01. 0625_p20_MS_60 Q: 1

(a) table:
at least 2 *d* values correct: 30.0, 24.2, 19.8, 17.2, 15.0 (cm) to ± 0.5 cm
(accept values 50–*d*) [1]
rule readings subtracted from 50 cm [1]
all 5 *d* values correct: 30.0, 24.2, 19.8, 17.2, 15.0 (cm) to ± 0.2 cm [1]
1/*d* values correct (note: at least 2 significant figures) [1]

(b) any one difficulty and corresponding solution from:
difficulty obtaining balance as rule tips one way then the other
allow to tip one way then the other and take average

mass obscuring marks on rule
mark centre of the mass so it can be read against rule
OR take average of right hand and left hand readings for mass position

mass sliding off rule
OR rule sliding off pivot
suitable means for preventing mass or rule sliding [max 2]

(c) graph:
axes labelled with quantity and unit [1]
scales suitable, plots occupying at least half grid [1]
plots all correct to ½ square (take centre of plot if large) [1]
well-judged thin line (≤ ½ square) [1]

(d) triangle method used and shown (any indication on graph) using at least half line
(can be seen in calculation) [1]

(e) μ = 27 – 33 (g) to 2 or 3 significant figures [1]

02. 0625_p20_MS_60 Q: 4

(a) apparatus:
measuring cylinder/jug OR ruler OR balance (to measure amount of water) [1]
protractor OR rule to measure height of raised surface
OR other means of measuring angle of tilt
OR newtonmeter to apply variable force
OR other method of applying quantifiable force [1]

instructions:
method of tilting or applying variable force and measuring point at which bottle topples [1]

attention to accuracy, any two from:
just starts to topple
slowly
repeats / more than 10 values for quantity of water
very large protractor
or any other suitable precaution which would improve accuracy of data [max 2]

values:
at least 5 values with range at least 1500 cm^3 or 30 cm or 1500 g, approximately evenly spaced [1]

graph:
plot of measured variable (angle or height or force) against quantity of water (volume or height or mass) (accept vice versa) [1]

(b) 20° [1]

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03. 0625_s20_MS_61 Q: 1

(a)	0.025, 0.037, 0.050, 0.063, 0.075	1
	Consistent significant figures	1
(b)	Graph: Axes correctly labelled and right way round	1
	Suitable scales	1
	All plots correct to $\frac{1}{2}$ small square	1
	Good line judgement, thin, continuous line	1
(c)	(0.02) Method shown clearly on graph	1
	Value correct to $\frac{1}{2}$ small square	1
(d)	Clear wording or diagram	1
(e)(i)	Difficult to obtain balance point	1
(e)(ii)	Idea of obtaining nearest to balance	1

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04. 0625_s20_MS_62 Q: 4

	MP1 diagram showing strip clamped to bench with majority overhanging	**1**
	MP2 means to measure bending, e.g. vertical metre rule at end of strip	**1**
	MP3 add load at / near end of strip and measure the amount of depression **MP4** repeat with other strips	**2**
	MP5 variables any **one** from: all strips to have same width / thickness / profile use of same load(s) allowance for unloaded depression	**1**
	MP6 table with columns for material, load and depression with correct units	**1**
	MP7 strip that bends most with same load is most bendy / alternative wording	**1**

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05. 0625_s20_MS_63 Q: 1

(a)(i)	l = 15.0 (cm)	**1**
	centre of weight at 25(.0) cm seen or implied / clear subtraction of 10.0 cm from candidate's value	**1**
(a)(ii)	1.3 (N)	**1**
(a)(iii)	ensure distances from bench at both ends are equal OR use set square between rule and stand OR align with known horizontal line (e.g. window ledge)	**1**
(b)	graph: • axes labelled with quantity and unit	**1**
	• appropriate scales (plots occupying at least $\frac{1}{2}$ grid)	**1**
	• plots all correct to $\frac{1}{2}$ small square and precise plots	**1**
	• well judged line and thin line	**1**
(c)(i)	F_0 correct from graph	**1**
(c)(ii)	W_R in range 1.2 to 2.0	**1**
(d)	hang load from cotton loop on metre rule and cotton can be placed on precise mark on metre rule	**1**

