

Solution: Exp. problem 1

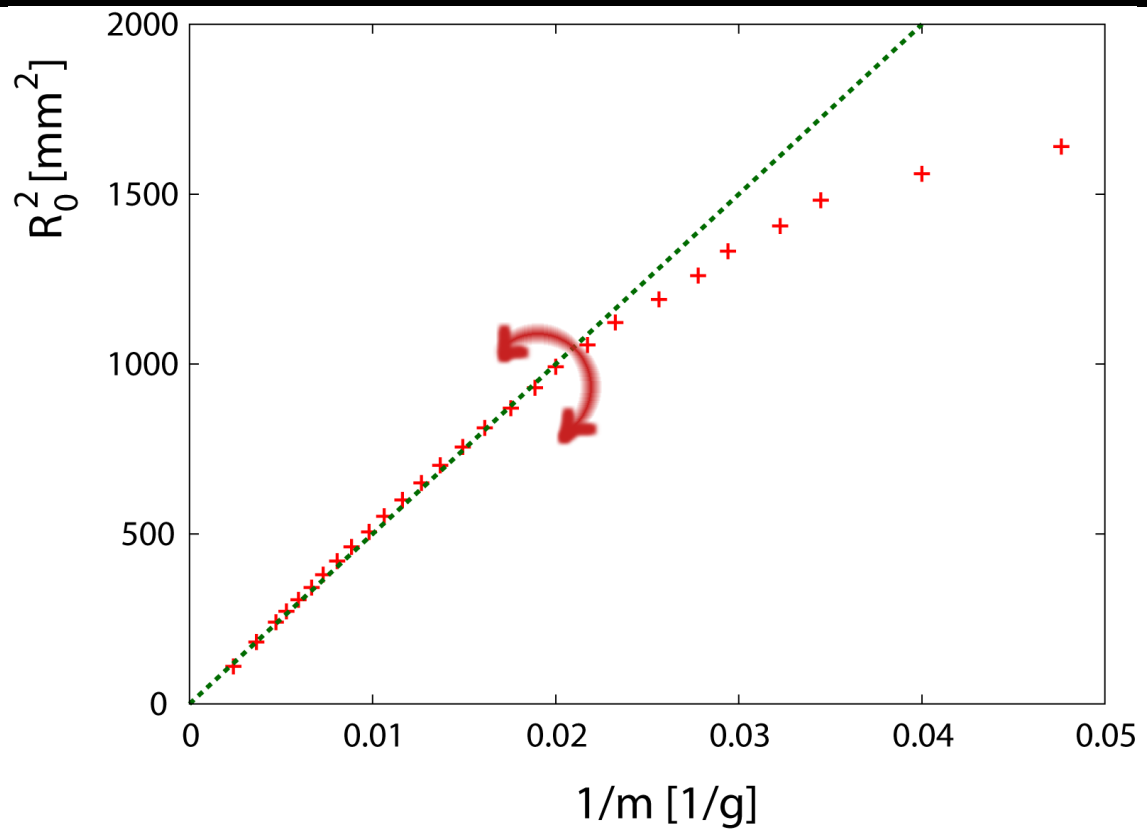
Task 1			Points
(a)	m[g]	R₀[mm]	0.95
	21	40.5	
	25	39.5	
	29	38.5	
	31	37.5	
	34	36.5	
	36	35.5	
	39	34.5	
	43	33.5	
	46	32.5	
	50	31.5	
	53	30.5	
	57	29.5	
	62	28.5	
	67	27.5	
	73	26.5	
	79	25.5	
	86	24.5	
	94	23.5	
	102	22.5	
	113	21.5	
	124	20.5	
	137	19.5	
	150	18.5	
	168	17.5	
	189	16.5	
	212	15.5	
	274	13.5	
	417	10.5	

