Only thing to improve draw gradient lines over wide part of graph

Year 11 Physics– Newton's Second Law Experiment

Name: Ayesha Khan	**Teacher:** Tracy Fisher	
Comment: A well presented & thoroughly done lab		**Due Date:**
Pre lab + Report : 57 **out of 57**	**Scaled Total** 50	**out of 50**

4

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)

1

The acceleration of an object is directly proportional to the force on the object and inversely proportional to the mass of the object. ✓

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

1

$$a = \frac{F_{net}}{m}$$ ✓

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)

2

By doing the experiment 3 times it reduces the random errors ✓ and identifies the systematic errors. This allows outliers to be identified and disregarded before averaging results. ✓

Systematic errors refers to an error that will occur again if the investigation is repeated in the same way.
→ It usually happens if instruments are not calibrated properly or a flawed method.

Random errors refers to small errors that are unpredictable ie. limitations of the device ✓

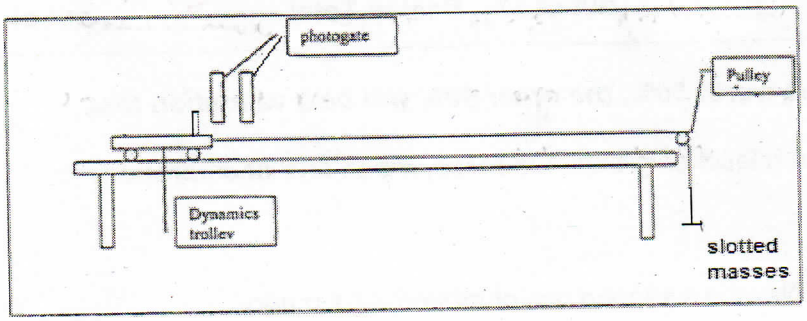
Excellent

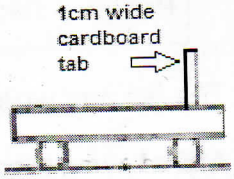
(4)

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: Mass providing the force ✓

Dependent Variable: Acceleration of the object ✓

Controlled Variables: Type of cart, the table, the pulley, total mass providing the force ✓

Hypothesis- If the mass increases, the acceleration will increase ✓

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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.

4

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 of the system ✓

Dependent Variable: acceleration of the cart ✓

Controlled Variable: Same table, same cart, same pulley Constant force ✓

4

Hypothesis- If the mass on the cart increases, 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.

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Results Part A (6 marks)

Total mass of system = 0.776 (kg)

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	0.49	0.535	0.538	0.538	0.537	± 0.001414
0.10	0.98	1.121	1.122	1.117	1.120	± 0.002168
0.15	1.47	1.690	1.710	1.690	1.697	± 0.00943
0.20	1.96	2.280	2.280	2.230	2.260	± 0.02387
0.25	2.45	2.889	2.889	2.882	2.887	± 0.00332
0.30	2.94	3.385	3.342	3.438	3.388	± 0.03927
0.35	3.43	4.009	3.913	4.022	3.981	± 0.04861
0.40	3.92	4.594	4.585	4.532	4.570	± 0.0864
0.45	4.41	5.205	5.246	5.277	5.243	± 0.0294

$y = 9.8x + c$

6

Results Part B (6 marks)

Mass of trolley 0.272 kg

Constant force = 0.1 x 9.8 = 0.98 N

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	0.372	2.255	2.255	2.265	2.2583	± 0.00472
0.100	0.472	1.772	1.798	1.797	1.7890	± 0.0542
0.2	0.572	1.496	1.497	1.496	1.4963	± 0.00057
0.3	0.672	1.275	1.280	1.277	1.2773	± 0.00126
0.4	0.772	1.115	1.118	1.1204	1.1178	± 0.00220
0.5	0.872	0.9897	0.993	0.989	0.9906	± 0.00174
0.6	0.972	0.891	0.8555	0.8872	0.8879	± 0.04578
0.7	1.072	0.8115	0.8103	0.8087	0.8102	± 0.001479
0.8	1.172	0.739	0.7374	0.7407	0.739	± 0.001379