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06. 0625_m19_MS_62 Q: 4

	MP1 **apparatus:** means of measuring dependent variable (e.g. stop watch / rule / protractor)	**1**
	MP2 **method** (one from): workable means of providing air resistance (e.g. fix card to rod / bob), allow pendulum to swing, suitable measurement (e.g. period, amplitude)	**1**
	MP3 repeat for different value of independent variable (e.g. area of card)	**1**
	MP4 **control variable** (one from): length of pendulum, angle of release, mass of bob	**1**
	MP5 **table:** suitable clear format with column headings and units	**1**
	MP6 **analysis:** compare readings to see if change in air resistance produces change in dependent variable (e.g. change in area of card changes period) / plot graph	**1**

	MP7 **additional point** (one from): time 10 oscillations / swings (and calculate period), small angle of swing, at least 5 sets of data taken, repeat each measurement and take average, adjust mass of pendulum to compensate for changing mass of card, repeat with different length of pendulum / mass of bob, length measured to centre of bob / centre of gravity of pendulum, use of fiducial aid	**1**

07. 0625_s19_MS_61 Q: 1

(a)	Graph:	
	Axes correctly labelled with quantity and unit and right way round	**1**
	Suitable scales	**1**
	All plots correct to ½ small square	**1**
	Good line judgement, thin, continuous line	**1**
(b)	triangle method indicated on graph	**1**
	triangle at least half of candidate's line	**1**
(c)	Correct calculation	**1**
	2 or 3 significant figures and unit N	**1**
(d)	Difficulty in achieving exact balance OR difficulty in judging centre of P OR load easily slips OR top of pivot not a sharp edge	**1**
(e)	113	**1**
(f)(i)	1.13	**1**
(f)(ii)	Statement and explanation to match results. Expect Yes, because values are close, owtte	**1**

08. 0625_s19_MS_62 Q: 1

(a)	centre of mass/gravity not in centre (however expressed)	1
(b)	graph:	
	axes correctly labelled and right way round	1
	suitable scales starting from (0,0)	1
	all plots correct to less than ½ small square	1
	good line judgement, thin, continuous line	1
(c)	triangle method used and seen on graph	1
	triangle at least half of distance between extreme plotted points i.e. $\Delta a \geqslant 10$	1
(d)	intercept correct to ½ small square – if graph not extrapolated, use the ruler tool	1
(e)	width 2.5(0) cm / 25 mm with correct unit	1
(f)	statement to match results	1
	justification to match statement and include idea of within (or beyond) limits of experimental accuracy	1
(g)	difficulty in achieving exact balance/keeping the pivot in the same position/locating the centre of load (Q)/load(s) slipping/load obscuring readings on rule	1

09. 0625_s19_MS_63 Q: 1

(a)	(difficult to see centre of block) and valid method, e.g. • (measure width of block and) add ½ width to 5.0 cm to find position for edge of block • mean value of marks at both edges of mass • mark centre line of mass and align with mark on rule	1
(b)(i)	move block back and forth to find the point of balance / owtte	1
(b)(ii)	graph:	
	axes labelled correct orientation, with quantity and unit	1
	appropriate scales (plots occupying at least ½ grid)	1
	plots all correct to less than ½ small square and precise plots	1
	well-judged line and thin line	1
(c)(i)	*G* present and triangle method seen on graph	1
(c)(ii)	M_U in range 61.0 to 81.0 (g)	1
	2/3 sig figs and unit	1
(d)	*a* and *b* are proportional	1
	b/*a* constant within limits of experimental accuracy / owtte	1

10. 0625_w19_MS_61 Q: 1

(a)(i)	*b* 16.9	**1**
(a)(i)	*a* / *b* 1.37 (ecf allowed)	**1**
(b)	Graph:	
	Axes correctly labelled and right way round	**1**
	Suitable scales	**1**
	All plots correct to ½ small square	**1**
	Good line judgement, thin, continuous line	**1**
(c)	triangle method indicated on graph	**1**
	triangle at least half of candidate's distance between extreme plots	**1**
(d)	Correct calculation, *W* = *G*	**1**
	to 2 or 3 significant figures	**1**
(e)	Balance on pivot with no load – balance point is at c of m	**1**
(f)	Obtaining a stable balance	**1**

11. 0625_w19_MS_61 Q: 4

	MP1 How the ball will move: Back and forth / like a pendulum	**1**
	MP2 Release from a determined position, time until stops	**1**
	MP3 Repeat with at least two more values of independent variable	**1**
	MP4 Statement of variable to be changed	**1**
	MP5 Statement of a variable to keep constant	**1**
	MP6 Table with columns for chosen variable that is changed and time with correct units, s for time.	**1**
	MP7 Compare chosen variable with time. Or plot graph of chosen variable against time	**1**