Task 1		Points																																																										
(a)	<table border="1"><thead><tr><th>m[g]</th><th>R₀[mm]</th></tr></thead><tbody><tr><td>40</td><td>29.9</td></tr><tr><td>42</td><td>29.8</td></tr><tr><td>45</td><td>29.6</td></tr><tr><td>47</td><td>29.4</td></tr><tr><td>50</td><td>29.3</td></tr><tr><td>52</td><td>29.1</td></tr><tr><td>54</td><td>28.9</td></tr><tr><td>57</td><td>28.8</td></tr><tr><td>59</td><td>28.6</td></tr><tr><td>61</td><td>28.4</td></tr><tr><td>64</td><td>28.3</td></tr><tr><td>71</td><td>27.8</td></tr><tr><td>78</td><td>27.3</td></tr><tr><td>92</td><td>26.3</td></tr><tr><td>105</td><td>25.3</td></tr><tr><td>118</td><td>24.3</td></tr><tr><td>129</td><td>23.3</td></tr><tr><td>143</td><td>22.3</td></tr><tr><td>157</td><td>21.3</td></tr><tr><td>171</td><td>20.3</td></tr><tr><td>189</td><td>19.3</td></tr><tr><td>211</td><td>18.3</td></tr><tr><td>235</td><td>17.3</td></tr><tr><td>259</td><td>16.3</td></tr><tr><td>293</td><td>15.3</td></tr><tr><td>336</td><td>14.3</td></tr><tr><td>386</td><td>13.3</td></tr><tr><td>449</td><td>12.3</td></tr></tbody></table>	m[g]	R₀[mm]	40	29.9	42	29.8	45	29.6	47	29.4	50	29.3	52	29.1	54	28.9	57	28.8	59	28.6	61	28.4	64	28.3	71	27.8	78	27.3	92	26.3	105	25.3	118	24.3	129	23.3	143	22.3	157	21.3	171	20.3	189	19.3	211	18.3	235	17.3	259	16.3	293	15.3	336	14.3	386	13.3	449	12.3	0.95
m[g]	R₀[mm]																																																											
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Task 1

Points

(b)