6

Std. $\pm \sqrt{\dfrac{(\bar{x}-x)^2 + (\bar{x}-x)^2 + (\bar{x}-x)^2}{3}}$

Processing results

Part A

6

1. Draw an appropriate graph of accelerating force and acceleration. (6 mks)

2. What is the shape of the graph? (1 mark)

1

linear

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

1

accelerating force is directly proportional to acceleration

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)

6

Experimental value for mass

From line of Best fit:

(1.0, 0.87) and (2.0, 1.72)

since $F_{net} = ma$

mass = slope

$$m = \frac{1.72 - 0.87}{2.0 - 1.0}$$

$$= 0.85 \text{ kg}$$

measured mass = 0.776 kg

$$\% \text{ error} = \frac{|\text{actual} - \text{theoretical}|}{\text{theoretical}} \times 100$$

$$= \frac{|0.776 - 0.85|}{0.85} \times 100$$

$$= 8.71\% \text{ error}$$

experimental value = 0.85kg

measured value = 0.776 kg

% error = 8.71%

Errors in this experiment includes not taking into account the the force of friction and the air resistance. This causes the experimental value to be larger than the measured value. The percent error was 8.71%. After plotting the points, the line of best fit was determined by eye. When conducting the experiment, the cart was not perfectly in line with the pulley and string. In this experiment as the mass providing the force was gradually increased the friction decreased because there is less kinetic friction since there is more mass for gravity to act on

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Part B

1. By manipulating the given relationship (pre lab Q2) draw an appropriate **linear** graph of accelerated mass and acceleration. (6 marks)

6

2. What is the mathematical term used to describe the relationship between accelerated mass and acceleration? (1 mark)

1

accelerated mass is inversely proportional to acceleration. ✓

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)

$F = ma$

$m = F \times \frac{1}{a}$

↑ gradient ✓

From line of best fit:

(0.64, 0.548) and (0.88, 0.76)

find gradient

$F \Rightarrow \frac{0.76 - 0.548}{0.88 - 0.64}$

$= 0.883N$ ✓

Measured force = 0.98N

$\%\ error = \frac{|actual - theoretical|}{theoretical} \times 100$

$= \frac{0.98 - 0.883}{0.883} \times 100$ ✓

$= 11.69\%$ error

experimental value = 0.883N
measured value = 0.98N
% error = 11.69% ✓

6

Errors in this experiment includes the force friction and air resistance not being taken into account. As the mass on the cart increases the kinetic friction also increases which decreases the acceleration. Since this is not taken into account, the experimental value is less than the measured value with an 11.69% error. After plotting the points, a line of best fit was determined by eye also increasing error. Another error was that when the experiment was being conducted the cart was not perfectly in line with the pulley and string. ✓

6

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

Part A - In the experiment, the total mass of the system was constant but 0.05kg was gradually added to the pan. Acceleration was found using the pasco carts. A graph of accelerated force vs. acceleration was plotted and a line of best fit was determined Using this line, an experimental value for mass was found because $F = ma$ means the mass was the slope. the mass found was 0.85kg when the measured mass was 0.776 kg and a 8.71% error was found. This was due to errors discussed in page 5, as the mass in the pan increases the acceleration increases. The controlled variable was the total mass of the system, the independent variable was the force and the dependent variable was the acceleration. The dependent and independent variable are directly proportional. This shows the hypothesis was true.

3

Part B - In the experiment, the mass on the cart was gradually increased by 0.1 kg. The acceleration was found using pasco carts. A graph of accelerated mass vs. acceleration was plotted linearly after inversing the acceleration since the two were inversely proportional and a line of best fit was determined. Using this line an experimental value for force was found using $m = F \times \frac{1}{a}$ meaning the force is the slope. The force found was 0.883 N when the measured force was 0.98 N. and a 11.69% error was found. This was due to the errors discussed in page 6, as the mass on the cart increases the acceleration decreases. The controlled variable was the constant force to pull down the cart, the independent variable was the mass on the cart and the dependent variable was the acceleration. The dependent and independent variables were inversely proportional which shows the hypothesis was true.

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A+B - This proves Newton's second law of motion (see Ques.

