

TEACHER NOTES

[Youtube video](#)

Stopping distance

Dr Andrew French. September 2021.

Equipment

Laptop running Capstone datalogging software

PASCO light gate connector

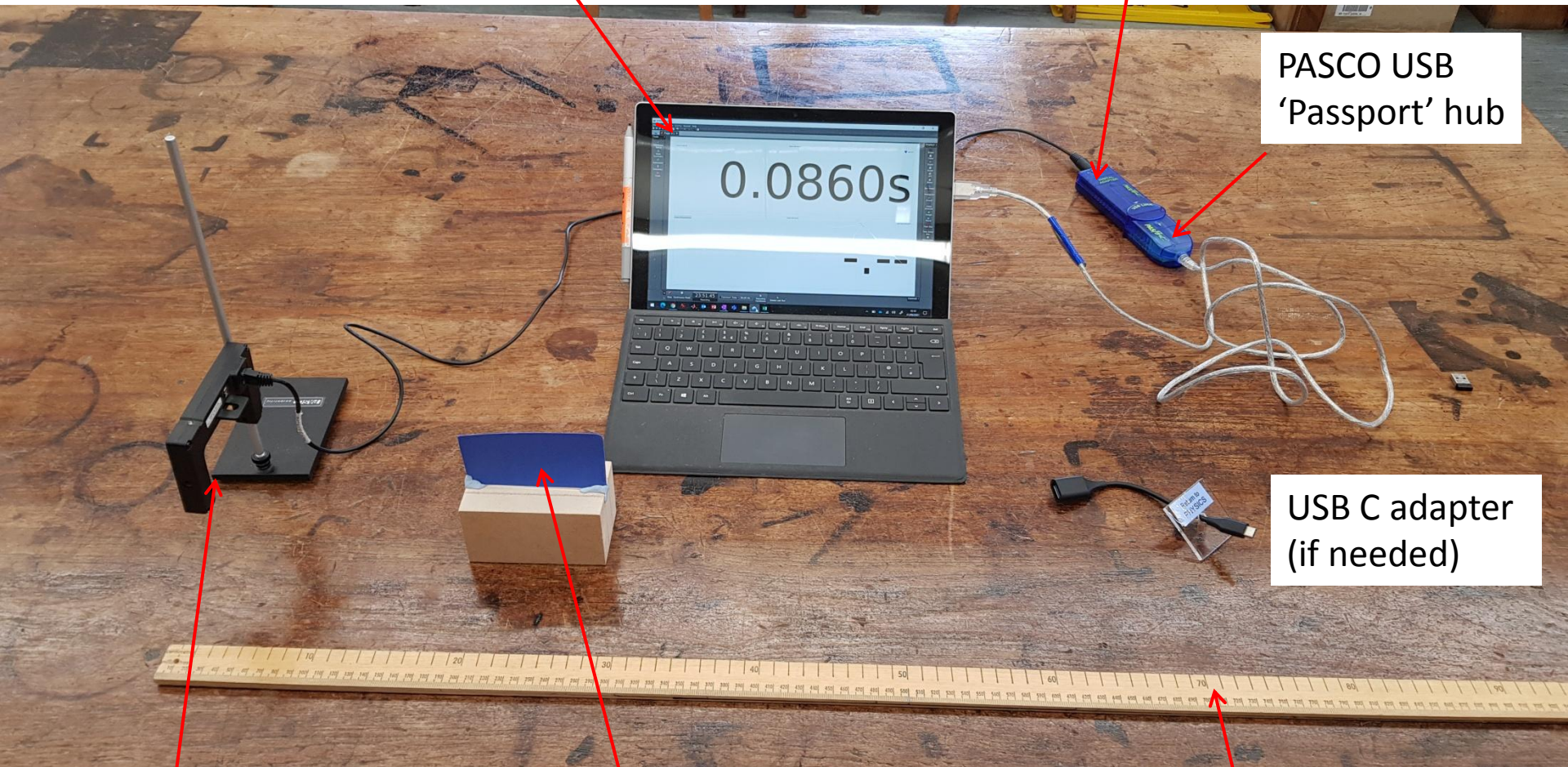
PASCO USB 'Passport' hub