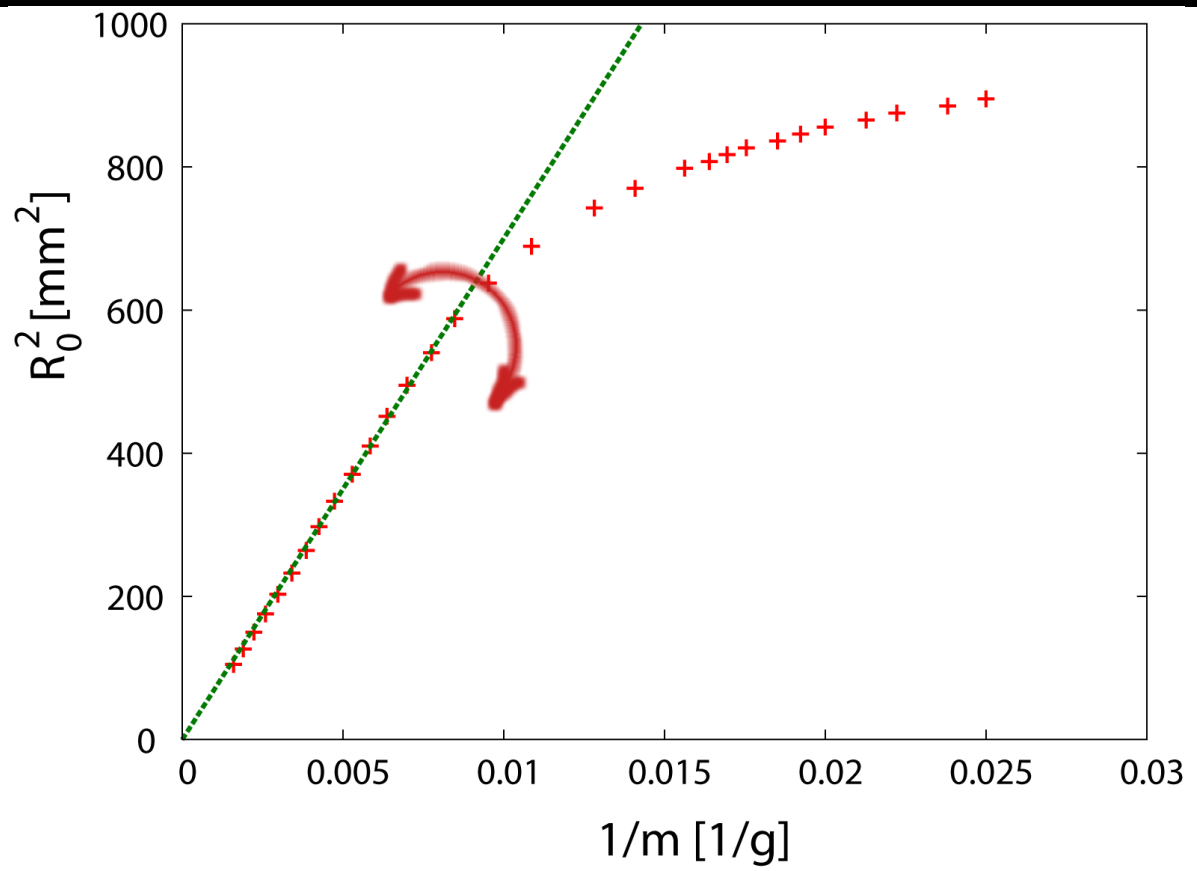
$$a = 50000 \text{ g mm}^2$$

1.4

Task 1

Points

(b)