12. 0625_w19_MS_63 Q: 3

(a)	any **two** from: □ rule close / parallel to spring ; □ eye perpendicular to reading / use set square ; □ clamp rule	**2**
(b)	correct calculations of *e* (4.2, 8.4, 12.6)	**1**
(c)(i)	l_x = 11.4(cm)	**1**
(c)(ii)	2.0 N < W_x < 2.5(N)	**1**
	working showing use of ratio/correct logic	**1**
(d)	data only given to 1 dp / 2 or 3 sig fig	**1**
(e)(i)	statement matching results	**1**
	correct justification matching statement e.g. □ *L*/*e* constant □ *e* doubles when *L* doubles	**1**
(e)(ii)	straight line	**1**
	(line) through origin	**1**

13. 0625_m18_MS_62 Q: 1

(a)	measure width of mass and add ½ width to mark at edge of mass / mean value of marks at both edges of mass / mark centre line of mass and edge of rule / line up mark through gap in slotted mass	**1**
(b)	method such as: find point which just tips one way move rule to find point which just tips other way	**1**
	balance point is between these where rule tips either way / owtte	**1**
(c)(i)	graph:	
	• axes labelled correct orientation, with quantity and unit	**1**
	• appropriate scales (plots occupying at least ½ grid)	**1**
	• plots all correct to ½ small square and precise plots	**1**
	• well judged line and thin line	**1**
(c)(ii)	*G* present and triangle method seen on graph	**1**
(c)(iii)	M_R in range 100 g to 400 g	**1**
	2 / 3 significant figures and unit	**1**
(d)	more accurate and errors have less effect (with larger values) / less % uncertainty	**1**

14. 0625_s18_MS_62 Q: 4

	method to include:	
	place truck on ramp (and release)	1
	measure distance (travelled) from bottom of ramp	1
	repeat with different mass(es) (loaded on the same truck)	1
	additional apparatus:	
	(metre) rule(r) / measuring tape	1
	control variables:	
	height / angle of ramp / number of supporting bricks	1
	release position / height above bench	1
	table with clear columns for mass, and distance travelled, with appropriate units in the headings of the table	1

15. 0625_s18_MS_63 Q: 4

	Apparatus: forcemeter, (10 g and 100 g) masses / masses only (if clear they are used to change the mass of the block and as weights to the block via the pulley)	1
	Diagram: block, workable means of pulling and measuring force	1
	Method (2): measure force required to make block slide / find mass (on pulley) required to make block slide	1
	repeat for new value of mass	1
	Precautions: any **one** from: same surface to slide on / repeat each measurement and take average / same angle of pulling force	1
	Graph: mass on block vs force (needed to slide)	1
	Any additional point: at least 5 sets of data taken / keep force horizontal / add mass of block to load / extra precaution	1

16. 0625_w18_MS_61 Q: 1

(a)	l_0 = 22 (mm)	1
(b)(i)	e = 31 (mm) ecf allowed	1
(b)(ii)	k = 0.0968 (N / mm) ecf allowed	1
(c)(i)	t = 3.46 (s)	1
(c)(ii)	T= 0.346 (s) T^2 = 0.12 (0.1197)	1
	units s and s^2	1
(c)(iii)	k = 0.1	1
(d)	Statement matches results	1
	Idea of within (or beyond) limits of experimental accuracy explained, e.g. close (enough), very close, nearly the same; (too) far apart	1
(e)	At least 3 additional values given	1
	Values between 50 g and 600 g	1

17. 0625_w18_MS_62 Q: 1

(a)	l_0 = 23 (mm)	1
(b)	recognisable set-square shown from spring to rule along one of the dotted lines	1
(c)(i)	*e* values 8, 17, 23, 32, 40	1
(c)(ii)	N, mm, mm	1
(d)	Graph:	
	axes correctly labelled and right way round	1
	suitable scales, at least ½ the grid used	1
	all plots correct to ½ small square	1
	good line judgement, thin, continuous line	1
(e)	triangle method used and seen on graph	1
	at least half of candidate's line used	1
(f)	answers within the range 0.025 □ 0.005 (N / mm) and expressed to 2 / 3 significant figures only	1

