	Y11 PHYSICS: MOVEMENT LAB VALIDATION	Name: Solutions
		MARKS / 25

Part 1
Acceleration down an incline

In a project designed to measure the acceleration down a slope two students, Sam and Riley, roll a Tonka Truck from rest from various heights and measure the time taken to fall.

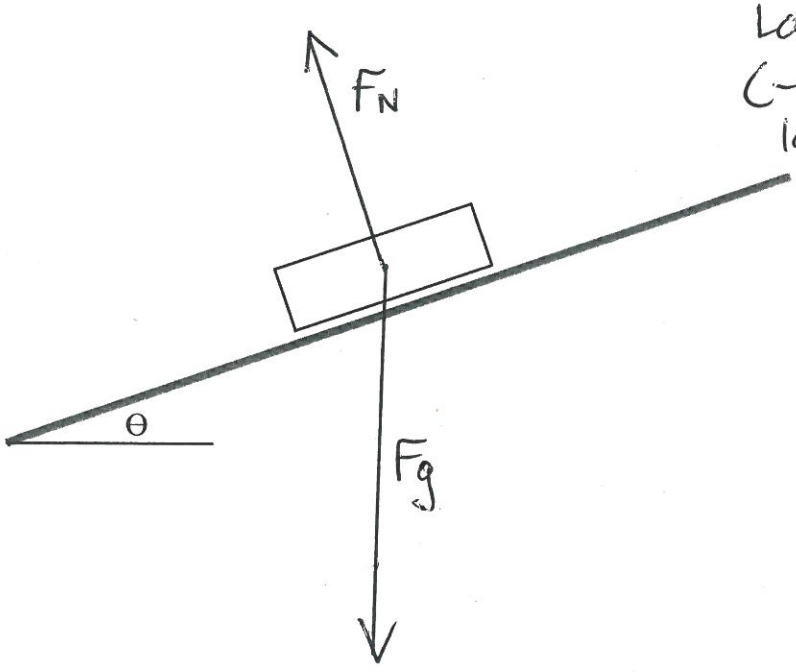
Their hypothesis is: *"The acceleration will be proportional to the gradient of the ramp"*

1. By considering what happens to gradient as a ramp gets very steep, explain why this hypothesis cannot be correct (1 mark)

As ramp gets steeper gradient $\rightarrow \infty$. ✓
Not reasonable, as in reality $a \rightarrow 9.8\ ms^{-2}$

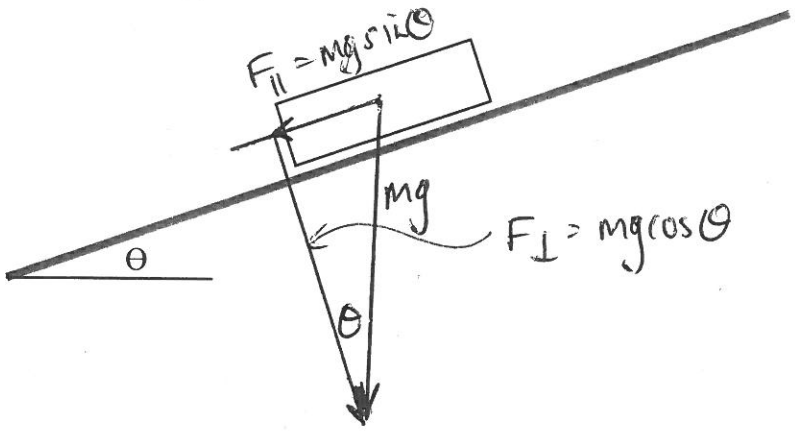
2. If the ramp is assumed to be frictionless, then there are only two forces acting on the truck when it is on the slope. Draw and label arrows to show these forces on the free body diagram below (2 marks)

Forces ✓
Labels ✓
(-½ if F_N is larger than F_g)



3. One of these forces can be broken up into a component parallel to the slope and one perpendicular to the slope. Draw these components on the diagram below and use this to show that the component of force down along the slope is equal to :

$F_{(parallel)} = m\,g\,\sin\Theta$ (2 marks)



triangle ✓
labels ✓
(including θ in triangle)