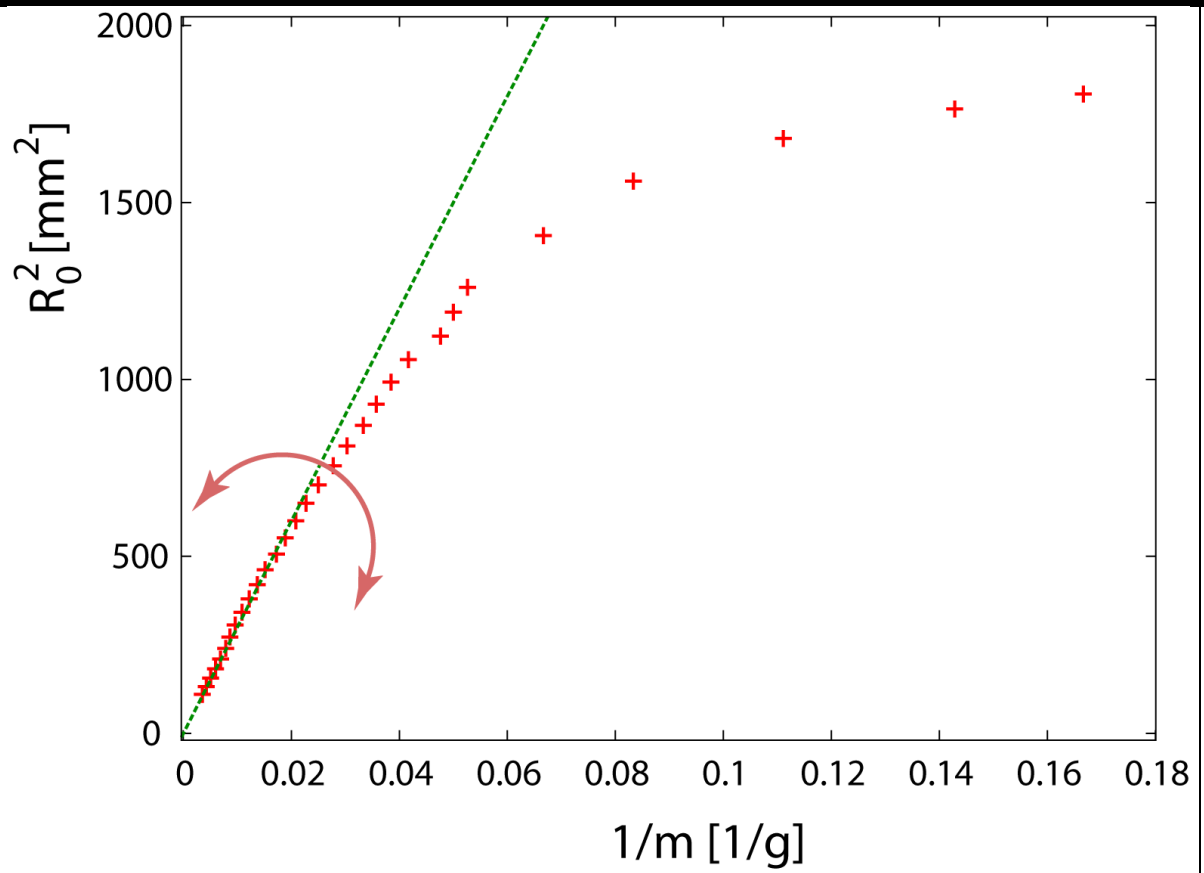
$$a = 70000 \text{ g mm}^2$$

1.4

Task 1		Points																																																										
(b)	$\kappa = \frac{2ag}{\pi l} = 1.5 \text{ mJ}$	0.5																																																										
	$\kappa = \frac{2ag}{\pi l} = 1.5 \text{ mJ}$	0.5																																																										
	$\frac{R_0}{R_c} \leq 0.70$ $\frac{R_0}{R_c} \leq 0.77$	0.5																																																										
Task 2		Points																																																										
<table border="1"> <thead> <tr> <th>m[g]</th> <th>R₀[mm]</th> </tr> </thead> <tbody> <tr><td>6</td><td>42.5</td></tr> <tr><td>7</td><td>42.</td></tr> <tr><td>9</td><td>41.</td></tr> <tr><td>12</td><td>39.5</td></tr> <tr><td>15</td><td>37.5</td></tr> <tr><td>19</td><td>35.5</td></tr> <tr><td>20</td><td>34.5</td></tr> <tr><td>21</td><td>33.5</td></tr> <tr><td>24</td><td>32.5</td></tr> <tr><td>26</td><td>31.5</td></tr> <tr><td>28</td><td>30.5</td></tr> <tr><td>30</td><td>29.5</td></tr> <tr><td>33</td><td>28.5</td></tr> <tr><td>36</td><td>27.5</td></tr> <tr><td>40</td><td>26.5</td></tr> <tr><td>44</td><td>25.5</td></tr> <tr><td>48</td><td>24.5</td></tr> <tr><td>53</td><td>23.5</td></tr> <tr><td>58</td><td>22.5</td></tr> <tr><td>66</td><td>21.5</td></tr> <tr><td>73</td><td>20.5</td></tr> <tr><td>82</td><td>19.5</td></tr> <tr><td>92</td><td>18.5</td></tr> <tr><td>104</td><td>17.5</td></tr> <tr><td>116</td><td>16.5</td></tr> <tr><td>127</td><td>15.5</td></tr> <tr><td>145</td><td>14.5</td></tr> <tr><td>168</td><td>13.5</td></tr> </tbody> </table>		m[g]	R ₀ [mm]	6	42.5	7	42.	9	41.	12	39.5	15	37.5	19	35.5	20	34.5	21	33.5	24	32.5	26	31.5	28	30.5	30	29.5	33	28.5	36	27.5	40	26.5	44	25.5	48	24.5	53	23.5	58	22.5	66	21.5	73	20.5	82	19.5	92	18.5	104	17.5	116	16.5	127	15.5	145	14.5	168	13.5	0.9
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Task 2