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18. 0625_m17_MS_62 Q: 4

	apparatus: MP1 springs made by winding wire around rod (or similar)	1
	method: MP2 apply load, measure length / extension of spring	1
	MP3 repeat for spring(s) of different material	1
	MP4 record results in suitable annotated table / bar chart / graph	1
	control variables: MP5 mark gained for any two of: unstretched length of spring, diameter of wire, coil spacing, load / range of loads used diameter of spring	1
	MP6 **precautions / difficulties / additional points:** MP7 any two from: clamp retort stand / might topple, use small loads / spring might overstretch/spring too weak/use loads which don't overstretch spring to support loads need to apply force smoothly / slowly, suggested range of loads, workable arrangement for applying load to spring (e.g. small loop at end of spring) trial experiment to find (range of) loads to use how to determine extension of spring, repeat each reading and take average, at least 5 loads for each sample if producing graph	2
	Total:	7

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19. 0625_s17_MS_61 Q: 1

(a)(i)	15	**1**
(a)(ii)	Ring(s) do not extend (owtte)	**1**
(b)	Use of set square to line up with scale OR perpendicular viewing	**1**
(c)	Graph:	
	Axes correctly labelled and right way round	**1**
	Suitable scales	**1**
	All 6 plots correct to ½ small square	**1**
	Good line judgement, thin, single, continuous line	**1**
(d)	(NO);line does not pass through origin	**1**
(e)	*L* in range 6–8	**1**
	L in range 7.2–7.8	**1**
	Total:	**10**

20. 0625_s17_MS_62 Q: 4

(a)	graph: axes correctly labelled	**1**
	suitable scales	**1**
	all plots correct to ½ small square	**1**
	good line judgement, thin, continuous line	**1**
(b)	expect NO line does not pass through origin	**1**
(c)	6,40,34	**1**
	consistent units of N cm	**1**
(d)	have not taken the weight of the rule/moment of the weight into account/not realised that $Qb + mX = Pa$ /the pivot is not at the centre (of mass) of the rule	**1**
	Total:	**8**

21. 0625_w17_MS_61 Q: 4

(a)	1 / Q values 1.(0), 0.5(0), 0.33(3), 0.25, 0.2(0)	1
(b)	Graph:	
	Axes correctly labelled and right way round	1
	Suitable scales	1
	All 5 plots correct to ½ small square	1
	Good line judgement, thin, continuous line	1
(c)(i),(ii)	At least half line used for triangle method	1
	Clearly shown on graph	1
	P = 1.8 – 2.2 (N)	1
(d)	1.9	1
(e)	Two from: Difficulty in obtaining balance Difficulty in judging centre of loads Loads may slip / slide Forcemeter not sensitive Forcemeter zero error	2

22. 0625_w17_MS_62 Q: 4

	method: **MP1** measure length of band	1
	MP2 hang load, measure new length	1
	MP3 repeat with different thicknesses/widths	1
	control variable: **MP4** use same (original) length of band each time	1
	table: **MP5** table with columns for thickness, (load) and length / extension with units	1
	conclusion: **MP6** plot a graph of extension / length against thickness (for the same load) OR load against extension / length for different thicknesses OR comparison via a table e.g. compare extensions / lengths of different thicknesses for the same load	1
	one additional point: **MP7** use same load / same range of loads use at least 5 thicknesses / take at least 5 different readings to plot a graph show how to measure extension e.g. $l - l_0$ use same type / material of rubber band	1

23. 0625_w17_MS_63 Q: 3

(a)(i)	F = 0.75	1
(a)(ii)	any reliable method e.g. equal distances between rule and bench in at least two places, line up with named horizontal surface, use of set-square between stand and rule	1
(b)	graph:	
	axes labelled with quantity and unit	1
	appropriate scales (plots occupying at least ½ grid and scales starting at 0,0)	1
	plots all correct to ½ small square AND precise plots	1
	Well-judged line AND thin line	1
(c)(i)	F_0 correct from graph	1
(c)(ii)	W_R in range 0.90 to 1.4	1
	2 / 3 sig figs and unit (N)	1
(d)	statement matching plotted points AND explanation referring to line and scatter of data	1
(e)	repeat all readings and take average	1

24. 0625_p16_MS_60 Q: 1

(a) table:
at least 2 *d* values correct: 30.0, 24.2, 19.8, 17.2, 15.0 (cm) to ± 0.5 cm
(accept values 50–*d*) [1]
rule readings subtracted from 50 cm [1]
all 5 *d* values correct: 30.0, 24.2, 19.8, 17.2, 15.0 (cm) to ± 0.2 cm [1]
1/*d* values correct (note: at least 2 significant figures) [1]

