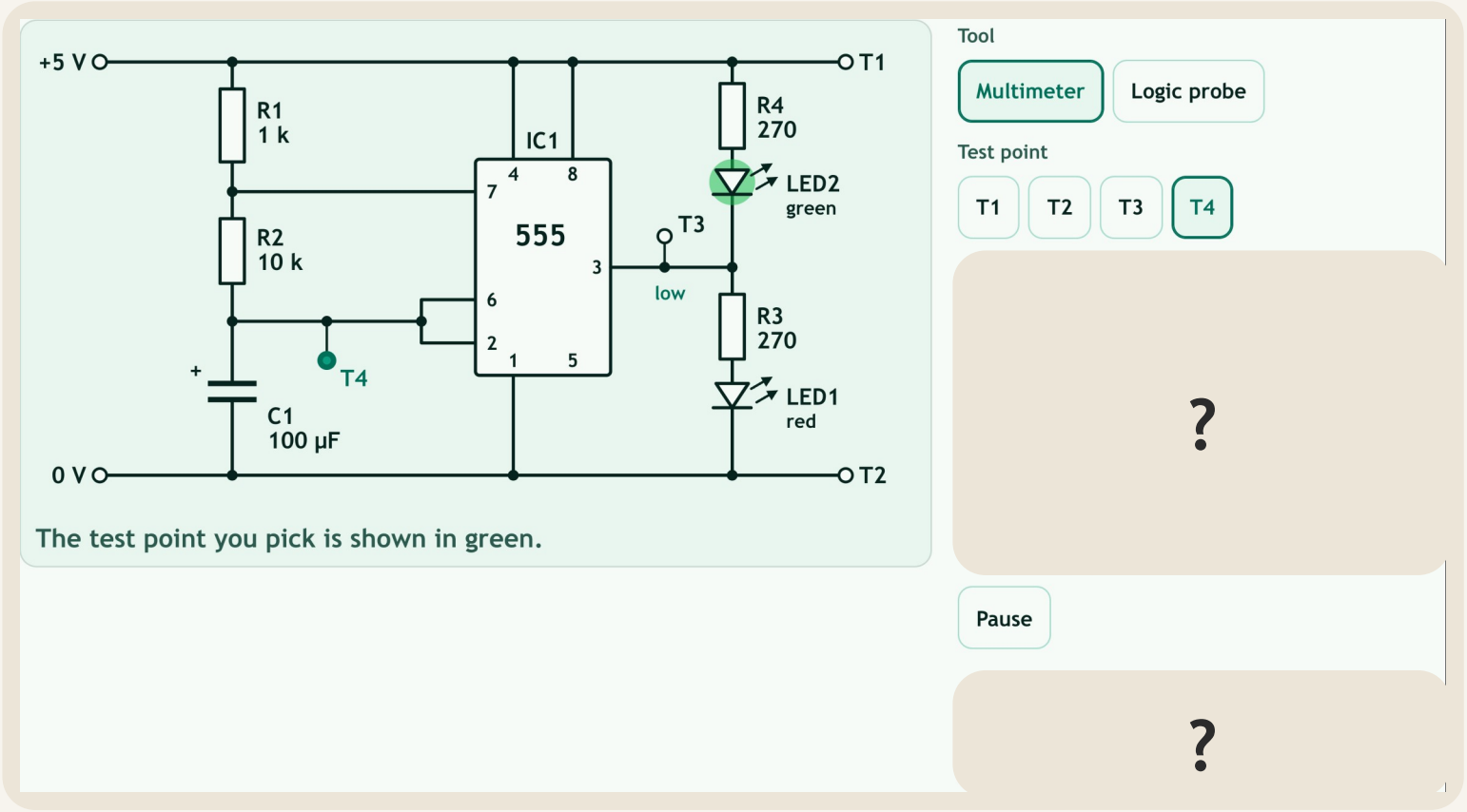
Meter and probe on your board, then count the flashes.