Points

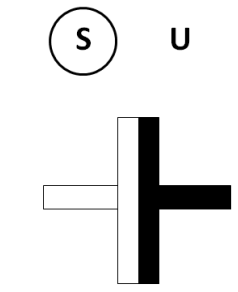
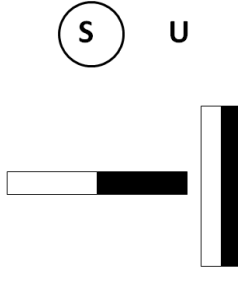
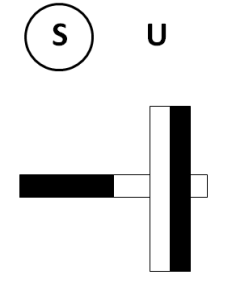
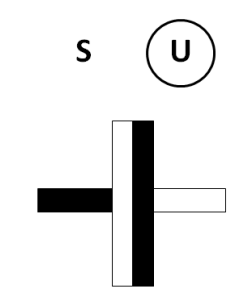


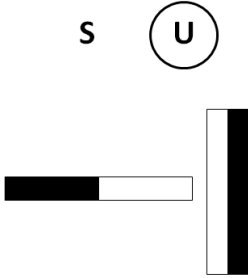
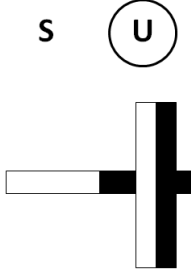
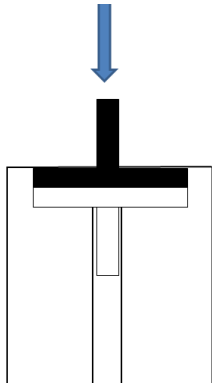
$$a = 27000 \text{ g mm}^2$$

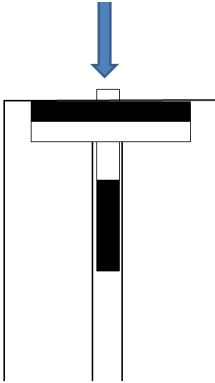
0.9

Task 2		Points
	$\mathcal{K} = 0.8 \text{ mJ}$	1.0
Task 3		Points
	Young modulus of the blue foil: $Y = 2.0 \text{ GPa}$	0.6
	Young modulus of the colorless foil: $Y = 2.5 \text{ GPa}$	0.4
Total:		10

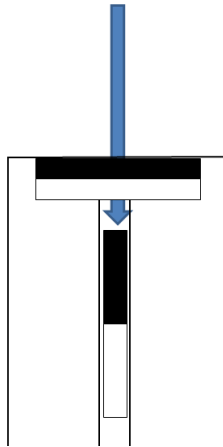
Solution - Exp. Problem 2

Task 1		Points
		0.25
		0.45
		0.45
		0.45

		0.45																		
		0.45																		
Task 2		Points																		
	<p>Symmetries that should be utilized in the measurements:</p> <table border="1" data-bbox="336 976 1110 1126"> <tr> <td>$F_{\uparrow\downarrow}(z) = -F_{\uparrow\downarrow}(-z)$</td> </tr> <tr> <td>$F_{\uparrow\downarrow}(z) = -F_{\uparrow\uparrow}(z)$</td> </tr> <tr> <td>From the two above one gets also $F_{\uparrow\uparrow}(z) = -F_{\uparrow\uparrow}(-z)$</td> </tr> </table>	$F_{\uparrow\downarrow}(z) = -F_{\uparrow\downarrow}(-z)$	$F_{\uparrow\downarrow}(z) = -F_{\uparrow\uparrow}(z)$	From the two above one gets also $F_{\uparrow\uparrow}(z) = -F_{\uparrow\uparrow}(-z)$	0,6															
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From the two above one gets also $F_{\uparrow\uparrow}(z) = -F_{\uparrow\uparrow}(-z)$																				
	<p>By using the setup as it is, the whole curve can be measured by starting the measurements from three stable equilibrium points; the equilibrium point (z_0) can be measured also by using the setup.</p> <p>Configuration:</p>  <p>Measurements:</p> <table border="1" data-bbox="336 1787 764 2022"> <thead> <tr> <th>$z_0=0\text{mm}$</th> <th>m [g]</th> <th>Δz [mm]</th> </tr> </thead> <tbody> <tr> <td></td> <td>0</td> <td>0</td> </tr> <tr> <td></td> <td>31</td> <td>1</td> </tr> <tr> <td></td> <td>55</td> <td>2</td> </tr> <tr> <td></td> <td>75</td> <td>3</td> </tr> <tr> <td></td> <td>97</td> <td>4</td> </tr> </tbody> </table>	$z_0=0\text{mm}$	m [g]	Δz [mm]		0	0		31	1		55	2		75	3		97	4	0,8
$z_0=0\text{mm}$	m [g]	Δz [mm]																		
	0	0																		
	31	1																		
	55	2																		
	75	3																		
	97	4																		