(b) any one difficulty and corresponding solution from:
difficulty obtaining balance as rule tips one way then the other
allow to tip one way then the other and take average

mass obscuring marks on rule
mark centre of the mass so it can be read against rule
OR take average of right hand and left hand readings for mass position

mass sliding off rule
OR rule sliding off pivot
suitable means for preventing mass or rule sliding [max 2]

(c) graph:
axes labelled with quantity and unit [1]
scales suitable, plots occupying at least half grid [1]
plots all correct to ½ square (take centre of plot if large) [1]
well-judged thin line (≤ ½ square) [1]

(d) triangle method used and shown (any indication on graph) using at least half line
(can be seen in calculation) [1]

(e) μ = 27 – 33 (g) to 2 or 3 significant figures [1]

25. 0625_p16_MS_60 Q: 4

(a) apparatus:
measuring cylinder/jug OR ruler OR balance (to measure amount of water) [1]
protractor OR rule to measure height of raised surface
OR other means of measuring angle of tilt
OR newtonmeter to apply variable force
OR other method of applying quantifiable force [1]

instructions:
method of tilting or applying variable force and measuring point at which bottle topples [1]

attention to accuracy, any two from:
just starts to topple
slowly
repeats / more than 10 values for quantity of water
very large protractor
or any other suitable precaution which would improve accuracy of data [max 2]

values:
at least 5 values with range at least 1500 cm^3 or 30 cm or 1500 g, approximately evenly spaced [1]

graph:
plot of measured variable (angle or height or force) against quantity of water (volume or height or mass) (accept vice versa) [1]

(b) 20° [1]

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26. 0625_s16_MS_61 Q: 1

(a)(i)	*A* and *B* values correct *A:40.0, 35.0, 30.0, 25.0, 20.0* *B:34.0, 28.8, 24.0, 19.2, 14.0*	**1**
(a)(ii)	cm, cm, N cm, N cm	**1**
(b)	Graph:	
	Axes correctly labelled with quantity, right way round	**1**
	Appropriate scales, starting at origin (0,0)	**1**
	All plots correct to ½ small square	**1**
	Good line judgement, thin, continuous, single line through the plots; with neat plots	**1**
(c)	Method shown on graph and Y correct to ½ small square.	**1**
(d)	*W* = 1.0–1.4. No ecf	**1**
(e)	Difficulty of achieving balance or other sensible suggestion	**1**
(f)	Expect agree; allow ecf. Explanation includes idea of close enough (or, ecf, too different)	**1**
		Total 10

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27. 0625_s16_MS_62 Q: 1

(a)	l_0 = 55 (mm) c.a.o.	**1**
(b)(i)	4, 9, 14, 19, 23 ecf **(a)**	**1**
(b)(ii)	Viewing scale at right angles or use of straight edge/set square/pointer between bottom of spring and scale/ruler	**1**
(c)	Graph: Axes correctly labelled with quantity and unit Suitable scales All plots correct to ½ small square Good line judgement, thin, continuous line, neat plots	 **1** **1** **1** **1**
(d)(i)	*e* = 17 (mm) ecf **(a)**	**1**
(d)(ii)	method clearly shown on graph *W* value 3.5–3.75 Unit N needed No ecf from **(i)**	**1** **1**
		Total: 10

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28. 0625_s16_MS_62 Q: 2

(a)	*x* shown clearly from centre of **P** to pivot	**1**
(b)	Make **Q** into a cube/regular shape/small contact area with rule	**1**
(c)	Move Q or P slowly one way until it just tips, then back other way until it tips back and take middle reading OR repeat procedure/experiment **AND** take average	**1**

(d)	Measure width w of cube Place w/2 either side of desired position OR draw centre line on cu e/find centre of mass of cube and mark side of rule in desired position OR take readings on both sides of the cube and find the mean	**1** **1**
(e)	Place rule on pivot (without P and Q) and record/find balance point	
		Total: 6

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29. 0625_s16_MS_63 Q: 2

(a)	indication of taking mean reading/deducing half load length and adding or subtracting scale reading = 70(.0)	**1** **1**
(b)	*F* values=1.45, 2.20, 2.80, 3.55, 4.05 consistent 2 dp	**1** **1**
(c)	**graph:** • axes labelled with quantity and unit • appropriate scales (plots occupying at least ½ grid) • plots all correct to ½ small square • well judged straight line and thin line, precise plots	 **1** **1** **1** **1**
(d)(i)	*y* read correctly from graph	**1**
(d)(ii)	*W* in range 1.4 to 2.0 to 2 or 3 sig fig and with unit of N	**1** **1**
(e)	any suitable source on inaccuracy, e.g.: • rule not uniform/weight not distributed evenly, • load slips on rule, • forcemeter not at zero to start, • load values not exact	**1**
		Total: 12