Accelerated mass vs. acceleration
Part B

Ayesha khan

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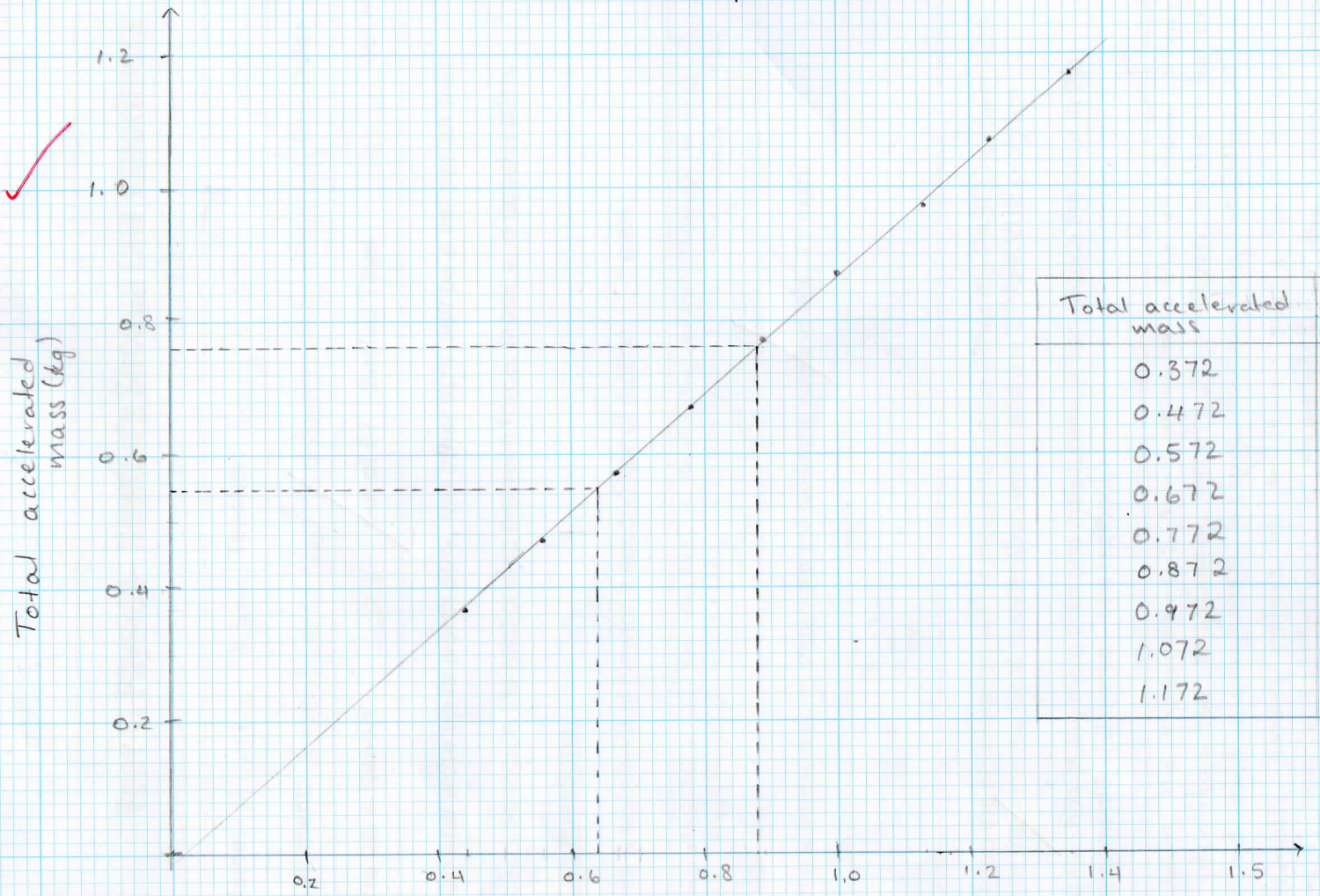
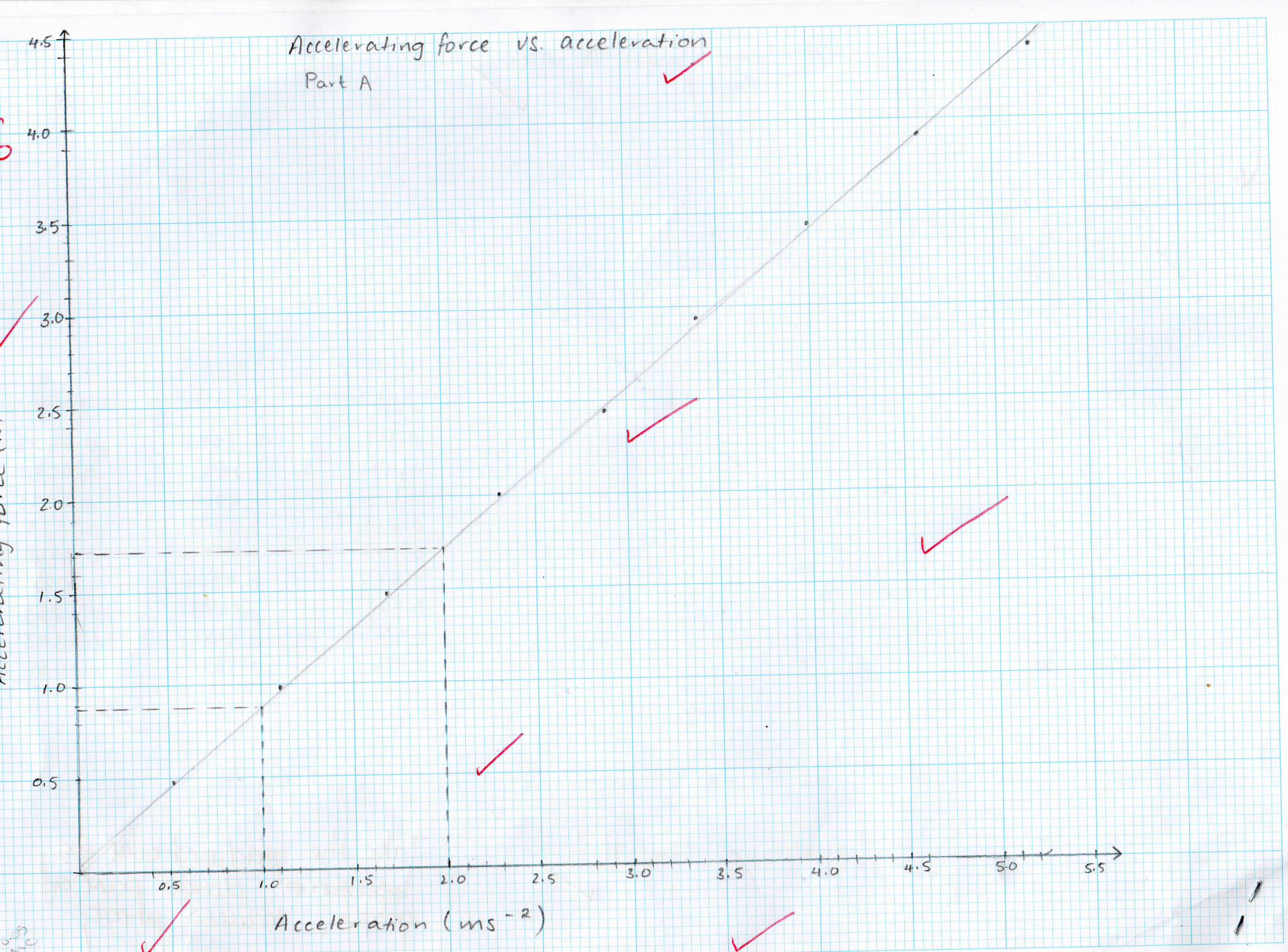


Total accelerated mass	acceleration	acceleration
0.372	2.2583	0.4428
0.472	1.789	0.5590
0.572	1.4963	0.6683
0.672	1.2773	0.7829
0.772	1.1178	0.8946
0.872	0.9906	1.0095
0.972	0.8879	1.1263
1.072	0.8102	1.2343
1.172	0.739	1.3531

Take the gradient over ~~as~~ a large part of graph, reduces error.


Accelerating force vs. acceleration
Part A
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
Acceleration (ms⁻²)