Year 11 – Newton's Second Law Experiment

Name:	Teacher:	
Comment:		Due Date:
Pre lab + Report : _____ out of 57	Scaled Total _____ out of 50	

The lab and write up is worth 50%, the other 50% will be a validation test.

AIM : To investigate the relationship between **force, mass and acceleration**.

Pre-Lab questions.

1. Write a statement of Newton's second law of motion. (1 mark)

The acceleration of an object is directly proportional to the net applied force & inversely proportional to mass

2. Write a mathematical statement for newtons second law. (1 mark)

$F = ma$

MUST HAVE TOTAL MASS

In this lab the acceleration will be measured using either the PASCO acceleration carts or the wireless force acceleration probe and the SPARKVUE program

3. Explain how doing more than one measurement can reduce the error in the experiment? (2 marks – see textbook)

Reduces random errors due to limitations of the experiment

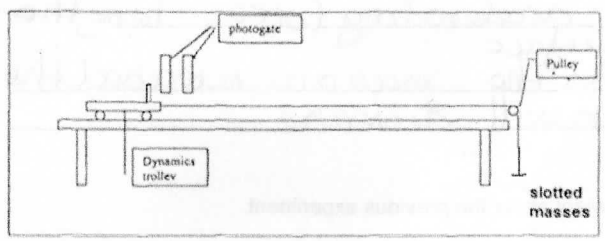
Identify outliers & systematic bias

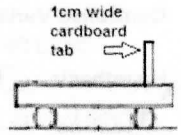
→ the accuracy of equipment & experiment design

Method

Equipment required

Acceleration cart or force acceleration probe
Slotted masses (10 x 50 g) *you don't need the cardboard or photogate*
ipad Large masses (0.5 kg)
Pulley and clamp String
Dynamics trolley if you are using force acceleration probe





Method A: Variable force , constant mass (4)

Independent Variable: Applied force – slotted masses

Dependent Variable: acceleration of trolley

Controlled Variables: total mass, same length, same surface.

Hypothesis- The greater the applied force the greater the acceleration

1. Set up the equipment as shown above, ensure that you have some way of stopping the cart fall over the edge.
2. Place up to ten 50 g (including the stand) slotted masses onto the trolley and weigh it. Record the mass.
3. Whilst holding the trolley, take the 50 g stand mass from the trolley and attach it to the end of the string over pulley. (this mass provides the accelerating force (Eg F = mg) Note the total mass of the system has not changed.
4. Place the trolley as far away from the edge of the bench as you can, but with the 50g stand mass hanging over the edge.
5. Run the SPARKVUE program to measure acceleration
6. Release the trolley and record the acceleration.
   (be sure to stop the trolley before any possible damage)
7. Repeat for another two trials.

8. Take another 50 g mass from the trolley and place it at the end of the string.
9. Repeat the procedure for 6 sets of data.

Method B: Variable mass, constant force (4 marks)

Independent Variable: total mass - mass on trolley + slotted masses

Dependent Variable: acceleration

Controlled Variable: accelerating force, length, same surface

Hypothesis- As the mass is increased the acceleration will decrease.

1. Set up the equipment as for the previous experiment.
2. Record the mass of the trolley and a 100 g mass. This is the **Total accelerated mass** for the first trial
3. Set the trolley in place the 100 g on the end of the string.
   Note the 100g is the accelerating force
4. Run the program, release the trolley and record the accleration.
5. Repeat for another two trials before resetting the program
6. Place 200 g on the trolley and repeat.
7. Repeat the procedure using additional masses of 300 g, 400g, 500g and 600g on the trolley.

Average $\bar{x} = \frac{x_1 + x_2 + x_3}{3}$

$\Delta x = \frac{\sqrt{(x_1 - \bar{x})^2 + (x_2 - \bar{x})^2 + (x_3 - \bar{x})^2}}{3}$

Results Part A (6marks)

Total mass of system = _____(kg) (1) mark

Mass in pan (kg)	Accelerating force Mass in pan x 9.8 (N)	Acceleration (ms^{-2})			
		Trial 1	Trial 2	Trial 3	**Average +error**
0.05					

(1) (1) (1) Calcs (2) average and error

Results Part B (6 marks)

Mass of trolley _____kg

Constant force = 0.1 x 9.8 = _____N (1)

Mass on trolley (kg)	Total accelerated mass (Trolley + 0.1 + mass on trolley) (kg)	acceleration(ms^{-1})			
		Trial 1	Trial 2	Trial 3	Average +error
0					

(1) (1) (1) Calcs average & error (2)

GRAPH: Title: (1) / labels axes. (1)

Correct axes (1) line of best fit (1)
Units (1)
Accurate Plotting (2)

Processing results

Part A

1. Draw an appropriate graph of accelerating force and acceleration. (6 mks)
2. What is the shape of the graph? (1 mark)

Linear (1)

3. What is the mathematical term used to describe the relationship between accelerating force and acceleration? (1 mark)

Proportional (1)

4. Use appropriate graphical techniques to determine the experimental value for the mass of the system and compare it to the measured value. Determine the percentage error and include a discussion on errors. Show all proof of working and logical explanations. (6 marks)

Draws gradient lines on graph (1)

Calculates gradient: gradient = $\frac{y_2 - y_1}{x_2 - x_1}$ (1)

Identifies gradient = m (1)

Value for m = _____

Percentage error = $\frac{\text{actual} - \text{theor}}{\text{theor}} \times 100$ (1)

Discussion errors: friction - reduction (2 sensible points) lining up of cart etc (2).

GRAPH: Title / labels axes (1)

(1) Correct axes - either m vs $\frac{1}{a}$ or a vs $\frac{1}{m}$

If not inversely proportional Max 3 marks

(1) Correct Units
(2) Accurate plotting
(1) Line of best fit

Part B

1. By manipulating the given relationship (pre lab Q2) draw an appropriate **linear** graph of accelerated mass and acceleration. (6 marks)
2. What is the mathematical term used to describe the relationship between accelerated mass and acceleration? (1 mark)

Inversely proportional (1)

3. Using appropriate graphical techniques determine the experimental value for the accelerating force of the system and compare it to the measured value. Determine the percentage error and include a discussion on errors. Show all proof of working and logical explanations. (6 marks)

Includes a table for $\frac{1}{m}$ or $\frac{1}{a}$ (1)

Gradient lines on graph (1)

Calculates gradient = $\frac{y_2 - y_1}{x_2 - x_1}$ (1)

Identifies gradient = F for m vs $\frac{1}{a}$ (1)
$a = \frac{1}{m}$.

Percentage error = $\frac{\text{actual} - \text{theor}}{\text{theor}} \times 100$ (1)

Discussion errors (1)

$F = ma$
then $m = F\left(\frac{1}{a}\right)$

$a = F\left(\frac{1}{m}\right)$

Conclusion- Write appropriate conclusions for each part of the experiment (6 marks)

Part A

- Summarises experiment (1)
- Compares mass result from experiment to directly measured mass (1)
- States whether results support hypothesis (1)

Part B

- Summarises experiment (1)
- Compares results from graph to direct measurement of Force. (1)
- States whether results supported hypotheses (1)