Test Your Board



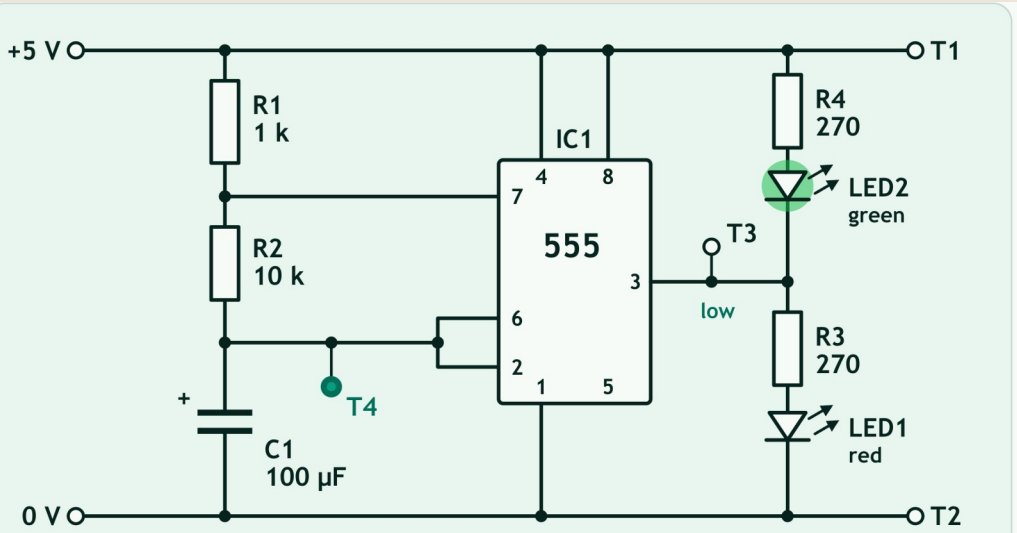
Meter on **DCV 20**, black on **T2**. **T1** reads **5 V**: the supply is there.

Meter on **T4**. **Predict** the **reading.**



Keeps changing: 1.7 V to 3.3 V

Reveal: Meter on T4



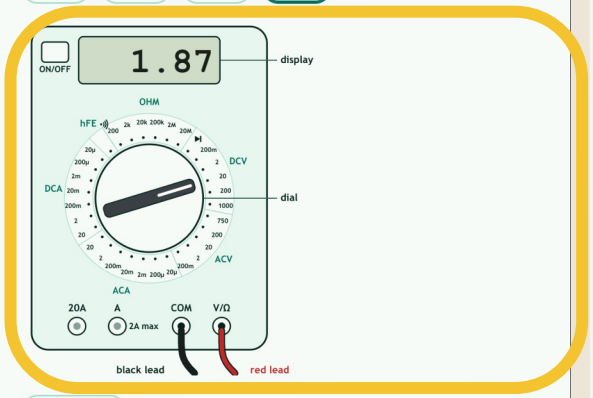
The test point you pick is shown in green.