4. The students decide then to change their hypothesis to

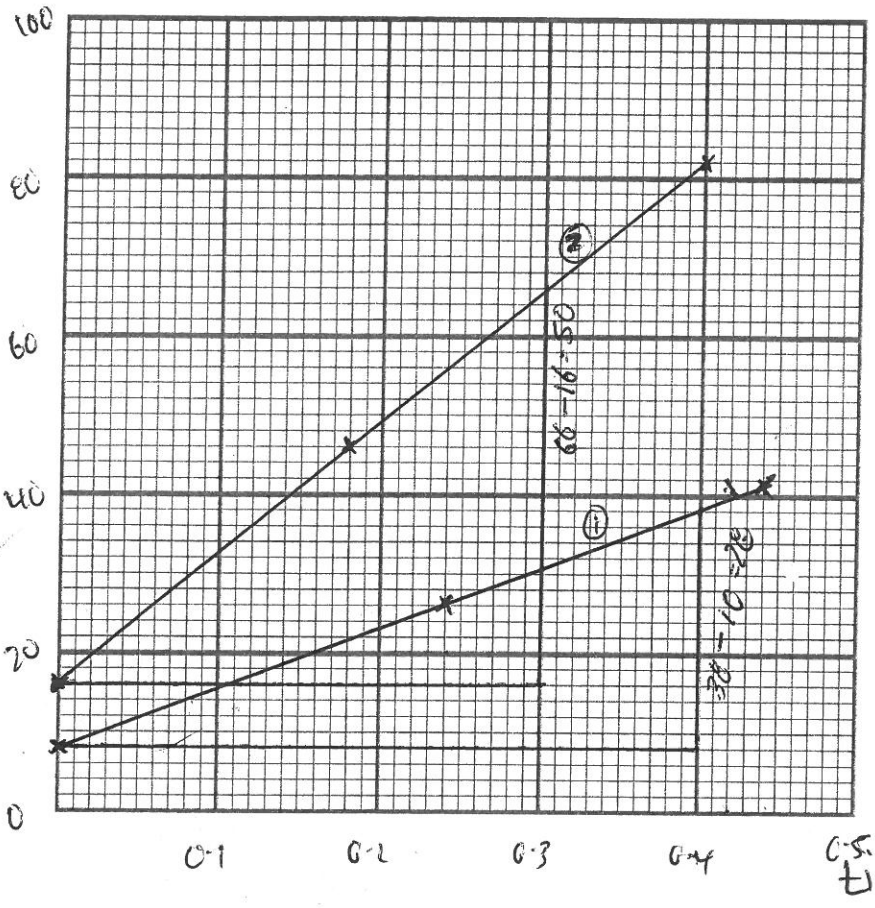
"The acceleration down the slope will be equal to g sin Θ"

They set up the same experiment Applecross Y11 students do, using tickertapes to measure acceleration down a slope. They did two trials at two different angles of ramp. On each ticker tape, they calculated the speed at THREE different times along the tape (by analysing the distance between dots). The following are their results.

RAMP ANGLE	Total Time elapsed during motion (s)	Calculated speed (cm/s)
5°	0	8
	.24	26
	.44	41

RAMP ANGLE	Total Time elapsed during motion (s)	Calculated speed (cm/s)
10°	0	16
	.18	46
	.40	82

Plot this data below as two lines (one for each angle). Fully label all aspects of the graph and draw a line of best fit for each set of data. (3 marks)



axes ½ + ½
units ½ + ½

line ½ + ½ / 3

(−½ for incorrect plots)

