

DIRECTORATE OF MERCHANT SHIPPING
GOVERNMENT OF SRI LANKA
CERTIFICATE OF COMPETENCY EXAMINATION

GRADE : CHIEF MATE ON SHIPS OF 500 GT OR MORE (UNLIMITED)
SUBJECT : SHIP'S STABILITY
DATE : 10th December 2015

Time allowed **THREE hours**

Total marks : 180

ANSWER ALL QUESTIONS

Pass marks : 60%

Formulae and all intermediate steps taken in reaching your answer should be clearly shown. You may draw sketches wherever required. Electronic devices capable of storing and retrieving are **not** allowed.

- 1) A box-shaped barge of uniform construction is 32 m long and displaces 352 t when empty, is divided by transverse bulkheads into four equal compartments. Cargo is loaded into each compartment and level stowed as follows:

No. 1 hold – 192 tonnes No. 2 hold – 224 tonnes
No. 3 hold – 272 tonnes No. 4 hold – 176 tonnes

- a) Construct load and shearing force diagrams at the bulkheads (15 marks)
b) Construct bending moments curve for the above positions (10 marks)
c) Find the value of the maximum bending moment along the ship's length (05 marks)

- 2) A box shaped vessel floating on an even keel in salt water has the following particulars:

Length	130.0 m	Breadth	20.0 m
Draught	5.0 m	KG	4.5 m

There is an empty forward end compartment of 20.0 m length that extends the full width of the vessel.

Calculate the final draughts fore and aft if this compartment is bilged.

(30 marks)

- 3) A bulk carrier, fully laden with ore in alternate holds has to be dry docked in the following conditions:

Displacement	73000 t	KM	13.10 m
Draughts	12.45 m (even keel)	Mean TPC	62
KG	10.9 m		

The dock initially has 14 m of water over the upper surfaces of the blocks which have no declivity.

- a) Calculate the GM when the water level has been lowered by 4.0 m
(20 marks)
- b) Explain why a small stern trim is generally to be preferred to the even keel condition when entering dry dock
(04 marks)
- c) Explain the possible dangers involved in dry docking this vessel and how these may be overcome if dry docking is for purpose of:
i) Inspection of some side shell damage only;
ii) Inspection of possible bottom damage.
(03 marks each)
- 4) The attached hydrostatic particulars provide the hydrostatic data for a vessel of, length between perpendiculars 140.0 m and summer load displacement of 14115 t.

In partly loaded condition, the vessel has the following draughts in salt water:

Fwd	5.26 m
Aft	5.48 m

The vessel is to complete loading at the summer displacement with a trim of 0.5 m by stern. The remaining cargo is to be loaded in two holds:

No. 1 hold lcg	116.0 m foap
No. 4 hold lcg	32 m foap

Using the hydrostatic data sheet, calculate each of the following:

- a) The quantity to load in each hold
(25 marks)
- b) The final draughts in salt water
(05 marks)

5) Answer the following questions with reference to the IMO stability criteria & ship's stability:

a) State the minimum stability requirements for a vessel in accordance with the IMO stability criteria

(10 marks)

b) At ballast passage a particular vessel complies in every respect with the stability requirements of the IMO stability criteria. At load draught, with the same GM, it does not comply. With the aid of a suitable diagram, explain why this may be so.

(10 marks)

c) Show, by means of labeled diagrams, the difference between a GZ curve for a vessel at an angle of loll and a GZ curve for a vessel with list due to an off centre weight.

(10 marks)

6) A vessel is floating upright with the following particulars:

Displacement = 20000 t KG = 9.0 m

The following cargo and bunkers are then loaded:

500 t	Kg 12.0 m	6.0 m to starboard of centerline
340 t	Kg 4.5 m	4.5 m to starboard of centerline
200 t	Kg 11.0 m	6.0 m to port of centerline

Bunkers (relative density 0.9) 150 t (Kg 1.2 m), in a centre tank of length 8 m, breadth 15 m which is slack.