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30. 0625_w16_MS_61 Q: 5

(a)	c	1
(b)(i)	(yes) straight line through the origin	1 1
(b)(ii)	0.174 or 0.17 N/mm	1 1
	Total:	5

31. 0625_w16_MS_62 Q: 1

(a)(i)	x = 30.2(cm)	1
(a)(ii)	Measure width w of load Place w/2 either side of desired position OR draw centre line on load/find centre (of mass) of load and mark **side** of rule in desired position OR take readings on both sides of the load and find the mean	1 1
(b)	W = 3.95 (N)	1
(c)	new x at least 5 cm different from original and in the range 10 cm–45 cm	1
(d)	**two** from: difficult to judge the best position of 'almost balanced' is the centre of mass of the ruler exactly over the pivot/has the ruler slipped on the pivot? the load(s) obscure the scale the position of the centre of the load(s) is difficult to judge	2
(e)	3.995 or 4 seen 2 or 3 significant figures (whatever the answer)	1 1
	Total:	9

32. 0625_w16_MS_63 Q: 4

	apparatus – workable arrangement	1
	how applied force is measured	1
	suitable table for results / plot a bar graph	1
	how to conclude which is strongest	1
	one suitable control variable: e.g. same width of sample same thickness / weight / length of paper all samples fixed in same way	1
	any 2 from: 2nd control variable, force applied smoothly / no jerking ensure no tears before applying force repeat for each type of sample / repeat with samples of different widths soft mat under weights (to cushion fall) / clamp stand to bench add weight of lower block to value of load any other suitable precaution	2
	Total	**7**

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33. 0625_m15_MS_62 Q: 1

(a) measure ½ mass length either side of 95.0 cm
OR mark side of mass AND rule [1]

(b) correct calculations of *S*, rounding to 0.17, 0.33, 0.51, 0.61, 0.80 [1]

(c) axes labelled with quantity and unit [1]
appropriate scales [1]
plots correct to ½ small square [1]
well-judged straight line, thin line, precise plots [1]

(d) **(i)** *G* present AND triangle method seen on graph [1]

(ii) M_R = in range 113 to 140 g AND to 2/3 sig. fig. [1]

(e) see if rule balances when pivot at 50 cm mark owtte [1]

[Total: 9]

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34. 0625_s15_MS_61 Q: 1

(a) x = 1.4 (cm) or 14 (mm) or 0.014 (m)
AND y = 2.6 (cm) or 26 (mm) or 0.026 (m) [1]

correct unit for x and y [1]

(b) X and Y both 10 × x and y, ecf **(a)** [1]

W = 1.08 (N), to 2 or more significant figures (ecf allowed) [1]

(c) sensible position indicated for Z, between pivot and centre of rule [1]

(d) statement matches results
(expect Yes, ecf from **(b)** only if difference >10%) [1]

justified with reference to results; must include idea of being close enough to be within limits of experimental accuracy, ecf **(b)** [1]

(e) difficulty in achieving balance OR difficulty in positioning load exactly, e.g. load covers rule markings or uncertainty about position of centre of mass of load [1]

[Total: 8]

35. 0625_s15_MS_63 Q: 1

(a) a_0 = 75.5 (cm) AND b_0 = 25.9 (cm), accept in mm [1]

matching unit [1]

(b) a_1 = 71.(0) AND b_1 = 32.9 [1]

d_A = 4.5 and d_B = 7.(0), allow ecf from earlier results [1]

(c) *M* value rounds to160 (g), allow ecf from **(b)** [1]

2 or 3 sig. figs. and unit: g [1]

(d) appropriate explanation, e.g.
- measure height (from bench)/distance from rule at two places
- line up with rule or suitable horizontal surface
- use of spirit level [1]

(e) repeat with different (sized) loops/different values (of d_A, d_B) [1]

any one from:
- (at least) 3 more sets of results and evaluate d_A:d_B
- plot a graph to (check if) a straight line through the origin [1]

[Total: 9]