Tool

Multimeter | Logic probe

Test point

T1 | T2 | T3 | T4

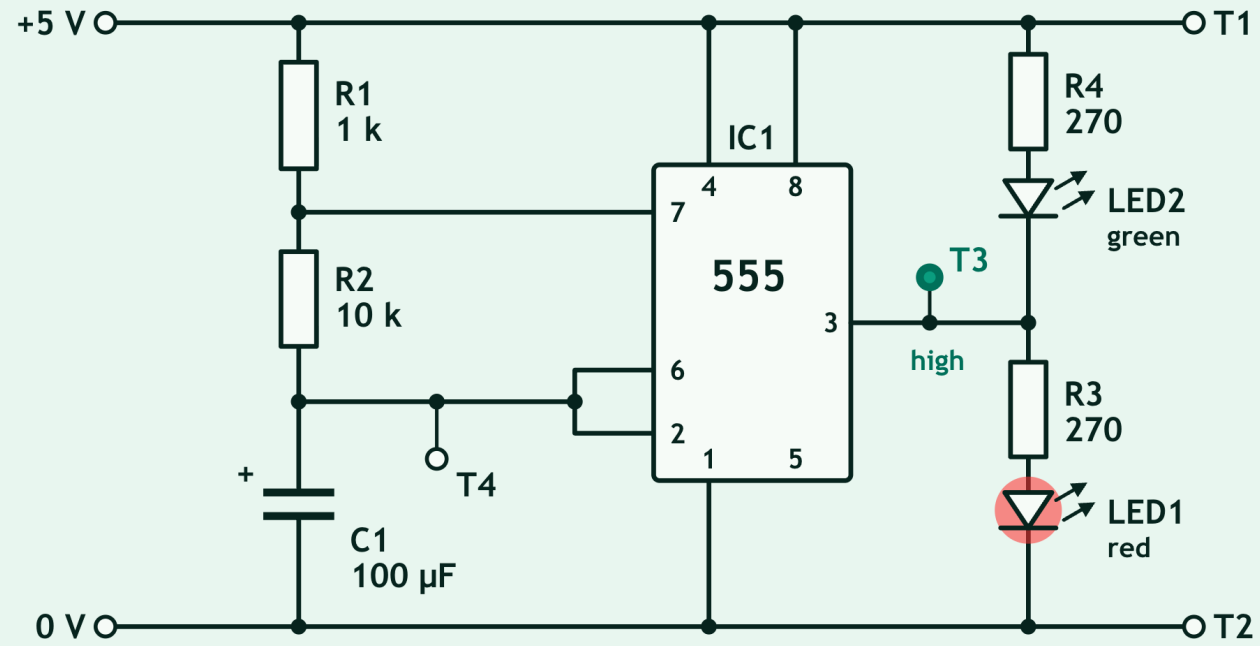


Pause

At T4, C1, pins 2 and 6: the reading rises and falls between about 1.7 V and 3.3 V: ⅓ and ⅔ of the supply.

T4 **keeps changing: 1.7 V** to **3.3 V**, ⅓ to ⅔ of 5 V.

Logic probe on **T3** (pin 3). **Predict** what it **shows.**



The test point you pick is shown in green.

Tool

Multimeter | Logic probe

Test point

T1 | T2 | T3 | T4

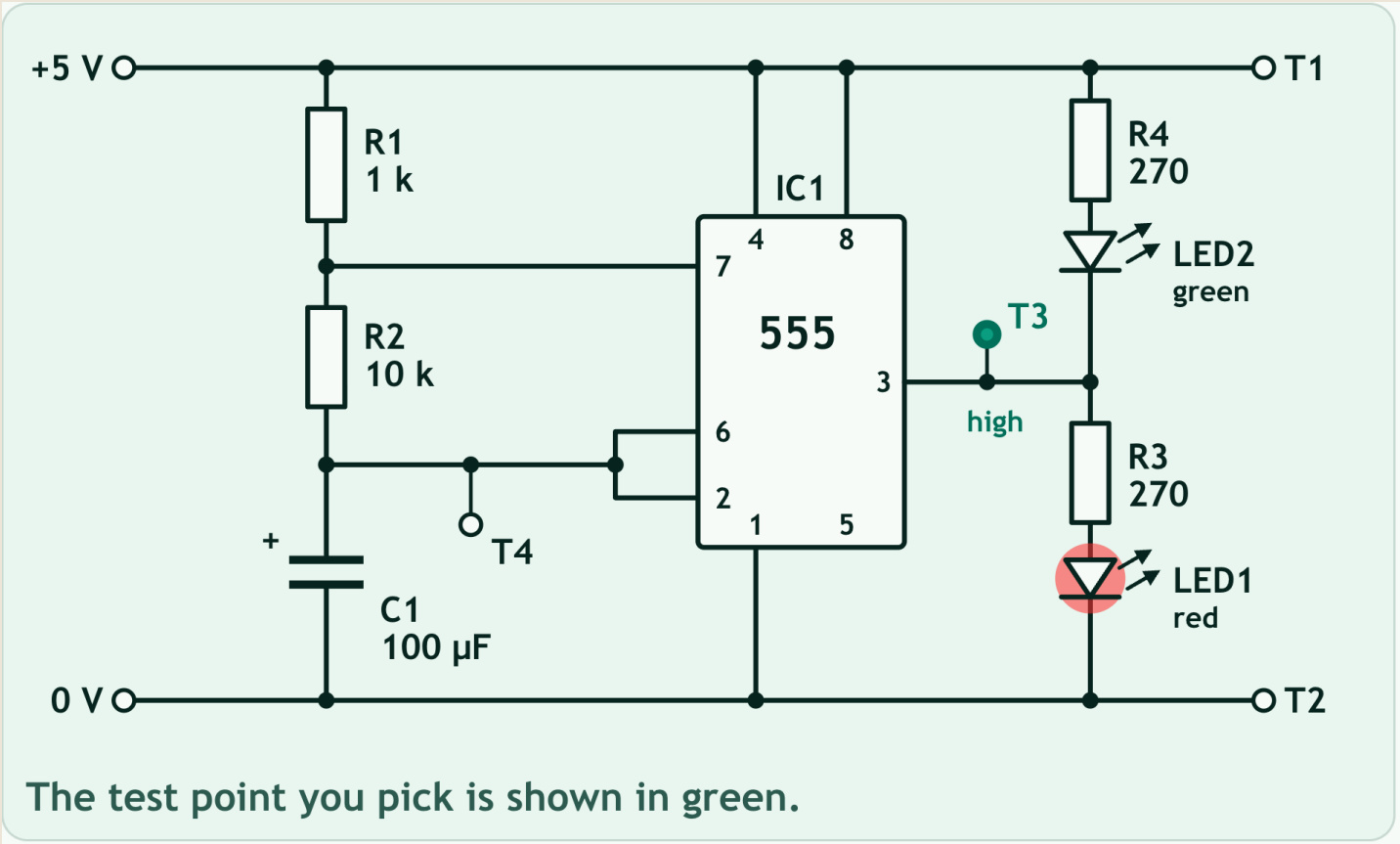
?