Calculate the list if the final KM is 10.55 m

(30 marks)

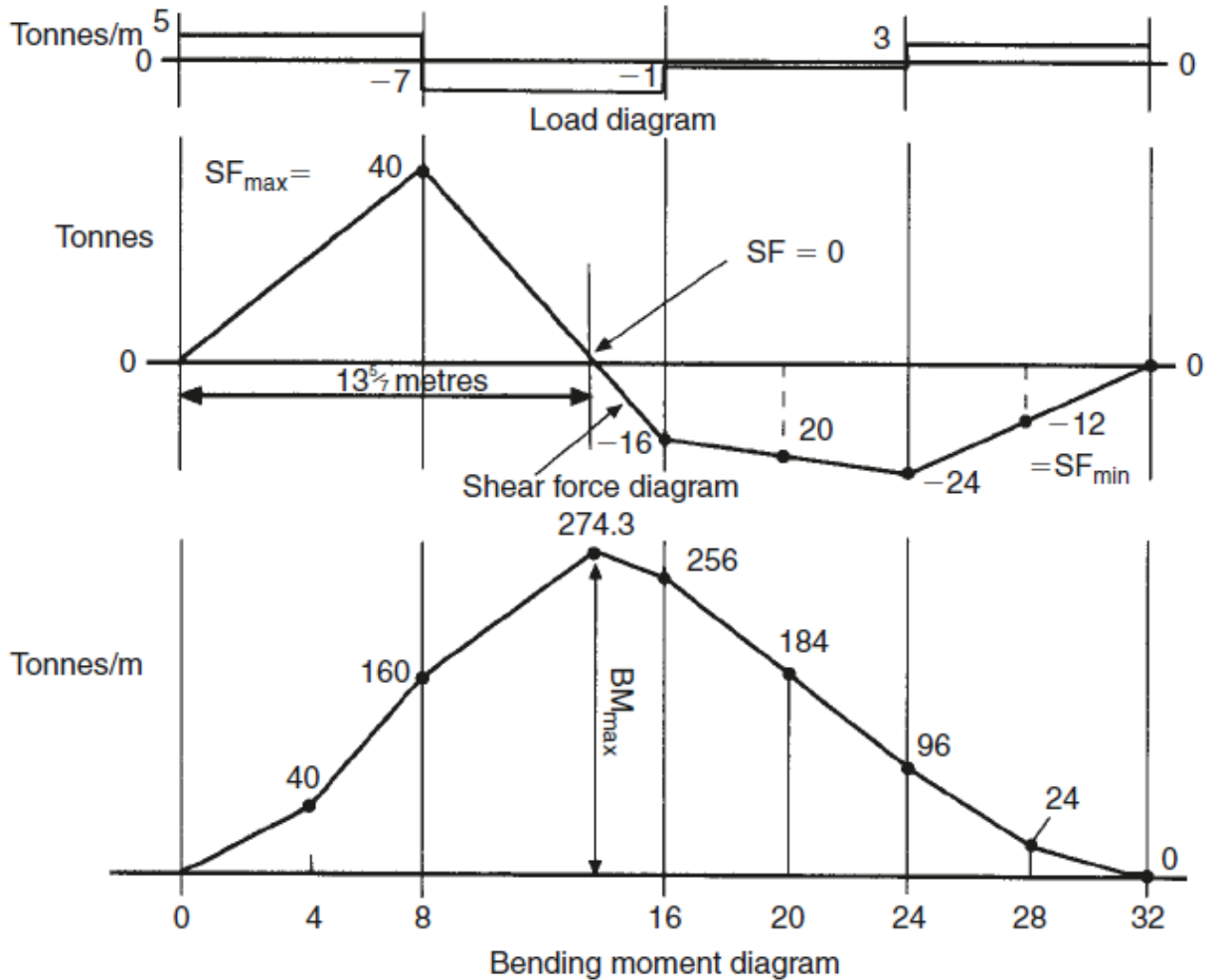
HYDROSTATIC PARTICULARS 'A'

