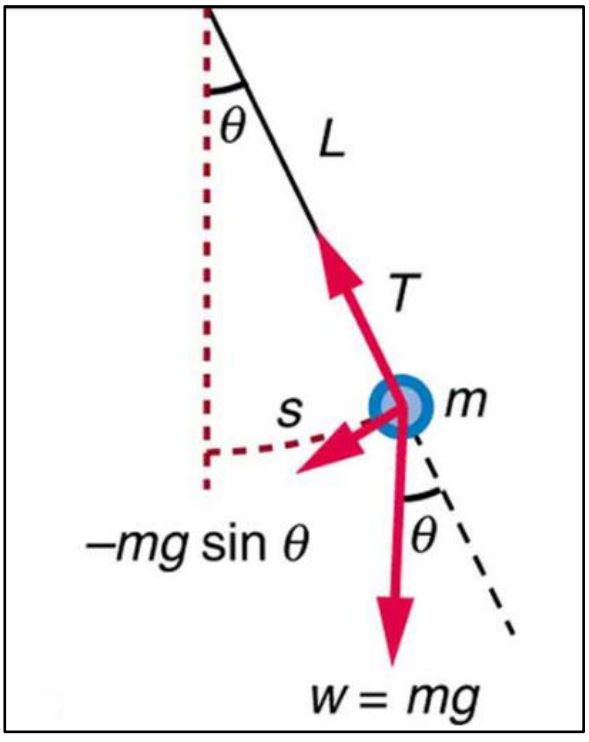
Candidate 5 evidence (Simple Pendulum)

Simple Pendulum

I am going to see if the mass & the length of a pendulum affects its period.
A simple pendulum is just a mass swinging at the end of a light string which is fixed at the top. Its period is the time it takes to swing from one position & get back to that position.
The forces that act on the mass are its weight & the tension in the string. These combine together as the next diagram shows.



(1)

The period of the mass can be predicted using the theory shown.

$$F = ma$$

$$F = -mg\sin\theta = ma$$

$$a = -g\sin\theta$$

$$s = \ell\theta$$

$$a = \frac{d^2s}{dt^2} = \ell\frac{d^2\theta}{dt^2}$$

$$\frac{d^2\theta}{dt^2} + \frac{g}{\ell}\sin\theta = 0$$

Small angle approximation: $\theta \ll 1$

$$\frac{d^2\theta}{dt^2} + \frac{g}{\ell}\theta = 0.$$

$$\theta(t) = \theta_0\cos\left(\sqrt{\frac{g}{\ell}}t\right) \qquad \theta_0 \ll 1.$$

$$T_0 = 2\pi\sqrt{\frac{\ell}{g}} \qquad \theta_0 \ll 1$$

(2)

THIS SAYS THAT THE PERIOD WILL DEPEND ON THE SQUARE ROOT OF THE LENGTH & WONT DEPEND ON THE MASS AT ALL.