4. Calculate the gradient of each line and showing clearly on the graph how you calculated the gradients. (2 marks)

$M_1 = \frac{28}{0.4} = 70 \text{ cms}^{-2}$ ✓

$M_2 = \frac{50}{0.3} = 166.7$

$= 167 \text{ cms}^{-2}$ ✓

5. USE THESE GRADIENTS to calculate and clearly state the accelerations for each ramp angle. (1 marks)

$a = 70 \text{ cms}^{-2}$ ½ and 167 cms^{-2} ½

6. Determine and clearly show which of the ramp angles best agrees with the hypothesis. (2 marks)

½ ① theory: $a = g\sin 5° = 0.854\ ms^{-2} = 85.46\ cms^{-2}$

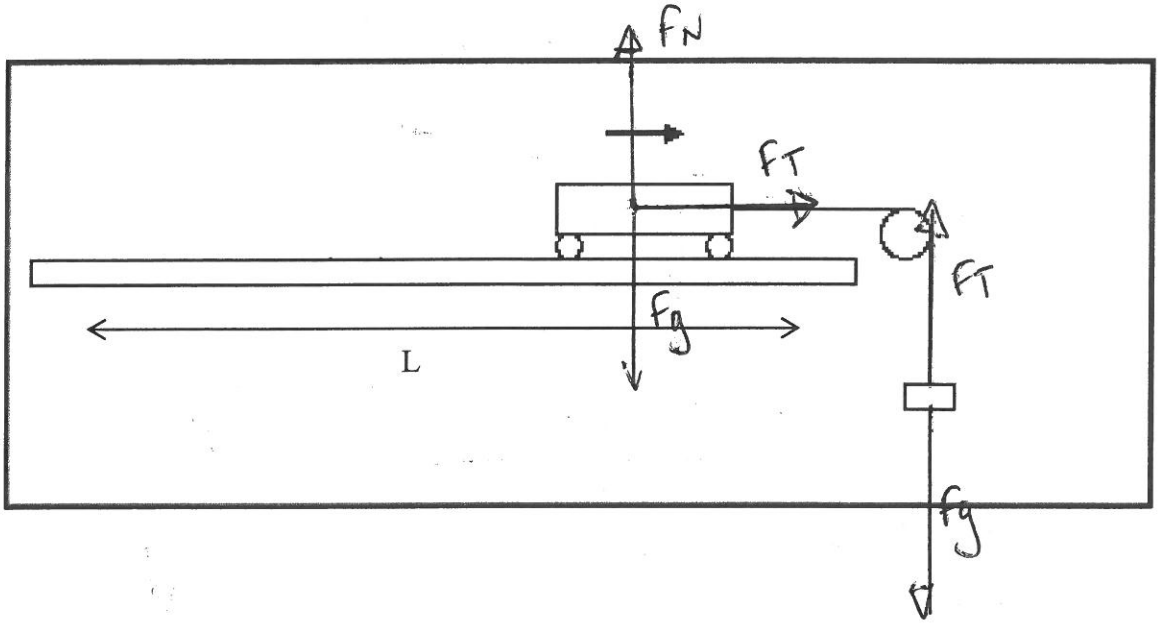
½ ② theory: $a = g\sin 10° = 1.70\ ms^{-2} = 170\ cms^{-2}$

½ units consist.
½ statement Clearly 2 is the closest to theoretical acceleration (167 vs 170 $cm\,s^{-2}$)

Part 2

Acceleration - varying force. Investigation of Newton's second law: F = ma

In experiment 16.1, a trolley was accelerated by the weight of a mass hanging in a cradle. The mass in the cradle was varied in order to vary the accelerating force. Time for the trolley to travel a given distance was measured, and this was used to calculate the acceleration of the trolley. The set up is shown below.



1. Draw LABELLED arrows on BOTH the trolley below to identify all the forces acting on each. Assume both are in motion. (4 marks)

$F_T \neq F_T \Rightarrow -½$

$F_g \not\neq F_T \Rightarrow -½$

−1 for any missing or incorrect forces

2. State which motion equation was used to calculate acceleration of the trolley and rearrange it to make acceleration to be the subject, given that the trolley started from rest (1 mark)