Draught m	Displacement t		TPC t		MCTC tm		KMt M	KB m	LCB foap m	LCF foap m
	SW RD 1.025	FW RD 1.000	SW RD 1.025	FW RD 1.000	SW RD 1.025	FW RD 1.000				
7.00	14576	14220	23.13	22.57	184.6	180.1	8.34	3.64	70.03	67.35
6.90	14345	13996	23.06	22.50	183.0	178.5	8.35	3.58	70.08	67.46
6.80	14115	13771	22.99	22.43	181.4	177.0	8.36	3.53	70.12	67.57
6.70	13886	13548	22.92	22.36	179.9	175.5	8.37	3.48	70.16	67.68
6.60	13657	13324	22.85	22.29	178.3	174.0	8.38	3.43	70.20	67.79
6.50	13429	13102	22.78	22.23	176.8	172.5	8.39	3.38	70.24	67.90
6.40	13201	12879	22.72	22.17	175.3	171.0	8.41	3.33	70.28	68.00
6.30	12975	12658	22.66	22.11	173.9	169.6	8.43	3.28	70.32	68.10
6.20	12748	12437	22.60	22.05	172.5	168.3	8.46	3.22	70.35	68.20
6.10	12523	12217	22.54	21.99	171.1	167.0	8.49	3.17	70.38	68.30
6.00	12297	11997	22.48	21.93	169.8	165.7	8.52	3.11	70.42	68.39
5.90	12073	11778	22.43	21.87	168.5	164.4	8.55	3.06	70.46	68.43
5.80	11848	11559	22.37	21.82	167.3	163.2	8.59	3.01	70.50	68.57
5.70	11625	11342	22.32	21.77	166.1	162.1	8.63	2.95	70.53	68.65
5.60	11402	11124	22.26	21.72	165.0	161.0	8.67	2.90	70.57	68.73
5.50	11180	10908	22.21	21.66	163.9	160.0	8.71	2.85	70.60	68.80
5.40	10958	10691	22.15	21.61	162.9	158.9	8.76	2.80	70.64	68.88
5.30	10737	10476	22.10	21.56	161.8	157.9	8.81	2.74	70.68	68.95
5.20	10516	10260	22.05	21.51	160.8	156.9	8.86	2.69	70.72	69.02
5.10	10296	10045	22.00	21.46	159.8	155.9	8.92	2.63	70.75	69.09
5.00	10076	9830	21.95	21.41	158.8	154.9	8.98	2.58	70.79	69.16
4.90	9857	9616	21.90	21.36	157.9	154.0	9.06	2.53	70.82	69.23
4.80	9638	9403	21.85	21.32	156.9	153.1	9.13	2.48	70.86	69.29
4.70	9420	9190	21.80	21.27	156.0	152.2	9.22	2.43	70.90	69.35
4.60	9202	8978	21.75	21.22	155.1	151.3	9.30	2.38	70.93	69.42
4.50	8985	8766	21.70	21.17	154.2	150.5	9.40	2.32	70.96	69.48
4.40	8768	8554	21.65	21.12	153.3	149.6	9.49	2.27	71.00	69.55
4.30	8552	8344	21.60	21.07	152.4	148.7	9.60	2.22	71.04	69.62
4.20	8336	8133	21.55	21.02	151.5	147.8	9.71	2.17	71.08	69.68
4.10	8121	7923	21.50	20.97	150.6	146.9	9.83	2.12	71.12	69.74
4.00	7906	7713	21.45	20.93	149.7	146.0	9.96	2.07	71.15	69.81
3.90	7692	7505	21.40	20.88	148.7	145.1	10.11	2.01	71.18	69.88
3.80	7478	7296	21.35	20.83	147.8	144.2	10.25	1.96	71.22	69.94
3.70	7265	7088	21.30	20.78	146.8	143.3	10.41	1.91	71.25	70.00
3.60	7052	6880	21.24	20.72	145.9	142.3	10.57	1.86	71.29	70.07
3.50	6840	6673	21.19	20.67	144.9	141.3	10.76	1.81	71.33	70.14

THESE HYDROSTATIC PARTICULARS HAVE BEEN DEVELOPED WITH THE
VESSEL FLOATING ON EVEN KEEL

Answers

Answers - 1



Maximum bending moment = 274.3 tm (14 m fwd of stern)

