

Answers to exercises

Exercise 1

1. 1800 Nm 2. 2 kg m, anti-clockwise 3. 0.73 m from the centre towards the 10 kg weight 4. 45.83 kg 5. 81 kg m

Exercise 2

1. 11.05 m 2. 10.41 m 3. 4.62 m 4. 6.08 m 5. 0.25 m

Exercise 3

1. 98.78 tonnes 2. 114.13 tonnes 3. 172.8 tonnes
4. 108 tonnes 5. $83\frac{1}{3}$ tonnes 6. 861 tonnes

Exercise 4

1. 0.484 m 2. 0.256 m 3. 1.62 tonnes 4. 11.6 tonnes
5. 0.04 m, 32 per cent 6. 900 kg, S.G. 0.75
7. 0.03 m 8. 1.02 9. 0.75 m, 182.34 tonnes
10. (a) 125 kg (b) 121.4 kg 11. 64 per cent
12. (a) 607.5 kg (b) 4.75 cm 13. 1.636 m 14. (a) 1.2 m
(b) 70 per cent 15. 9.4 per cent

Exercise 5

1. 7612.5 tonnes 2. 4352 tonnes 3. 1.016 m 4. 7.361 m
5. 0.4875 m 6. 187.5 tonnes 7. 13 721.3 tonnes 8. 6 406.25 tonnes
9. 6.733 m F 6.883 m A 10. 228 tonnes 11. 285 tonnes
12. (a) 8515 tonnes (b) 11 965 tonnes 13. 27 mm 14. 83.2 mm

Exercise 6

5. 2604 tonnes metres

Exercise 8

1. (b) 3.78 tonnes 4.42 tonnes (c) 2.1 m 2 (b) 6.46 tonnes 7.8 tonnes
(c) 3.967 m 3. 4.53 m 4. (b) 920 tonnes (c) 3.3 m (d) 6.16 tonnes
5. (a) 2.375 m (b) 3092 tonnes (c) 1125 tonnes 6. (b) 3230 tonnes

- (c) 1.625 m 7. (b) 725 tonnes (c) 4.48 m (d) 5 tonnes
 8. (b) 5150 tonnes 4.06 m (c) 5.17 m

Exercise 9

1. (b) 12.3 tonnes 2. (b) 8302.5 tonnes 3. 12 681.3 tonnes
 4. 221 tonnes 5. 180 tonnes 6. 95 7. 53

Exercise 10

1. (a) 508 m^2 (b) 5.2 tonnes (c) 0.8 m aft of amidships 2. (a) 488 m^2
 (b) 5 tonnes (c) 0.865 (d) 0.86 m aft of amidships 3. (a) 122 mm
 (b) 43.4 m from forward 4. (a) 30 476.7 tonnes (b) 371.4 mm (c) 15.6 m
 5. 5062.5 tonnes 6. (a) 978.3 m^2 (b) 15.25 cm
 (c) 2.03 m aft of amidships 7. (a) $9993\frac{3}{4}$ tonnes (b) 97.44 mm (c) 4.33 m
 8. (a) 671.83 m^2 (b) 1.57 m aft of amidships
 9. 12.125 m^2 10. 101 m^2 11. (a) 781.67 m^3 (b) 8.01 tonnes
 12. (a) 2893.33 m^3 or 2965.6 tonnes (b) 3 m

Exercise 11

1. 2.84 m 2. 3.03 m 3. 3.85 m 4. 5.44 m 5. 0.063 m
 6. 1466.67 tonnes 7. 1525 tonnes
 8. 7031.3 tonnes in L.H and 2568.7 tonnes in T.D. 9. 1.2 m 10. 1.3 m
 11. 55 tonnes 12. 286.3 tonnes 13. 1929.67 tonnes

Exercise 12

1. 5 m 2. (a) 1.28 m (b) 4.56 m 3. (a) 1.78 m (b) 3 m
 4. No. Unstable when upright. 5. (a) 6.2 m, 13.78 m (b) 4.9 m
 6. (a) 10.6 m, 5.13 m (b) 4.9 m at 4.9 m draft 7. (a) 6.31 m, 4.11 m
 (b) 4.08 m 8. (b) GM is +1.8 m, vessel is in stable equilibrium
 (c) GM is zero, $KG = KM$, so ship is in neutral equilibrium

Exercise 13

1. $6^\circ 03'$ to starboard 2. 4.2 m
 3. 216.5 tonnes to port and 183.5 tonnes to starboard 4. $9^\circ 30'$
 5. 5.458 m 6. $12^\circ 57'$ 7. 91 9 tonnes
 8. 282.75 tonnes to port, 217.25 tonnes to starboard
 9. 8.52 m to port GM = 0.864 m 10. $14^\circ 4'$ to port 11. $13^\circ 24'$
 12. 50 tonnes 13. 3.8°