$s = \cancel{ut}^{\,0} + ½at^2$

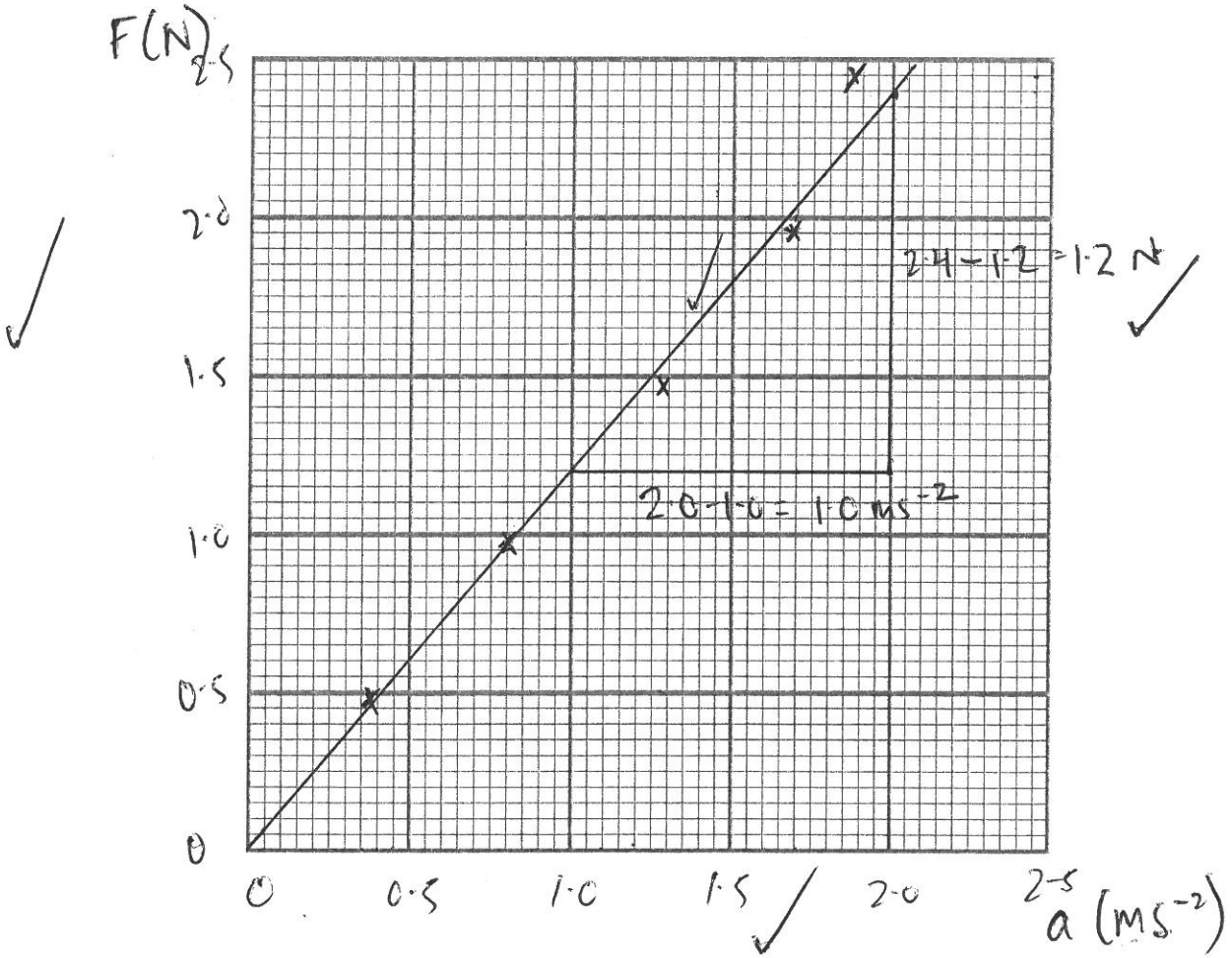
$\Rightarrow a = \frac{2s}{t^2}$ ✓

3. The following data was collected by a group carrying out experiment 3.1. Calculate the missing data. (2 marks)

Accelerating mass (mass in cradle) (kg)	Accelerating force (N)	Distance travelled by trolley (m)	Measured time to fall (s)		Mean time (s)	Calculated acceleration (m/s^2)
			Trial 1	Trial 2		
.05	0.49	1.6	2.90	2.93	2.92	0.375
.1	0.98	1.6	2.00	2.02	2.01	0.792
.15	1.47	1.6	1.60	1.56	1.58	1.282
.2	1.96	1.6	1.40	1.35	1.38	1.68
.25	2.45	1.6	1.30	1.32	1.31	1.86

(-½ for each mistake)

4. Plot force against acceleration, and using the line of best fit, calculate the total mass of the trolley system (trolley + cradle + mass). Show all working in your calculation. (5)



$m = \frac{\Delta y}{\Delta x} = \frac{1.2}{1.0} = 1.2$ kg Mass of trolley = 1.2kg ✓