Answer - 2

Lost buoyancy = gained buoyancy

$$20 \times 20 \times 5 = 110 \times 20 \times S$$

$$2000 = 2200 \times S$$

$$S = 0.909 \text{ m}$$

$$KB = 2.955 \text{ m}$$

$$\begin{aligned} BM_L &= I/V = 20 \times 110^3 / (12 \times 13000) \\ &= 170.641 \text{ m} \end{aligned}$$

$$KM_L = 173.596 \text{ m}$$

$$KG = 4.5 \text{ m}$$

$$GM_L = 169.1 \text{ m}$$

$$\begin{aligned} MCTC &= \text{Disp} \times GM_L / (100 \times L) \\ &= 13000 \times 1.025 \times 169.1 / (100 \times 130) = 173.3 \text{ tm} \end{aligned}$$

$$COT = \text{disp.} \times (LCB - LCG) / MCTC = 13325 \times 10 / 173.3 = 768.9 \text{ cm}$$

$$T_a = 768.9 \times 55 / 130 = 325.3 \text{ cm}$$

$$T_f = 443.5 \text{ cm}$$

	FWD	AFT
Even keel draught	5.909	5.909
T_f / T_a	+ 4.435	- 3.253
Final draughts	10.344	2.656

Answer – 3

$$\text{Water level} = 14.0$$

$$\text{Draft} = 12.45$$

$$\text{Depth} = 1.55$$

$$\text{Reduction} = 2.45$$

$$\text{Initial GM} = 13.10 - 10.90 = 2.20 \text{ m}$$

$$\begin{aligned} P &= \text{TPC} \times \text{reduction of draught} \\ &= 62 \times 245 = 15190 \text{ t} \end{aligned}$$

$$\text{Loss of GM} = 15190 \times 13.1 / 73000 = 2.726 \text{ m}$$

$$\text{Final GM} = -0.53 \text{ m}$$

Answer – 4

$$\text{AMD} = (5.48 + 5.26) / 2 = 5.37 \text{ m}$$

$$\text{LCF for AMD} = 68.90 \text{ m}$$

$$\text{TMD for above LCF} = 5.372 \text{ m}$$

For above TMD, from table:

$$\text{Displ.} = 10896 \text{ t}$$

$$\text{LCB} = 70.64$$

$$\text{MCTC} = 162.9$$

Initially, LCB is larger than LCG, therefore,

$$\text{Trim} = \text{displ.} \times (\text{LCB} - \text{LCG}) / \text{MCTC}$$

$$0.22 \times 100 = 10896 \times (70.64 - \text{LCG}) / 162.9$$

$$\text{LCG} = 70.31 \text{ m}$$

$$\text{Final displacement} = 14115 \text{ t}$$

$$\text{Therefore, cargo to load} = 3219 \text{ t}$$

For final displacement, from table:

$$\text{TMD} = 6.8 \text{ m}$$

$$\text{MCTC} = 181.4$$

$$\text{LCB} = 70.12$$

$$\text{LCF} = 67.57$$

Final LCB is larger than LCG, therefore:

$$\text{Trim} = \text{displ.} \times (\text{LCB} - \text{LCG}) / \text{MCTC}$$

$$0.5 \times 100 = 14115 \times (70.12 - \text{LCG}) / 181.4$$

Final LCG = 69.48 m

By taking moments about aft perpendicular (amount to load in hold no 1 is y tones):

$$116 \times y + 32 \times (3219 - y) + 10896 \times 70.31 = 69.48 \times 14115$$

Y = 1328.6 t

In hold 1 = 1328.6 t

In hold 4 = 1890.4 t

Calculation of final draughts:

$$T_a = 0.5 \times 67.57 / 140 = 0.241 \text{ m}$$

$$T_f = 0.5 - 0.241 = 0.259 \text{ m}$$

	FWD	AFT
Final draught	6.8	6.8
Tf / Ta	- 0.259	+0.241
Final draughts	6.541	7.041

Question – 6

Take moments about keel and entreline:

Load	Kg	Moments	Dist. From centre line	Moments about centre line	
				P	S
20000	9.0	180000			
500	12.0	6000	6 (Stbd)		3000
340	4.5	1530	4.5 (Stbd)		1530
200	11.0	2200	6 (Prt)	1200	
150	1.2	180			
21190		189910		1200	4530
					3330

KG = 8.962 m

KM = 10.550 m

$$\begin{aligned} \text{FSE} &= 8 \times 15^3 \times 0.9 / (12 \times 21190) \\ &= 0.096 \text{ m} \end{aligned}$$

$$\text{GM solid} = 1.588 \text{ m}$$

$$\text{GM fluid} = 1.492$$

$$\text{Tan list} = 3330 / (21190 \times 1.492)$$

$$\text{List} = 6^0 \text{ stbd}$$