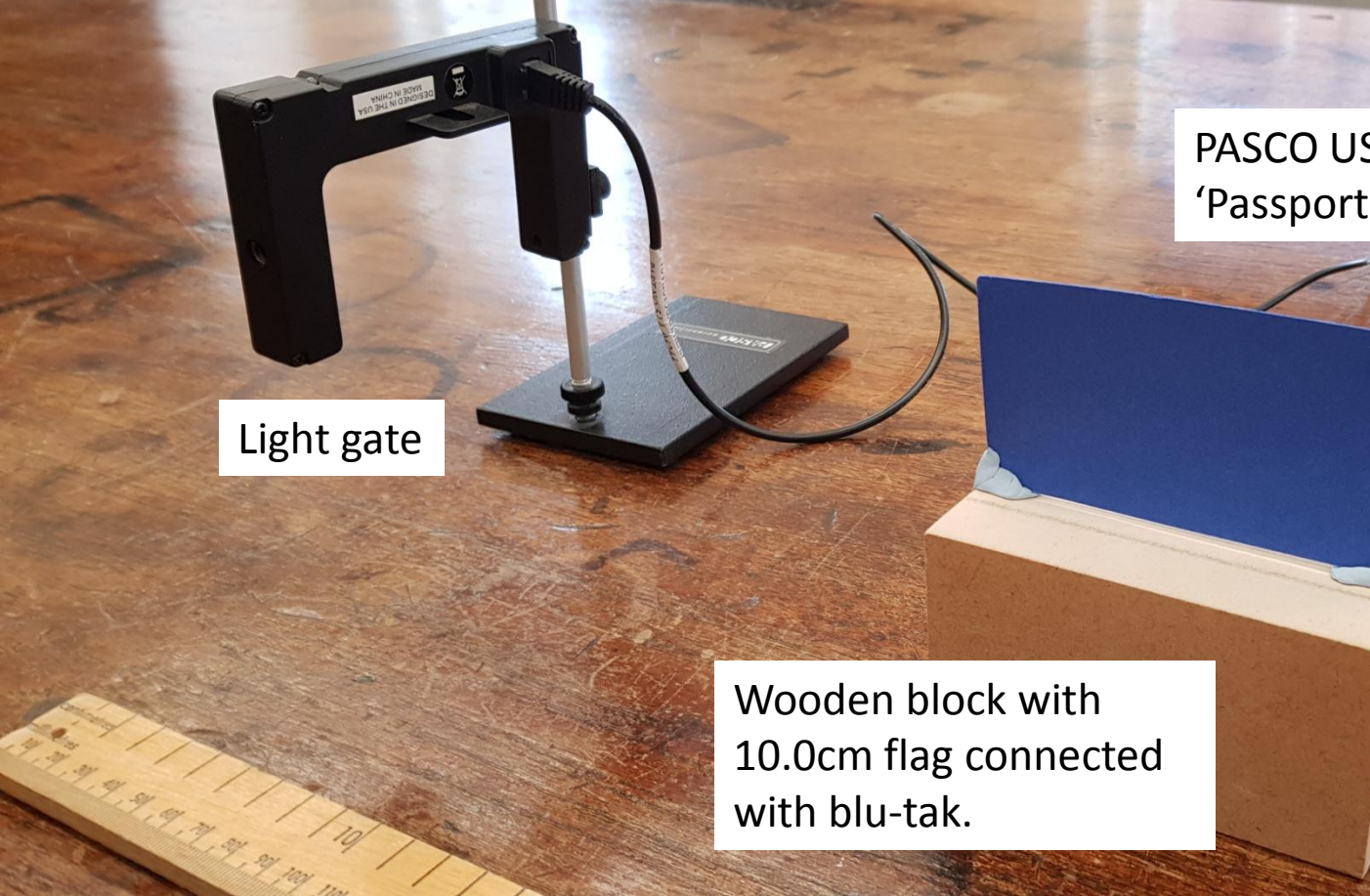
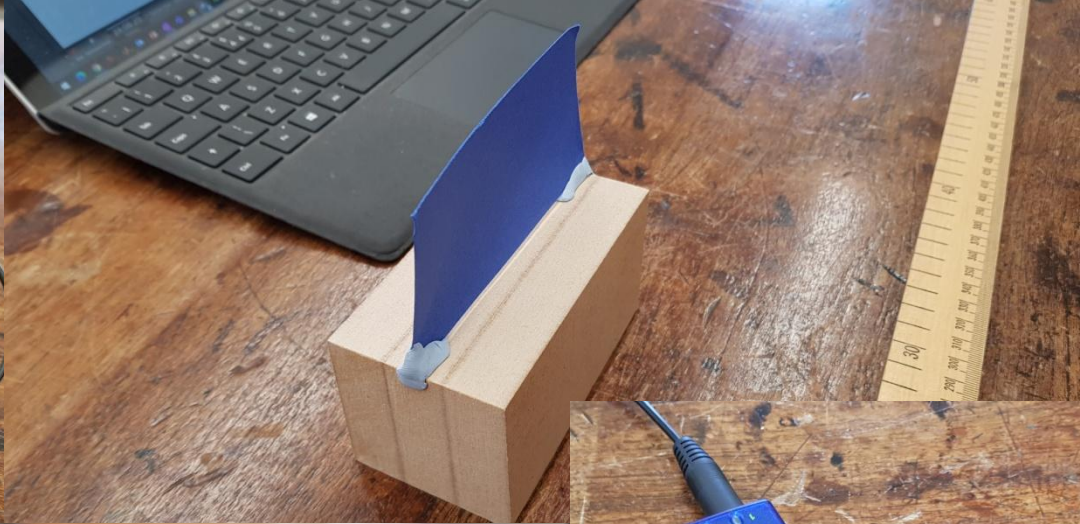
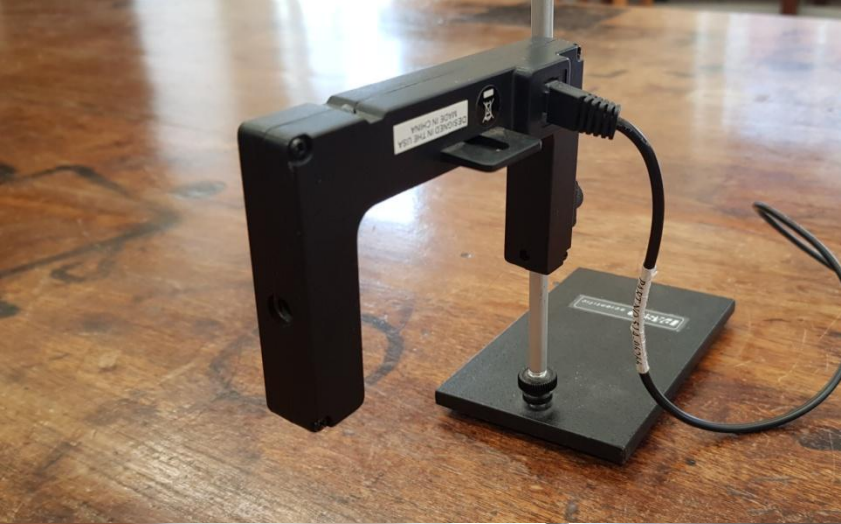
USB C adapter (if needed)