	<table> <tbody> <tr><td>119</td><td>5</td></tr> <tr><td>140</td><td>6</td></tr> <tr><td>158</td><td>7</td></tr> <tr><td>171</td><td>8</td></tr> <tr><td>170</td><td>9</td></tr> <tr><td>118</td><td>10</td></tr> <tr><td>85</td><td>10,25</td></tr> <tr><td>50</td><td>10,5</td></tr> <tr><td>10</td><td>10,75</td></tr> </tbody> </table>	119	5	140	6	158	7	171	8	170	9	118	10	85	10,25	50	10,5	10	10,75																									
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	<p>Configuration:</p>  <p>Measurements:</p> <table border="1"> <thead> <tr> <th>$z_0=10.8\text{mm}$</th> <th>m [g]</th> <th>Δz [mm]</th> </tr> </thead> <tbody> <tr><td></td><td>0</td><td>0</td></tr> <tr><td></td><td>233</td><td>1</td></tr> <tr><td></td><td>538</td><td>2</td></tr> <tr><td></td><td>927</td><td>3</td></tr> <tr><td></td><td>996</td><td>3,5</td></tr> <tr><td></td><td>1124</td><td>4</td></tr> <tr><td></td><td>1154</td><td>4,5</td></tr> <tr><td></td><td>1213</td><td>5</td></tr> <tr><td></td><td>1212</td><td>5,5</td></tr> <tr><td></td><td>1120</td><td>6</td></tr> <tr><td></td><td>873</td><td>6,5</td></tr> <tr><td></td><td>284</td><td>7</td></tr> <tr><td></td><td>36</td><td>7,5</td></tr> </tbody> </table>	$z_0=10.8\text{mm}$	m [g]	Δz [mm]		0	0		233	1		538	2		927	3		996	3,5		1124	4		1154	4,5		1213	5		1212	5,5		1120	6		873	6,5		284	7		36	7,5	0,8
$z_0=10.8\text{mm}$	m [g]	Δz [mm]																																										
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Configuration:



0,8

Measurements:

