



MERCHANT SHIPPING SECRETARIAT
GOVERNMENT OF SRI LANKA
CERTIFICATE OF COMPETENCY EXAMINATION

GRADE : CHIEF MATE ON SHIPS OF 500 GT OR MORE (UNLIMITED)
SUBJECT : SHIP BOARD OPERATIONS
DATE : 16.10.2023

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) With regard to statutory certificates on board a vessel,

- a) Explain how and why flag States delegate the responsibilities to recognized organisations for the purpose of maintain the safe operation of their vessels. **(12 marks)**
- b) Explain the Harmonize System of Survey and Certification (HSSC) **(10 marks)**
- c) What main differences could you highlight in the trading certificates of a Bulk Carrier and a Passenger vessel ? **(08 marks)**

2) With regard to the IMDG Code,

- a) Explain the objectives of the code. **(08 marks)**
- b) Explain how a DG package of multiple hazards and a severe pollutant by nature is labeled before being placed on board a vessel. **(08 marks)**
- c) Explain the importance of entries under the following columns in the Dangerous Cargo manifest.
 - (i) Subsidiary Risk
 - (ii) Limited Quantities
 - (iii) Packing group **(09 marks)**
- d) What are the content of the dangerous goods declaration form? . **(05 marks)**

- 3) a) Explain in brief the requirements prescribed in the Ballast water convention.
(05 marks)
- b) What certificates, documents and records are required to carry on board vessels engaged in international trade to comply with the ballast water convention requirements?
(05 marks)
- c) Explain LD₁ and D₂ standards of ballast water management (10 marks)
- d) With reference to MARPOL, all vessels when discharging machinery space bilges shall comply with Annex I in special areas as well as outside special areas. Describe how you discharge machinery space bilges from your vessel.
(10 marks)
- 4) Answer the following questions with regard to carriage of goods:
- a) During the process of drawing stowage plan, ship's officers are required to gather various information to develop an effective stowage plan. List the important information you should consider when preparing an effective stowage plan.
(12 marks)
- b) Over carriage and short landing of cargoes will lead to huge financial losses in merchant shipping trade. Briefly explain what precautions to be taken as a chief officer to minimize such claims.
(08 marks)
- c) Ventilation in merchant ships is being used for varieties of situations. Briefly explain main purposes of ventilation and give practical examples for each purpose you mention.
(10 marks)
- 5) A ship of Length 170 m; Beam 30 m; GM 2.6 m; Speed 16 knots is to load at 0.3L on deck low. Specification of cargo unit are mass = 58 t; dimensions = 12 x 3 x 6 m.

With the aid of the attached data tables, find the minimum required number of lashing if following lashings is to use.

Securing material to use are:

Wire rope (re-useable), breaking strength = 150 kN

Shackles, turnbuckles, deck rings: breaking strength = 160 kN

Stowage on dunnage boards

(30 marks)

(31

- 6) With reference to grain regulations explain,
- a) what are the minimum criterion to comply for a vessel to set out to sea with a consignment of grain?
(10 marks)
 - b) how the heeling arm due to grain shift is derived and what are the parameters for the vessel to remain seaworthy?
(10 marks)
 - c) what actions you could take to improve the situation if the vessel is found not complying with the requirements?
(10 marks)

Shipboard Operations

Formulas and Tables to be used for Lashing Calculations

External forces calculating formula

$$F_{(x,y,z)} = ma_{(x,y,z)} + F_{w(x,y)} + F_{s(x,y)}$$

Balance forces calculation formulas

Transverse sliding : $F_y \leq \mu \cdot m \cdot g + fy_1 \cdot CS_1 + \dots + fy_n \cdot CS_n$

Longitudinal sliding : $F_x \leq \mu(m \cdot g - F_z) + fx_1 \cdot CS_1 + \dots + fx_n \cdot CS_n$

Transverse tipping : $F_y \cdot a \leq b \cdot m \cdot g + 0.9(CS_1 \cdot c_1 + CS_2 \cdot c_2 + \dots + CS_n \cdot c_n)$

MSLs for different securing devices (Table 1)

Material	MSL
Shackles, dekeyes, twistlocks, lashing rods, D-rings, stackers, bridge fittings, turnbuckles of mild steel	50% of breaking strength
Fibre rope	33% of breaking strength
Wire rope (single use)	80% of breaking strength
Wire rope (re-useable)	30% of breaking strength
Steel band (single use)	70% of breaking strength
Chains	50% of breaking strength
Web lashings	50% of breaking strength

The basic acceleration data (Table 2)