Light gate

Wooden block with 10.0cm flag connected with blu-tak.

1 metre ruler



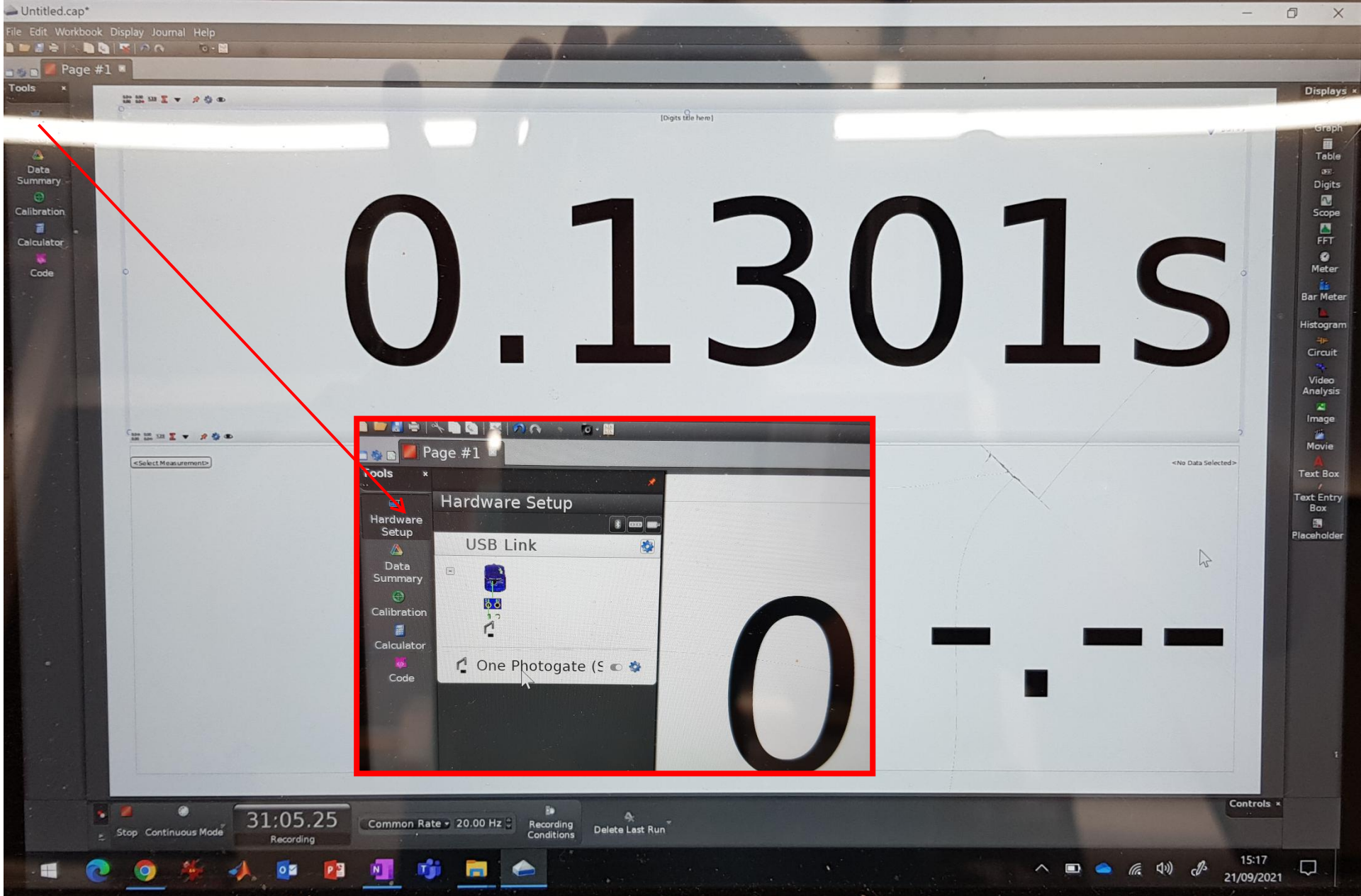