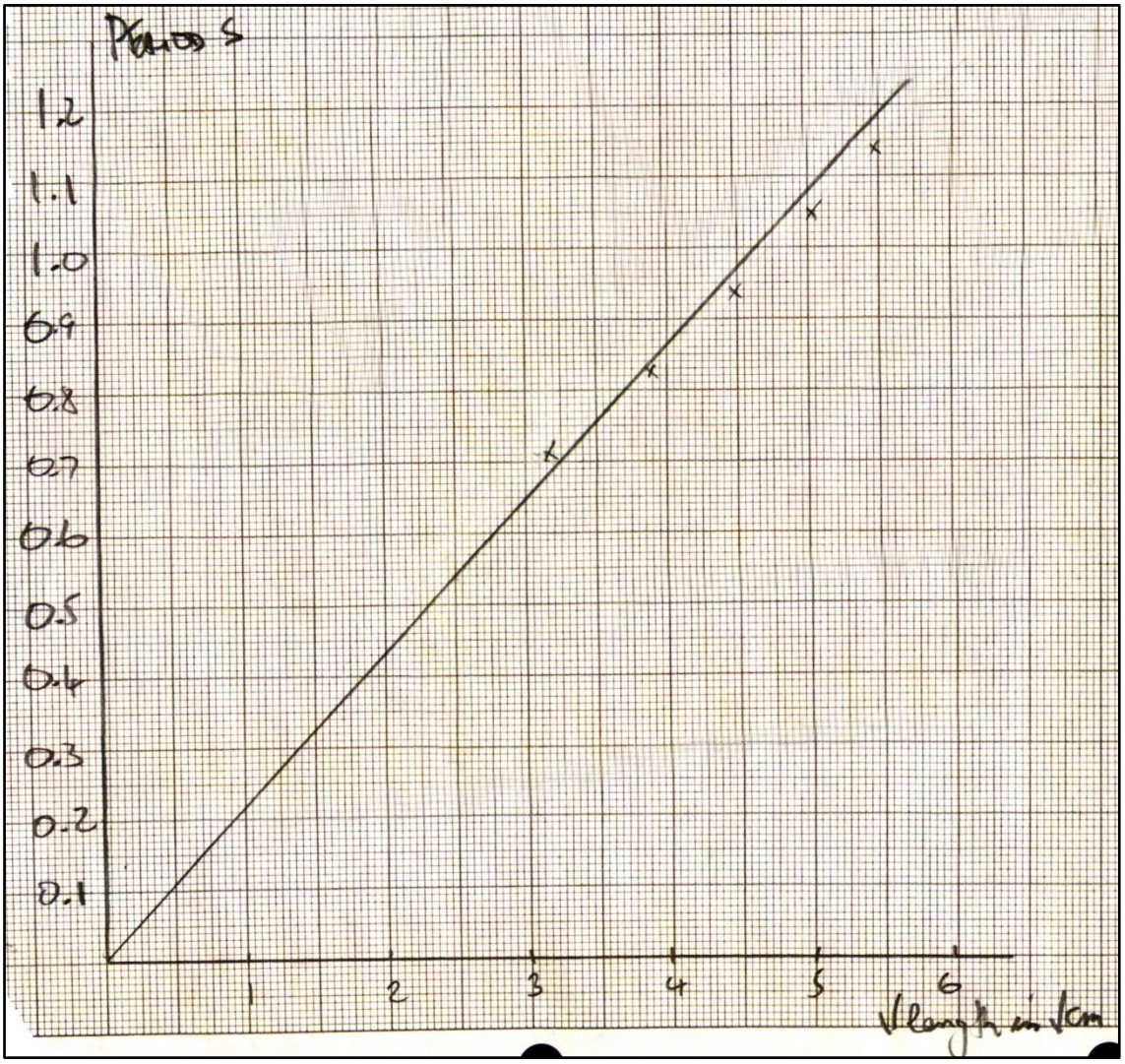
MY EXPERIMENTS WILL SEE IF THIS IS RIGHT.

EXPERIMENT 1

I ATTACHED A SLOT MASS CARRIER TO A LIGHT STRING & FIXED THE OTHER END OF THE STRING TO A CLAMP STAND. I PULLED THE MASS ASIDE & LET IT SWING. I TIMED THE PERIOD OF THE MASS USING A STOPWATCH THAT IS THE TIME FOR THE MASS TO SWING TO THE OTHER SIDE & GET BACK AGAIN 10 TIMES.

I DIVIDED THIS BY 10. I MEASURED THE LENGTH OF THE STRING WITH A RULER. I REPEATED THE EXPERIMENT TO MAKE IT ACCURATE I CHANGED THE LENGTH & DID IT AGAIN.

Length in 'cm'	Time for 10 swings in 's'			Period in 's'	Square Root of Length in Square Root of 'cm'	Random Uncertainty in Period in 's'
	1	2	Avg			
10	7 23	6·96	7 10	0·71	3·16	0·14
15	8·42	8 25	8 34	0 83	3 87	0 09
20	9 37	9 42	9 40	0·94	4·47	0·02
25	10 54	10·36	10·45	1·05	5·00	0·09
30	11 56	11·27	11·42	1·14	5 48	0·15