Pause

?

Red and green flash in turn

Reveal: Probe on T3



Tool

Multimeter | Logic probe

Test point

T1 | T2 | T3 | T4



Pause

At T3, pin 3, the output: red and green flash in turn. Pin 3 is pulsing. That is right for an astable.

Red and **green** in **turn**: pin 3 is **pulsing**.

Fault From Readings

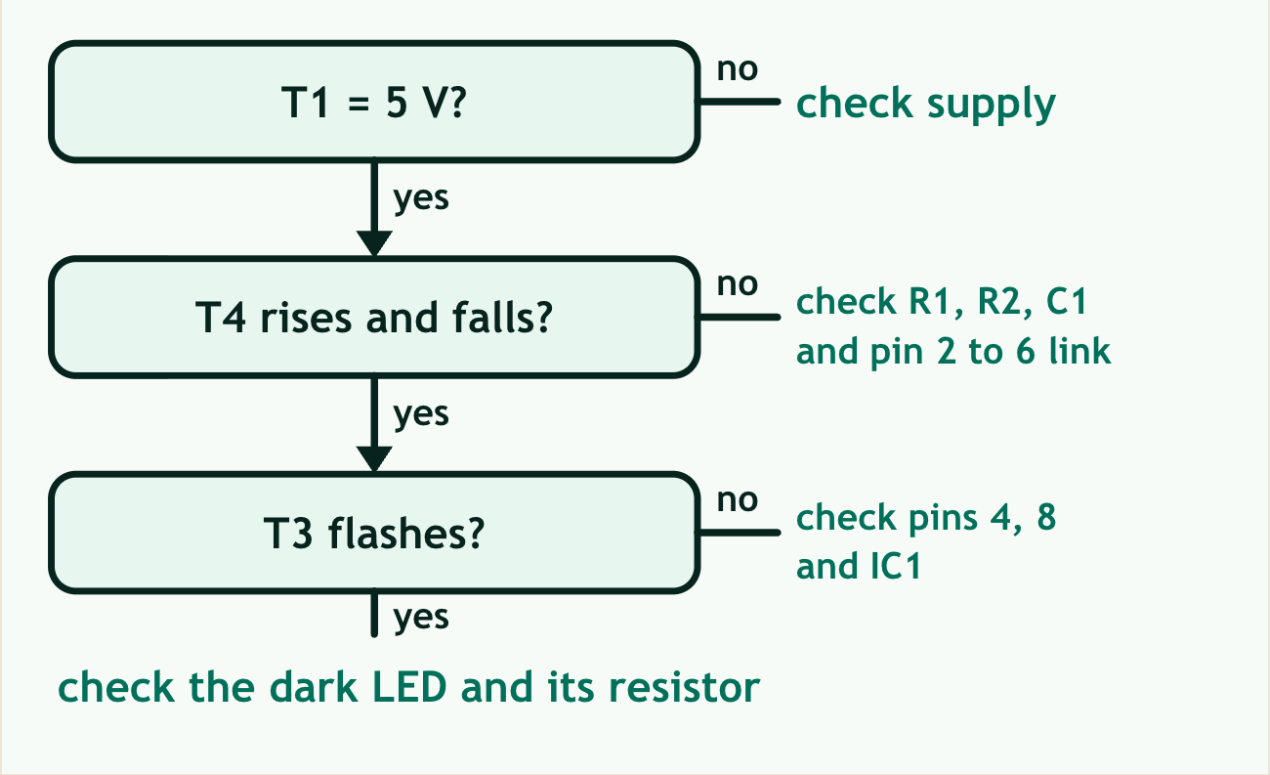
Test **supply** to **output**.