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36. 0625_w15_MS_62 Q: 1

(a)(i)(ii) *x* = 40 mm / 4(.0) cm AND *y* = 19 mm / 1.9 cm
both with correct unit [1]

(iii) 40(.0) AND 19(.0) in first line of table [1]

(b) graph:
- axes both correctly labelled, right way round and with units [1]
- suitable scales [1]
- all plots correct to within ½ small square [1]
- good best-fit line judgement, single, thin, continuous line [1]

(c) triangle method using at least half candidate's line, shown on graph [1]

G = 0.41–0.52 (2–3 sig. figs. only) [1]

(d) **P** = 20–500 g [1]
Q = 2 × **P** (exactly) OR Q = **P**/*G* [1]

[Total: 10]

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37. 0625_w15_MS_63 Q: 2

(a) any one from: [1]
- clamp rule
- rule close to spring
- ensure rule vertical
- avoidance of parallax errors (explained)
- use of set square / fiducial aid

(b) graph:
- axes both correctly labelled, right way round and with units [1]
- suitable scales [1]
- all plots correct to within ½ small square [1]
- good best-fit straight line, single, thin, continuous line [1]

(c) value consistent with candidate's graph [1]

(d) **(i)** 8(.0) (cm) [1]

(ii) W = 1.4–1.7 (N) [1]
indication on graph which matches candidate's value [1]

(e) any one from: [1]
- data only to 2 sig. figs.
- cannot plot / read graph to that level of accuracy
- cannot read rule to that level of accuracy

[Total 10]

38. 0625_s14_MS_61 Q: 1

(a) (b) 21 (mm) [1]

210 (mm) ecf from l_0 [1]

(b) 45 (mm) and
0.067 or 0.0667 (N/mm), 2 or 3 sig. figs.
ecf from l_0 and L_0 [1]

correct unit N/mm or N/m or N/cm as appropriate [1]

(c) T = 1.342 (s) or 1.34 (s) [1]

(d) T = 1.724 s (no mark)
statement NO (ecf from **(c)**) [1]

difference too large (for experimental inaccuracy) (ecf) [1]

(e) clear diagram or explanation that indicates:
perpendicular viewing of spring or scale
OR appropriate use of horizontal pointer/set square/rule, etc.
OR rule touching/very close to spring [1]

[Total: 8]

39. 0625_w14_MS_63 Q: 1

(a) h_0 present and H_0 = 84(.0) (cm) [1]

(b) suitable explanation,
e.g. same no. of graduations between 60 cm mark and each end of mass owtte,
or mark on side of rule and mass [1]

(c)(d) h present and H = 83(.0) [1]

D = 1(.0) and $d \times D$ calculations correct: 60, 75, 100, 111, 100 [1]

(e) $d \times D$ not constant / D doesn't always double when d halves owtte [1]

(f) **(i)** reference to mass/weight of rule [1]

(ii) measure height at bench [1]

subtract H_0 [1]

[Total: 8]

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40. 0625_s13_MS_61 Q: 1

(a) 9.7, 5.7, 2.0 (accept 2) or 97, 57, 20 [1]
all given to correct unit [1]
line AC drawn correctly, corner to corner [1]
α = 18 – 20° [1]

(b) number from 3 to 20 with no unit [1]

(c) correct statement for results (expect Yes) [1]
idea of within (or beyond) experimental accuracy [1]

[Total: 7]

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41. 0625_s13_MS_61 Q: 5

(a) 40.0 or 40(cm) [1]

(b) accuracy / reliability / check readings / spot anomaly / o.w.t.t.e. [1]

(c) correct method used [1]
30 or 30.0(g) [1]

(d) rule never quite balances, o.w.t.t.e. [1]
take average position / nearest to balance, o.w.t.t.e. [1]

[Total: 6]

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42. 0625_s13_MS_62 Q: 1

(a) **(i)(ii)** *M* values 112.3, 113.5 (to 3 or 4 sig. figs **only)** [1]
g at least once, not contradicted (symbols or words) [1]

(iii) 113 or 112.9 or correct average of candidate's values (ignore sig. figs) [1]

(b) 114 (g) c.a.o. [1]

(c) any two from:
centre of mass of rule not at 50.0 cm
mass X not uniform / of varying density
reference to difficulty in obtaining balance implied o.w.t.t.e.
mass of pan
mass not exactly 100 g [2]

(d) one from:
mark line through the centre of the mass (can award from diagram)
use position of edges of mass on rule

[1]

[Total: 7]