Light gate

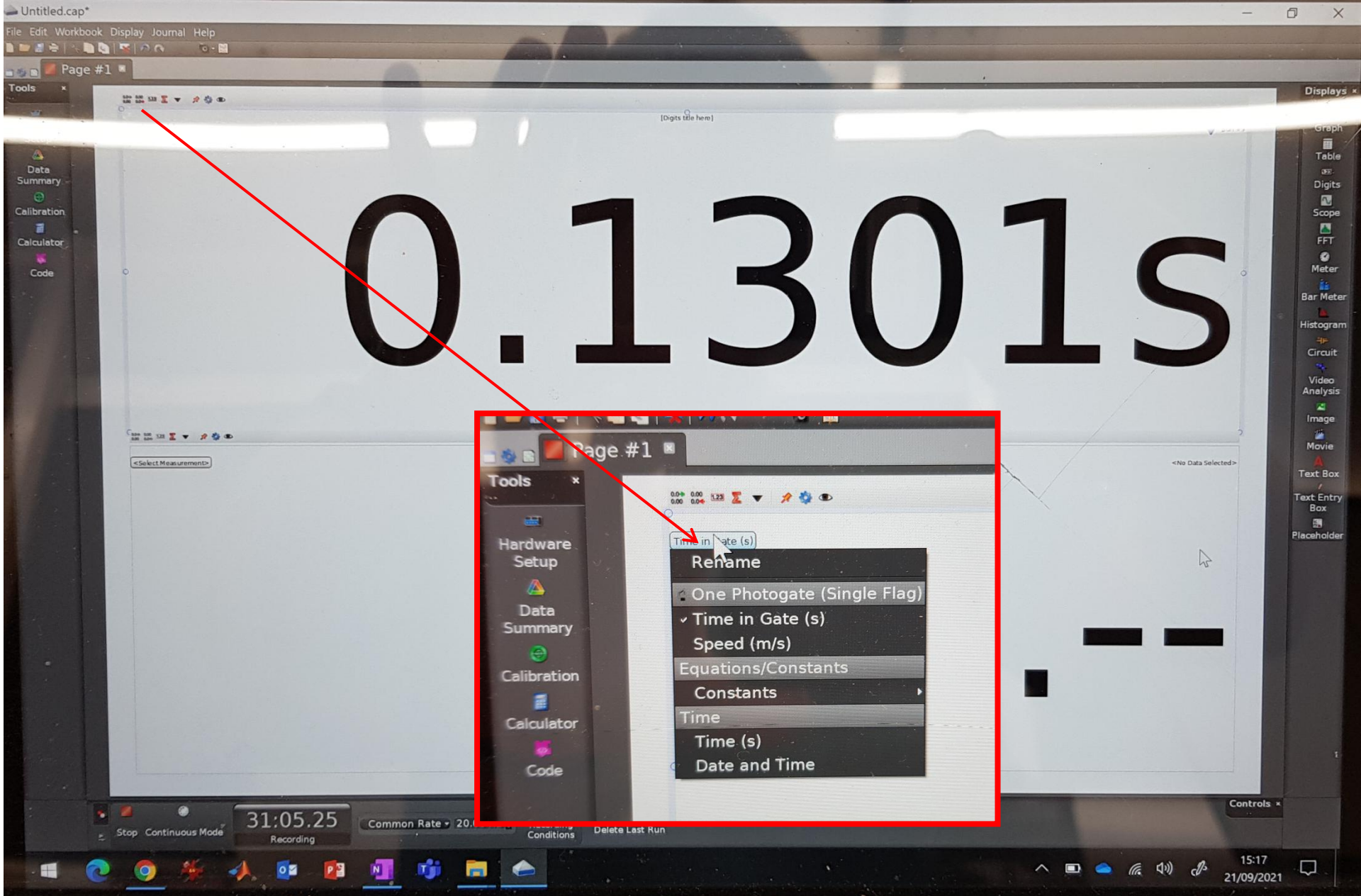
PASCO USB
'Passport' hub

Wooden block with
10.0cm flag connected
with blu-tak.