T1 not 5 V: the **supply**.

T4 steady: **R1**, **R2**, **C1**.

T3 steady: pins **4**, **8**, IC1.

One LED dark: that **LED**, its **resistor**.



Your Turn: Test It

Task 5 (B6-L4-p28-29)

Test T1 to T4 with the **meter**, then the **probe**.
Count flashes in 30 s **three** times.
Compare with Yenka.

SAFETY Power **off** to change it.

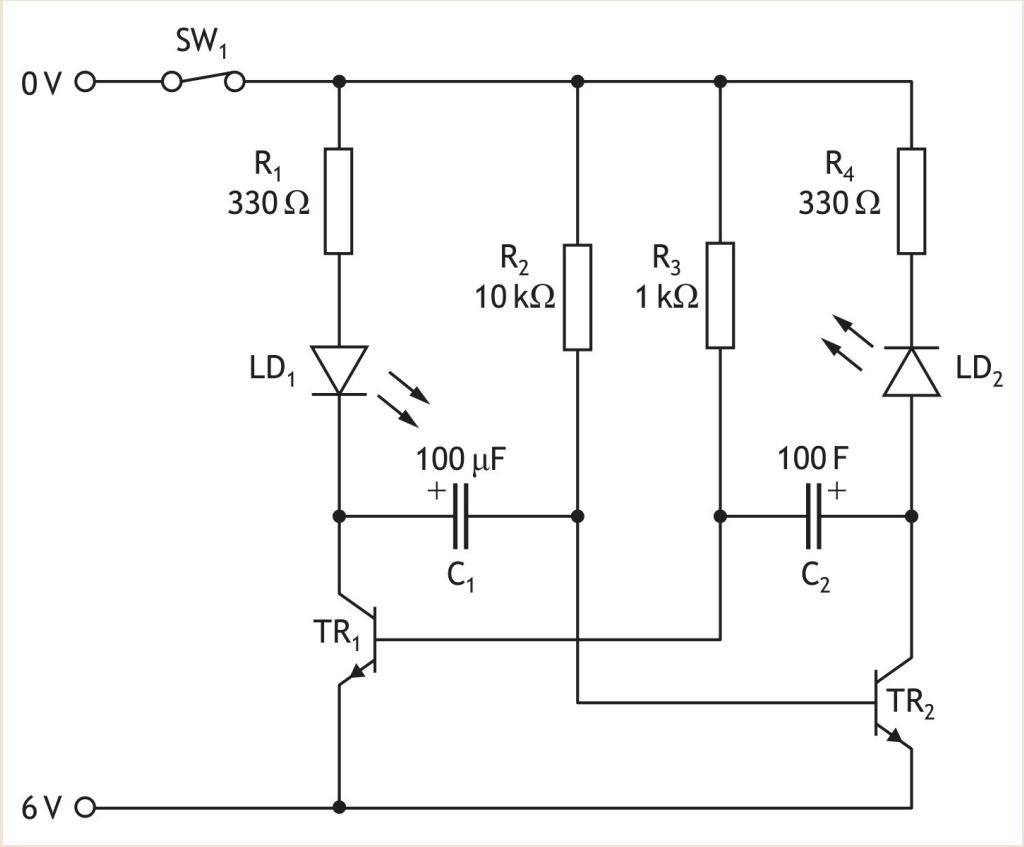
TASK 5 — Test it

Test point	What it is	Expected	Measured
T1	+5 V supply	5 V	
T2	0 V	0 V	
T3	pin 3, output	keeps changing: about 0 V, then 3.5 V to 5 V	
T4	C1, pins 2 and 6	rises and falls between about 1.7 V and 3.3 V	

2018 Question 8

8. When switched on, the circuit shown should have the LEDs alternately **flashing at the same rate**. However the student has made four errors.