Exercise 14

1. 674.5 tonnes metres 2. 7.773 m 3. 546.2 m
 4. 6.027 m, 2000 tonnes metres 5. (a) 83.43 tonnes metres
 (b) 404.4 tonnes metres 6. (a) 261.6 tonnes metres
 (b) 2647 tonnes metres 7. (a) 139.5 tonnes metres
 (b) 1366 tonnes metres 8. 0.522 m
 9. Angle of Loll is 14.96° , KM is 2.67 m, GM is -0.05 m

Exercise 15

1. 218.4 tonnes in No. 1 and 131.6 tonnes in No. 4
2. 176.92 tonnes
3. 5.152 m F 5.342 m A
4. 6.162 m F 6.726 m A
5. 668.4 tonnes from No. 1 and 1331.6 tonnes from No. 4
6. 266.7 tonnes
7. 24.4 cm
8. 380 tonnes, 6.785 m F
9. 42.9 tonnes in No. 1, and 457.1 in No. 4 GM = 0.79 m
10. 402.1 tonnes from No. 1 and 47.9 tonnes from No. 4
11. 3.118 m F 4.340 m A
12. 5.50 m F 5.56 m A
13. 5.679 m F 5.901 m A
14. 4 metres aft
15. 3.78 metres aft
16. 4.44 metres aft
17. 55.556 metres forward
18. 276.75 tonnes; 13.6 metres forward
19. 300 tonnes; 6.3 m
20. 200 tonnes; 7.6 m
21. 405 tonnes in No. 1 and 195 tonnes in No. 4
22. 214.3 tonnes
23. 215.4 tonnes; 5.96 m F
24. 200 metres
25. 240 metres
26. Draft aft is 8.23 m. Draft forward is 7.79 m. Dwt is 9195 t. Trim by the stern is 0.44 m

Exercise 16

1. GM = 2 m, Range 0–84.5°, Max. GZ = 2.5 m at 43.5° heel.
2. GM = 4.8 m, Max. Moment = 67 860 tonnes metres at 42.25° heel, Range 0–81.5°
3. GM = 3.07 m, Max. GZ = 2.43 m at 41° heel, Range 0–76°, Moment at 10° = 16 055 tonnes metres. Moment at 40° = 59 774 tonnes metres
4. Moment at 10° = 16 625 tonnes metres, GM = 2 m, Max. GZ = 2.3 m at 42° heel, Range 0–82°
5. GM = 3.4 m. Range 0–89.5°, Max. GZ = 1.93 m at 42° heel.
6. 6.61 m
7. 8.37 m
8. 25.86 m forward
9. 39 600 tonnes; 513 tonnes metres; 40.5 tonnes; 9.15 m
10. 3.15 m F 4.53 m A
11. (a) 0–95°, (b) 95°, (c) 3.18 m at 47.5°
12. (a) 0–75°, (b) 75°, (c) 2.15 m at 40°
13. 1.60 m 40°, 12°, 72.5°
14. 1.43 m, 39.5°, 44 000 tonnes metres, 70°

Exercise 17

1. 1.19 m
2. 1.06 m
3. 0.64 m
4. 7 m
5. 4.62 m

Exercise 18

1. 1.545 m
2. 6.15 tonnes/m²
3. 7.175 tonnes/m², 1,435 tonnes
4. 6.15 tonnes/m², 55.35 tonnes
5. 9 tonnes/m², 900 tonnes
6. 6.15 tonnes/m², 147.6 tonnes
7. 1 tonne
8. 386.76 tonnes on side with density 1010 kg/m³
9. 439.4 tonnes on side with density 1016 kg/m³
10. 3075 tonnes
11. 128.13 tonnes

Exercise 19

1. Transfer 41.94 tonnes from starboard to port, and 135 tonnes from forward to aft.
2. Transfer 125 tonnes from forward to aft, and 61.25 tonnes from port to starboard. Final distribution: No. 1 Port 75 tonnes, No. 1 starboard

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200 tonnes, No. 4 Port 63.75 tonnes, No. 4 starboard 61.25 tonnes
3. $13^{\circ} 52'$ 3.88 m F 4.30 m A 4. Transfer 133.33 tonnes from each side of No. 5. Put 149.8 tonnes in No. 2 Port and 116.9 tonnes in No. 2 starboard