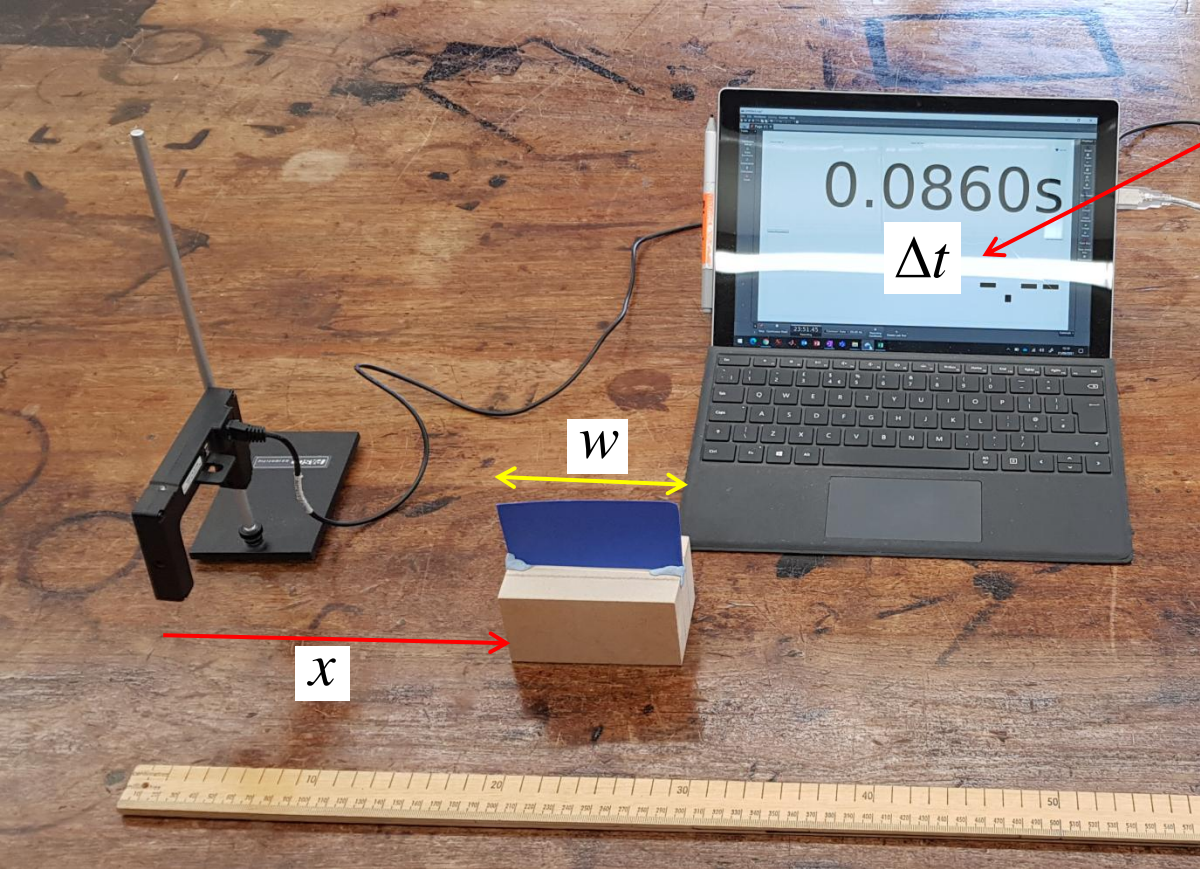




Connect light gate to Surface via PASCO Passport USB hub. Load Capstone and select the connected port of the USB link to be **One Photogate (single flag)**



Use 'Classic templates' and choose the display with timer on it. In the top left corner select **Time in Gate**.



This is the time the blue flag is in the light gate. So block exit speed is (on average) :

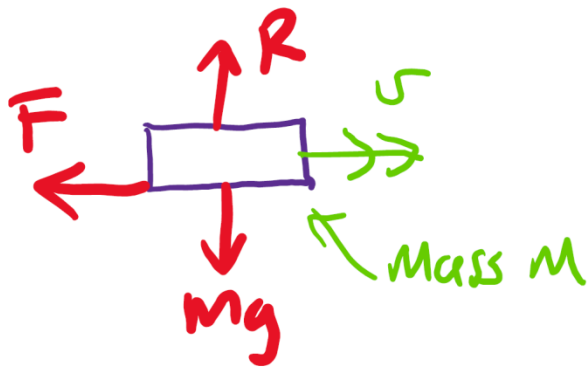
$$v = \frac{w}{\Delta t}$$

Use a straight edge to help measure the displacement x of the back edge of the blue flag from the light gate.

Make sure you accelerate (i.e. shove) the block *before* the light gate!

Ignore any blocks that rotate more than ninety degrees.