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43. 0625_w13_MS_61 Q: 1

(a) rule balanced and pivot at centre of mass [1]

(b) EITHER take readings from 50.2 cm mark
OR add mass/weight/load
OR place pivot at 50.2 cm mark [1]

(c) **(i)** cm, cm [1]

(ii) clockwise 77.5 (or 78) (N cm)
anticlockwise 78 (N cm) [1]

(d) EITHER repeats
OR estimate between two best positions that almost balance but tip opposite sides o.w.t.t.e
OR suitable method to locate centre of mass **Q** [1]

[Total: 5]

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44. 0625_w13_MS_61 Q: 5

(a) 54 – 55 [1]

(b) **(i)** table:
e values 12, 22, 36, 50, 60 (e.c.f. from **(a)**) [1]

(ii) graph:
axes correctly labelled *e* / mm and *F* / N and correct way round [1]
suitable scales [1]
all plots correct to ½ small square [1]
good line judgement [1]
thin, single continuous line [1]

(iii) triangle method using at least half of candidate's line, shown on the graph [1]
G = 11 – 13, no e.c.f. [1]

[Total: 9]

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45. 0625_s12_MS_61 Q: 1

(a) 50–250 g (or 0.05–0.25 kg) correct unit required [1]

(b) Centre of mass marked close to centre of cylinder [1]
Clear indication of how centre of mass is placed above the 90.0 cm mark [1]

(c) Rule unlikely to exactly balance/ difficult to balance
OR rule could slide on pivot
OR mass could slide
OR centre of mass of rule not at 50.0 cm mark
OR rule not uniform1

Do not accept comments about poor/careless technique [1]

(d) Repeat readings (wtte) [1]
OR a reference to finding exact position of centre of mass of metre rule
OR a reference to dealing with centre of mass of rule not being at 50.0 cm mark

(e) Good/ fine/ reasonable/ same to 3 significant figures
OR Within limits of experimental accuracy (wtte)
OR Too many significant figures in experimental result [1]

[Total: 6]

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46. 0625_s12_MS_63 Q: 1

(a) Table:
correct *d* values
70.0, 60.0, 50.0, 40.0, 30.0, 20.0, 10.0 [1]
cm, N ALLOW m, mm if consistent with figures [1]

(b) **(i)** *d* against *F* (or vice versa) OR distance against force/forcemeter reading
NOT 'extension', 'forcemeter', quantity expressed just as units [1]

(ii) Straight line [1]
Through origin or wtte [1]

(c) Would change forcemeter reading/change mass on rule/wtte [1]

(d) Check distance from bench is the same at two points or wtte/
Line up by eye with windowsill (or suitable horizontal reference) [1]

[Total: 7]

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47. 0625_w12_MS_61 Q: 1

(a) d_0 = 21 (mm) [1]

(b) D_o = 210 (mm) or 10 × candidate's **(a)** [1]

(c) *L* values 1.0, 2.0, 3.0, 4.0, 5.0 [1]
e values 1.0, 9.0, 21.0, 29.0, 40.0 [1]

(d) Graph:
Axes correctly labelled with quantity and unit and correct way around [1]
Suitable scales [1]
All plots correct to ½ small square
Good line judgement and a single, thin, continuous line [1]

(e) Triangle method used and shown on the graph [1]
Using at least half of line [1]

(f) Any one from:
Always measure from same point on spring (top or bottom of ring)
Wait for spring/weight to stop bouncing
Use of horizontal aid/ensure ruler is vertical
Bench surface not uniform [1]

[Total: 11]

48. 0625_w12_MS_63 Q: 1

(a) **(i)** and **(ii)** l_o = 2.0 and l_1 = 6.1 [1]

(iii) e_1 = 4.1cm unit required ecf from **1(a)(i)** and **1(a)(ii)** [1]

(iv) Correct calculation for k = 24/24.4 ecf from **1(a)(iii)** [1]
Unit g/cm [1]

(b) **(i)** Appropriate method (can be written and/or in diagram)
e.g. measure half width of mass either side of 40 cm/mark centre of mass [1]

(ii) and **(iii)** e_2 seen and M = 190 g (no ecf) unit required for M [1]
2 or 3 significant figures [1]

(c) Any two from:
rule bends
mass not exactly at 40 cm
mass may slip
end of rule may slip
hook not directly above 0 cm
spring extension not uniform/owtte
proportional limit exceeded
mass irregular/C of G not at centre [2]

[Total: 9]