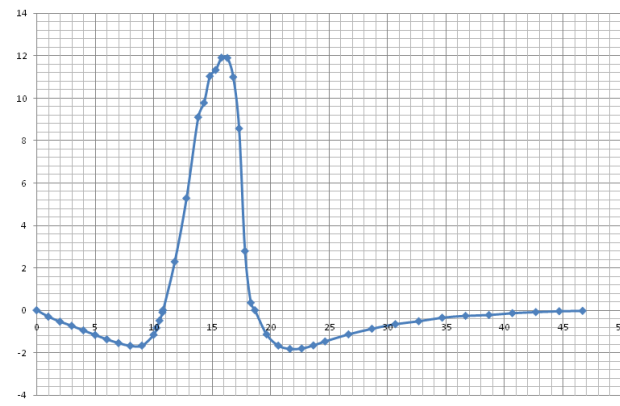
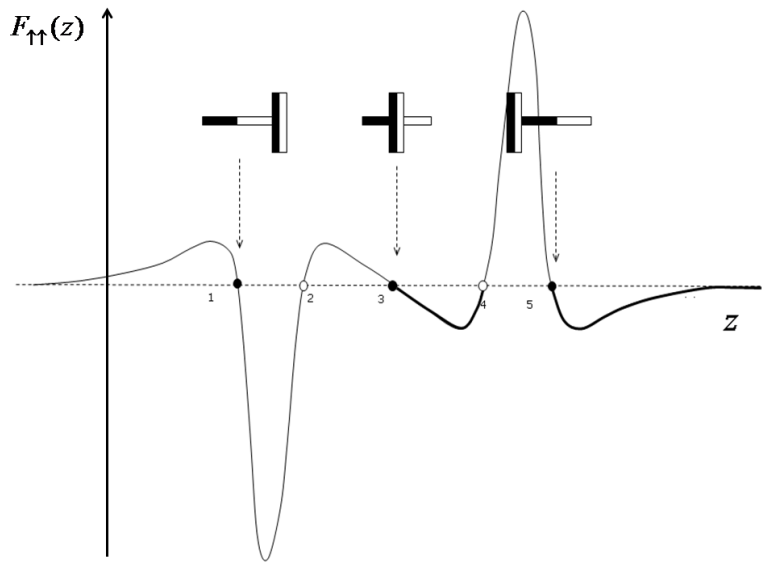
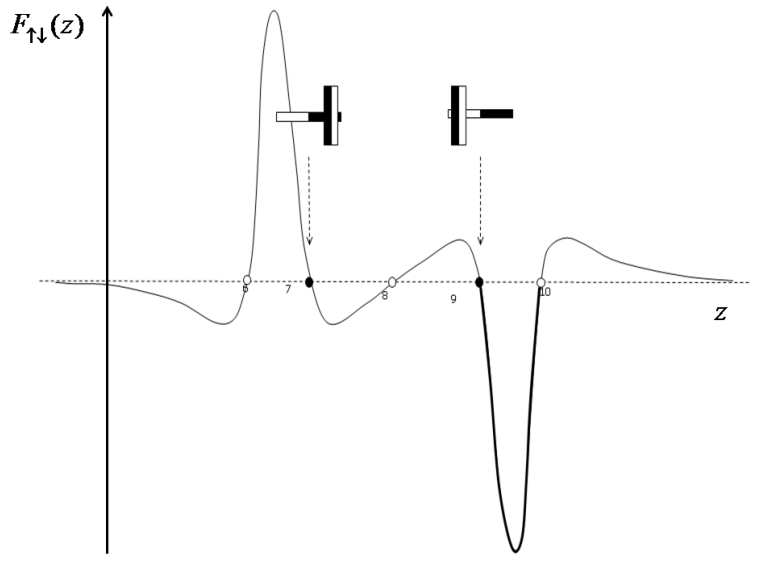
$z_0=18.6\text{mm}$	m [g]	Δz [mm]
	0	0
	116	1
	170	2
	186	3
	184	4
	169	5
	150	6
	116	8
	89	10
	67	12
	53	14
	36	16
	27	18
	23	20
	14	22
	9	24
	5	26
	3	28

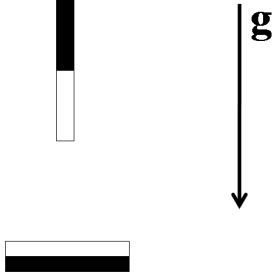
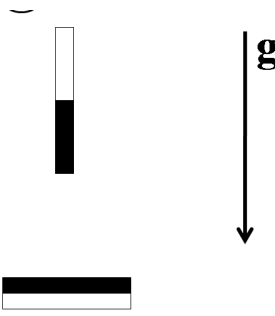
Task 3

Points

Due to symmetry, it is sufficient to plot e.g., the following graph in detail:

2

	<p>$F_{\uparrow\uparrow}(z)$ [N]</p>  <p style="text-align: right;">z [mm]</p>	
	<p>$F_{\uparrow\uparrow}(z)$</p>  <p style="text-align: right;">z</p>	1
	<p>$F_{\uparrow\downarrow}(z)$</p>  <p style="text-align: right;">z</p>	1

		0,5
	<p>OR</p> 	
Total:		10.0