Identify the **four** errors. **4**



Marking: 2018 Question 8

Question	Expected response	Max mark	Additional guidance
8.	Power supply reversed/wrong way round. (1 mark) LD2 wrong polarity/wrong way round. (1 mark) C2 value incorrect/too big/different. (1 mark) R2 / R3 value incorrect/different. (1 mark)	4	Errors can be listed in any order. Battery not accepted

Costing: Worked Example

Supplier A

Component	Code	Cost (p)
470R	AR-470	1.2
Red LED	AL-501	6
Push switch	AS-120	25

Supplier B

Component	Code	Cost (p)
470R	B0470	0.8
Red LED	BL5R	8
Push switch	BS-PB	19

Supplier	Component	Code	Cost (p)
B	470R	B0470	0.8
A	Red LED	AL-501	6
B	Push switch	BS-PB	19
	Total		**25.8**

Cheapest for **each** part.

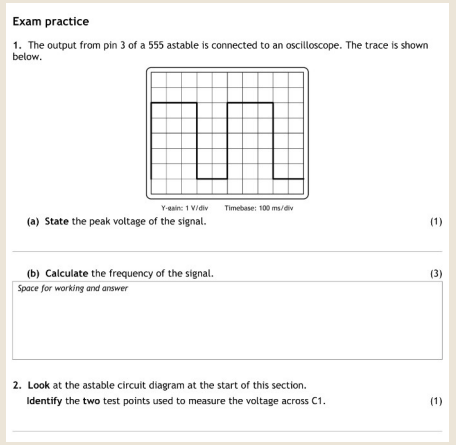
Not the cheapest **supplier**.

Your Turn: Exam Practice

Exam practice (B6-L4-p29-34)

Answer questions **1** to **5**.

Then **complete** the **key words**.



Exam practice

1. The output from pin 3 of a 555 astable is connected to an oscilloscope. The trace is shown below.

Y-axis: 1 V/div Timebase: 100 ms/div

(a) State the peak voltage of the signal. (1)

(b) Calculate the frequency of the signal. (3)

Space for working and answer

2. Look at the astable circuit diagram at the start of this section.
Identify the **two** test points used to measure the voltage across C1. (1)

Look back — by the end of this part…



1. I can **plan** an astable on the **Stripboard Builder**, with **track cuts** and **test points**
2. I can **build** and **test** an astable with a **meter** and a **logic probe**

Course Specification — 1 of 3

Content and concepts

- From an oscilloscope trace of a sinusoidal or square wave determine the peak voltage and the period and frequency of the signal, given the Y-gain and time base settings.
- Identify an oscilloscope trace/signal as either analogue or digital.
- Describe the effect on the timing of the output waveform of changing the capacitance of a capacitor in a given circuit.

Course Specification — 2 of 3

Circuit simulation and design

- Given a printout of a simulated circuit, identify potential faults, eg incorrect supply voltage, incorrect resistor values or wrong component orientation (test points to be included).
- Compile a pre-power up checklist for a given simulation printout, layout diagram or circuit diagram.
- Determine costs of constructing circuits given component codes and component costs.

Course Specification — 3 of 3

Circuit construction

- Describe the use of a logic probe and continuity tester in circuit testing.
- State at least two safety measures to be taken when soldering.
- Describe the uses of prototype board, stripboard and printed circuit board (PCB) in electronic design and construction.

Credits

Screenshots and page figures: mrstewartphysics.co.uk, Lesson 4 The 555 Astable page and its stripboard guide, R Stewart.

Daily Reviews: © Qualifications Scotland (SQA). N5 Practical Electronics 2025 Q1(b)(ii), Q3(a)(i); 2026 Q1(c), Q3(a)(ii).

Drawings: Circuit drawings, 555 symbol, graphs, oscilloscope trace, catalogues and booklet pages: Block 6 booklet and deck, R Stewart.

2024 Question 8: © Qualifications Scotland (SQA). N5 Practical Electronics 2024 Q8: question, figure and marking instructions.

2018 Question 8: © Qualifications Scotland (SQA). N5 Practical Electronics 2018 Q8: question, figure and marking instructions, via J Keegan's past-paper compilation (Nov 2025 update).

Course specification: © Qualifications Scotland (SQA). N5 Electronics course specification v3.1, pp.5-7

R Stewart - October 2026