1 *To investigate the force needed to pull a cylinder up a step.*

Qn	Marking criteria	Mark	Remark
1(a)	Evidence that more than one measurement is made **<u>and</u>** average calculated. Correct d.p. of measured/average value*	**1**	No mark awarded if **<u>BOTH</u>** criteria are not evident Mark awarded for correct d.p and with correct unit
1(b)(ii)	Correct d.p. of measured value.	**1**	
1(c)	Evidence that more than one measurement is made **<u>and</u>** average calculated Radius *r* determined	**1**	No mark awarded if **<u>BOTH</u>** criteria are not evident Working optional
1(d)(i)	Correct d.p. of measured value.	**1**	
1(d)(ii)	Angle α calculated. Working shown.	**1**	
PLAN	▪ Independent, dependent variable ▪ one measurable controlled variable given ▪ Detail instructions on how the experiment is carried out to investigate relationship including instructions of how accurate results are achieved and instructions on tabulation and graph to be sketched. ▪ Explanation on how to reach conclusion from sketched graph.	**1** **1** **2** **1**	Award mark for only for all three correct variables given
	Total	**10**	

***all readings are expected to have the correct unit**

Independent variable: mass, *m*
Dependent variable: applied force, *F*
Controlled variable: Height of string loop above the benchtop; loop parallel to ½ metre rule; newton meter parallel to benchtop.

Procedure

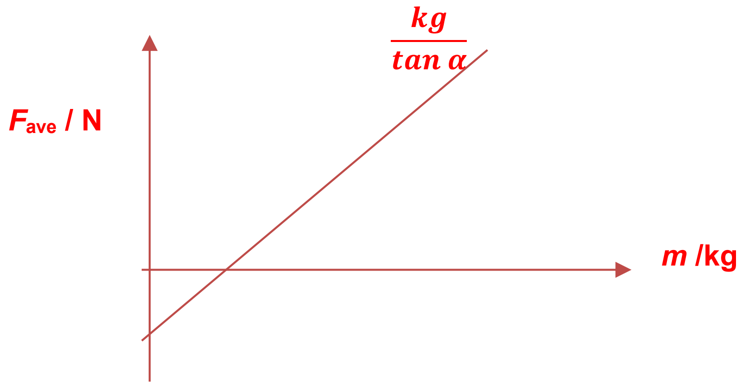
1. Measure the mass each of the circular weight using the digital balance. Record the reading as *m*.
2. Take corresponding measurements for the diameter of the circular weight. Determine its radius *r*.
3. Measure the height *h* of the ½ metre rule using a vernier caliper. Determine the average height, h_{ave}.
4. Set up the experiment as shown in Fig. 1.3
5. Pull the mass and ensure that the string is taut.
6. Measure the height of the string loop above the bench top. This height is to be measured and remain constant for every repeated measurement of the applied force.
7. View the string loop and the newton meter from the top. Ensure that both are aligned parallel to the benchtop.
8. Increase the applied force slowly until the mass is just about to roll up the edge of the ruler. Note the newton meter reading, *F*.
9. Repeat 4 to 8 to obtain another reading for *F*. Determine the average force applied, F_{ave}.
10. Repeat steps (6) and (7) to obtain five other values of F_{ave} .
11. Tabulate all readings. Convert the mass to kg. Include

Reading	m/kg	F_1/N	F_2/N	F_{ave}/N
1				
2				
3				
4				
5				

12. Plot a graph of F_{ave} against *m*.
13. Determine the gradient of the graph.
14. The equation is re-written as

$$F = \frac{kmg}{\tan\alpha}$$ where g = 10 N/kg is the acceleration due to gravity

15. A graph of F_{ave} against *m* is expected to yield a straight line passing through the origin with gradient.



[5]

2 *In this experiment you will determine the focal length of a semicircular block using two methods.*

Qn	Marking criteria	Mark	Remark
METHOD 1			
2(a)	R measured to correct d.p.	**1**	either ruler or digital caliper is used
2(b)(i)	A and B measured to correct d.p. $E = B/A$ calculated to correct s.f.	**1**	
2(b)(ii)	d_1 measured to correct d.p.	**1**	
2(b)(iii)	d_2 measured to correct d.p.	**1**	
2(c)	k determined to correct d.p.	**1**	d.p. determined by instrument used.
2(d)	f calculated to correct s.f.	**1**	
METHOD 2			
2(e)(v)	α recorded to correct 1°	**1**	
2(f)	n_{glass} calculated to correct sig.fig. Working shown	**1**	
2(g)	f calculated to correct sig.fig. Working shown	**1**	
2(h)	One improvement suggested	**1**	
	Total	**10**	

***all readings are expected to have the correct unit**

3 *In this experiment you will investigate an electrical circuit.*

Qn	Marking criteria	Mark	Remark
3(a)	E recorded to correct d.p.	**1**	
3(b)	w and I_1 recorded to correct d.p.	**1**	
3(e)	I_2 recorded to correct d.p.	**1**	
3(f)	▪ Table with quantities recorded using solidus notation with correct unit in headings ▪ 5 sets of readings of I_1, I_2 and w recorded ▪ $I_1 I_2$ and $\frac{1}{w}$ calculated to correct sig.fig. ▪ Good range recorded (98 cm > w > 40 cm)	**1** **1** **1** **1**	e.c.f. for d.p.
3(g)	▪ Axes labeled with units and correct orientation (allow ecf from wrong unit in table). (A) ▪ Suitable scale; graph occupying ½ of graph paper. (S) ▪ All points plotted correctly. (P) ▪ Best fit line and fine crosses. (L)	**1** **1** **1** **1**	-1 m for incorrect axis labelling
3(h)	▪ Triangle drawn that uses more than half the drawn line ▪ Coordinates (not points plotted) for determining gradient indicated on graph. ▪ Calculation of gradient shown to correct sig.fig. No unit.	**1** **1**	Collective mark. Deduct if one condition not satisfied.
3(i)	1. Correct circuit diagram 2. Record of V and I to correct d.p. 3. Working shown clearly for the determination of R_Y.	**1** **2** **2**	
3(j)	Key source of error • The crocodile clip G is not clipped to the actual reading due to the large area of contact with the wire and this affects the accuracy of the value of *w.* • There may exist kinks in the wire and this affects the current flowing through the wire.	**1**	

Qn	Marking criteria	Mark	Remark
(k)	▪ The equation is not valid for LDR and thermistors because the resistance of the resistors listed varies non-linearly with corresponding changes in environmental conditions e.g. light intensity, temperature. The graph of $I_1 I_2$ against R_V will not be linear. ▪ The resistance of a wire is directly proportional to its length. The resistance of a thermistor is not directly proportional to its length. Hence graph of $I_1 I_2$ against R_V will not be linear. ▪ The proposed theory will be valid (subject to further investigation) for the two variable resistors mentioned if the axes are changed to $lg(I_1 I_2)\ [y\ axis]\ and\ lgS$ [x-axis]*	**1**	$* R_V = \frac{K}{S^n}$ (a generalised inverse function to the power *n*) where *K* is a constant, *S* is the environmental conditions (temperature, light intensity) The equation $I_1 I_2 = \frac{E^2}{R_Y}\left(\frac{1}{R_V}\right)$ can be linearized to $lg(I_1 I_2) = 2\lg E - lgR_Y + lgK - nlgS$ *y* = *c* + *mc*
	Total	**20**	