Friction force $F = \mu R$

$$R = mg$$

$$\therefore F = \mu mg$$

If block leaves
light gate at speed v
and stops after x metres

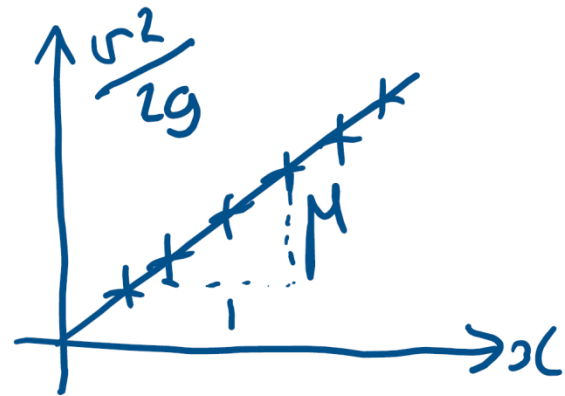
$$\frac{1}{2}mv^2 = Fx$$

Kinetic energy

Work done by
friction

$$\therefore \frac{1}{2}Mv^2 = \mu mgx$$

$$\frac{v^2}{2g} = \mu x$$



μ is gradient

of $\frac{v^2}{2g}$ vs x

Coefficient of sliding friction μ

STOPPING DISTANCE

A. French 21/9/2021

Try to aim for a reasonable spread of stopping distances between 1cm and 50cm

flag length /m

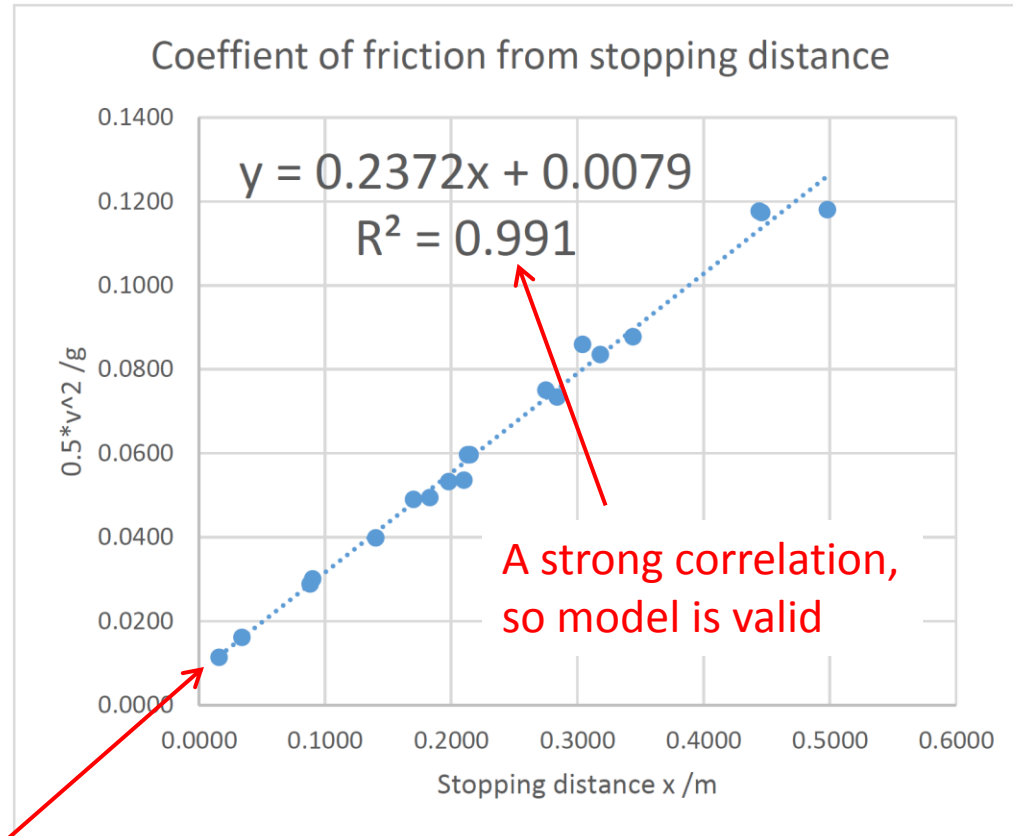
0.1

- x Displacement of rear flag position from light gate
- t Time of 0.100m flag in light gate
- v Average speed of block in light gate (m/s)

g Gravitational field strength (N/kg)

9.81

x /cm	t /s	v / ms ⁻¹	0.5*v ² /g	x /m
8.8	0.1329	0.7524	0.0289	0.0880
9.0	0.1301	0.7686	0.0301	0.0900
21.3	0.0924	1.0823	0.0597	0.2130
18.3	0.1015	0.9852	0.0495	0.1830
31.8	0.0781	1.2804	0.0836	0.3180
28.4	0.0833	1.2005	0.0735	0.2840
14.0	0.1130	0.8850	0.0399	0.1400
21.0	0.0975	1.0256	0.0536	0.2100
17.0	0.1019	0.9814	0.0491	0.1700
34.4	0.0762	1.3123	0.0878	0.3440
19.8	0.0978	1.0225	0.0533	0.1980
30.4	0.0770	1.2987	0.0860	0.3040
49.8	0.0657	1.5221	0.1181	0.4980
44.6	0.0659	1.5175	0.1174	0.4460
27.5	0.0824	1.2136	0.0751	0.2750
3.4	0.1774	0.5637	0.0162	0.0340
1.6	0.2108	0.4744	0.0115	0.0160
21.5	0.0924	1.0823	0.0597	0.2150
44.4	0.0658	1.5198	0.1177	0.4440



Coefficient of sliding friction is about 0.237

M

Small systematic error, since we are using the back end of the flag but the average block speed in the light gate.