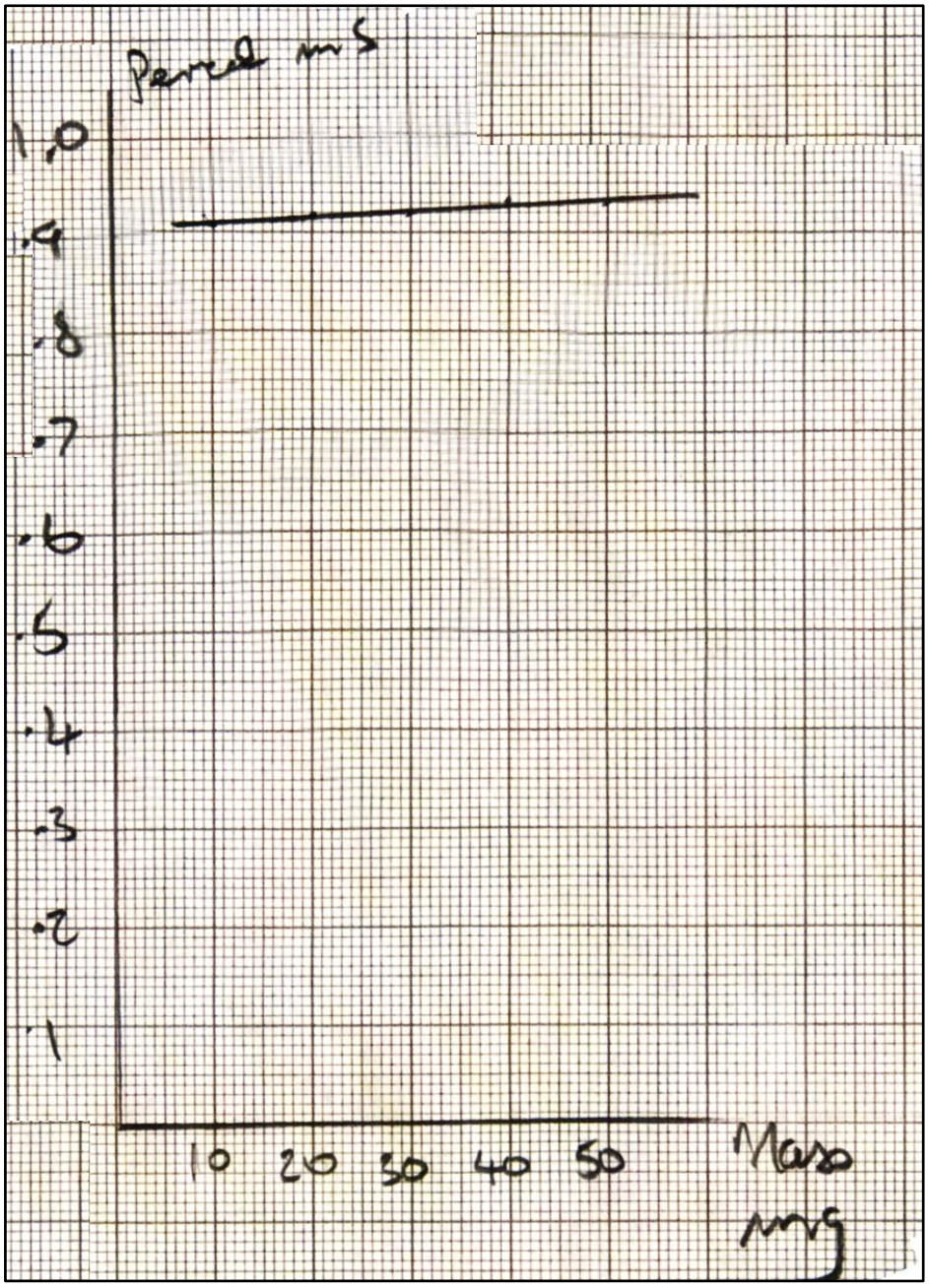


THE GRADIENT OF THE LINE IS 0.22.
THE READING ERROR IN THE STOPWATCH WAS 0.005 s & THE RULER WAS 0.05 cm.

EXPERIMENT 2

I ATTACHED A SLOT MASS CARRIER TO A LIGHT STRING & FIXED THE OTHER END OF THE STRING TO A CLAMP STAND. I PULLED THE MASS ASIDE & LET IT SWING. I TIMED THE PERIOD OF THE MASS USING A STOPWATCH THAT IS THE TIME FOR THE MASS TO SWING TO THE OTHER SIDE & GET BACK AGAIN 10 TIMES. I DIVIDED THIS BY 10. I COUNTED THE NUMBER OF 10 GRAM MASSES I PUT ON. I REPEATED THE EXPERIMENT TO MAKE IT ACCURATE. I ADDED MORE MASSES & DID IT AGAIN.

MASS IN 'g'	TIME FOR 10 SWINGS IN 's'			PERIOD IN 's'	RANDOM UNCERTAINTY IN PERIOD IN 's'
	1	2	AVG		
10	9.16	9.07	9.12	0.91	0.05
20	9.17	9.23	9.20	0.92	0.03
30	9.27	9.12	9.20	0.92	0.08
40	9.32	9.36	9.34	0.93	0.02
50	9.35	9.27	9.31	0.93	0.04



THE GRADIENT OF THE LINE IS 0·005.
THE READING ERROR IN THE STOPWATCH WAS 0·005S ± THE RULER WAS 0·05CM.

IF I HAD TRIED TO MEASURE THE TIME FOR 1 SWING OF THE MASS IT WOULD NOT HAVE GIVEN ACCURATE RESULTS BECAUSE OF HUMAN REACTION TIME. I MEASURED THE TIME FOR 10 SWINGS & DIVIDED BY 10 TO MAKE IT MORE ACCURATE.

I MEASURED THE LENGTH OF JUST THE STRING. BUT THE PENDULUM IS THE MASS AS WELL, SO IT WOULD HAVE BEEN BETTER TO MEASURE FROM THE TOP OF THE STRING TO THE MIDDLE OF THE MASS.

I CAN CONCLUDE THAT THE THEORY WAS RIGHT. THE PERIOD DEPENDS ON THE SQUARE ROOT OF THE LENGTH & DOESN'T DEPEND ON THE MASS AT ALL.

1. http://philschatz.com/physics-book/resources/Figure_17_04_01a.jpg (Jan 2018)
2. http://laser.physics.sunysb.edu/~samantha/journal/ForceDerv.png (Jan 2018)