Exercise 20

1. 0.148 m 2. 0.431 m 3. 1.522 m
4. $7^{\circ} 2'$ 5. Dep. GM = 0.842 m, Arr. GM = 0.587 m 6. $3^{\circ} 0'$
7. 112.4 tonnes 8. 6.15 m + 0.27 m

Exercise 21

1. 5.12 m 2. 0.222 m 3. 0.225 m 4. 0.558 m 5. 0.105 m
6. 0.109 m 7. 0.129 m 8. 3.55 m F 2.01 m A 9. 7.529 m F 5.267 m A
10. 6.25 m F 2.96 m A 11. 5.598 m F 3.251 m A
12. 5.305 m F 4.859 m A

Exercise 22

1. 1344 m tonnes 2. 2038.4 m tonnes 3. 1424 m tonnes
4. 13.67 m tonnes 5. 107.2 m tonnes

Exercise 24

1. No; $35^{\circ} 49'$ 2. $39^{\circ} 14'$
3. Probable cause of the list is a negative GM
4. Discharge timber from the high side first.

Exercise 25

1. 33 tonnes 2. 514 tonnes 3. 488 tonnes 4. 146.3 tonnes. Sag 0.11 m
0.843 m

Exercise 26

1. 15.6 cm 2. 1962 tonnes 4.087 m 3. 4.576 m 4. 5000 tonnes
5. 39.1 cm 6. 10.67 m 7. 2.92 m 8. 4.24 m
9. 0.48 m, 1.13° , 8050 tonnes, 8.51 m

Exercise 27

1. 1.19 m 2. 69.12 tonnes 1.6 m

Exercise 28

1. -0.2 m or -0.25 m 2. $+0.367$ m or $+0.385$ m
3. $+0.541$ m or $+0.573$ m. Safe to drydock vessel.
4. $+0.550$ m or $+0.564$ m. Safe to drydock vessel.
5. Max trim 0.896 m or 0.938 m by the stern.

Exercise 29

1. 0.707 2. $\frac{8a^4}{3}$ 3. 9:16 4. 63 281 cm⁴ 5. (a) 3154 m⁴
(b) 28 283 m⁴ 6. (a) 18 086 m⁴ (b) 871 106 m⁴
7. BM_L 206.9 m BM_T 8.45 m 8. I_{CL} 35 028 m⁴ I_{CF} 1 101 540 m⁴

9. $I_{CL} 20\,267\text{ m}^4$ $I_{CF} 795\,417\text{ m}^4$ 10. $I_{CL} 13\,227\text{ m}^4$ $I_{CF} 396\,187\text{ m}^4$

Exercise 30

1. 658.8 tonnes 4.74 m 2. 17.17 m 3. 313.9 tonnes 2.88 m
 4. 309.1 tonnes 1.74 m 5. 5.22 m

Exercise 31

1. (a) 366.5 m (b) 0.100 (c) 0.65 m (d) 0.85 m
 2. (a) W of I is $418\text{ m} > 350\text{ m}$ (c) 9.05 kt 3. 10.56 kt

Exercise 32

1. $4^\circ 34'$ 2. $6^\circ 4'$ 3. $5^\circ 44'$ 4. 6.8° to starboard

Exercise 33

1. 20.05 s 2. 15.6 s 3. 15.87 s 4. T_R is 28.2 s – rather a ‘tender ship’

Exercise 34

1. 3.6° 2. 11.57° 3. 5.7° 4. 4.9° 5. 8°

Exercise 36

1. Passenger liner (0.78 m) and general cargo ship (0.66 m)

Exercise 37

1. 4.1 m F 8.2 m A 2. 2.44 m F 4.39 m A
 3. Draft aft is 6.91 m, draft forward is 6.87 m

Exercise 38

1. $14^\circ 33'$ 2. $13^\circ 4'$ 3. $9^\circ 52'$ 4. $5^\circ 35'$

Exercise 40

1. Max. BM 2.425 tonnes m at 5.8 m from A
 2. (a) Max. BM 29.2 tonnes m between the positions of the two masses. (b) At $\frac{1}{3}L$ from L.H. side SF = 4.87 tonnes BM = 24.34 tonnes m. At $\frac{1}{3}L$ from R.H. side SF = 0.13 tonnes, BM = 28.65 tonnes m

Exercise 43

1. Max. SF = ± 40 tonnes Max. BM = + 145.8 tonnes m, -62.5 tonnes m
 2. Max. BM = 150 tonnes m at amidships.
 3. Max. SF = ± 250 tonnes at 25 m from each end. Max. BM = 6250 tonnes m at amidships
 4. Descriptive
 5. SF_{\max} is 128.76 MN, BM_{\max} is 10 220 MN m at station 5.2, just forward of mid-LOA

Exercise 44

1. 420 tonnes