Transverse acceleration a_y in m/s^2										Longitudinal acceleration a_x in m/s^2		
on deck, high	7.1	6.9	6.8	6.7	6.7	6.8	6.9	7.1	7.4	3.8		
on deck, low	6.5	6.3	6.1	6.1	6.1	6.1	6.3	6.5	6.7	2.9		
'tween-deck	5.9	5.6	5.5	5.4	5.4	5.5	5.6	5.9	6.2	2.0		
lower hold	5.5	5.3	5.1	5.0	5.0	5.1	5.3	5.5	5.9	1.5		
	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	L	
Vertical acceleration a_z in m/s^2												
7.6 6.2 5.0 4.3 4.3 5.0 6.2 7.6 9.2												

Correction factors for length and speed (Table 3)

Length [m] \ Speed [kN]	30	40	50	60	70	80	90	100	120	140	160	180	200	250	300
9	1,37	1,31	1,20	1,09	1,00	0,92	0,85	0,79	0,70	0,63	0,57	0,53	0,49	0,41	0,36
12	1,56	1,47	1,34	1,22	1,12	1,03	0,96	0,90	0,79	0,72	0,65	0,60	0,56	0,48	0,42
15	1,75	1,64	1,49	1,36	1,24	1,15	1,07	1,00	0,89	0,80	0,73	0,68	0,63	0,55	0,48
18	1,94	1,80	1,64	1,49	1,37	1,27	1,18	1,10	0,98	0,89	0,82	0,76	0,71	0,61	0,54
21	2,13	1,96	1,78	1,62	1,49	1,38	1,29	1,21	1,08	0,98	0,90	0,83	0,78	0,68	0,60
24	2,32	2,13	1,93	1,76	1,62	1,50	1,40	1,31	1,17	1,07	0,98	0,91	0,85	0,74	0,66

Table 3 – Correction factors for length and speed

Correction factor for B/GM<13 (Table 4)

B / GM	4	5	6	7	8	9	10	11	12	13 →
on deck, high	2,30	1,96	1,72	1,56	1,40	1,27	1,19	1,11	1,05	1,00
on deck, low	1,92	1,70	1,53	1,42	1,30	1,21	1,14	1,09	1,04	1,00
Tween-deck	1,54	1,42	1,33	1,26	1,19	1,14	1,09	1,06	1,03	1,00
lower hold	1,31	1,24	1,19	1,15	1,12	1,09	1,06	1,04	1,02	1,00

Table 4 - Correction factors for B/GM < 13

Friction coefficients (μ) (Table 5)

Materials in contact	Friction coefficient, (μ)
timber-timber, wet or dry	0,4
steel-timber or steel-rubber	0,3
steel-steel, dry	0,1
steel-steel, wet	0,0

Table 5 – Friction coefficients

Table 7 – fx-values and fy-values as a function of α , β and μ

Table 7.1 for $\mu = 0.4$

β for fy	α													β for fx	
	-30	-20	-10	0	10	20	30	40	45	50	60	70	80		90
0	0.67	0.80	0.92	1.00	1.05	1.08	1.07	1.02	0.99	0.95	0.85	0.72	0.57	0.40	90
10	0.65	0.79	0.90	0.98	1.04	1.06	1.05	1.01	0.98	0.94	0.84	0.71	0.56	0.40	80
20	0.61	0.75	0.86	0.94	0.99	1.02	1.01	0.98	0.95	0.91	0.82	0.70	0.56	0.40	70
30	0.55	0.68	0.78	0.87	0.92	0.95	0.95	0.92	0.90	0.86	0.78	0.67	0.54	0.40	60
40	0.46	0.58	0.68	0.77	0.82	0.86	0.86	0.84	0.82	0.80	0.73	0.64	0.53	0.40	50
50	0.36	0.47	0.56	0.64	0.70	0.74	0.76	0.75	0.74	0.72	0.67	0.60	0.51	0.40	40
60	0.23	0.33	0.42	0.50	0.56	0.61	0.63	0.64	0.64	0.63	0.60	0.55	0.48	0.40	30
70	0.10	0.18	0.27	0.34	0.41	0.46	0.50	0.52	0.52	0.53	0.52	0.49	0.45	0.40	20
80	-0.05	0.03	0.10	0.17	0.24	0.30	0.35	0.39	0.41	0.42	0.43	0.44	0.42	0.40	10
90	-0.20	-0.14	-0.07	0.00	0.07	0.14	0.20	0.26	0.28	0.31	0.35	0.38	0.39	0.40	0

Table 7.2 for $\mu = 0.3$

β for fy	α														β for fx
	-30	-20	-10	0	10	20	30	40	45	50	60	70	80	90	
0	0.72	0.84	0.93	1.00	1.04	1.04	1.02	0.96	0.92	0.87	0.76	0.62	0.47	0.30	90
10	0.70	0.82	0.92	0.98	1.02	1.03	1.00	0.95	0.91	0.86	0.75	0.62	0.47	0.30	80
20	0.66	0.78	0.87	0.94	0.98	0.99	0.96	0.91	0.88	0.83	0.73	0.60	0.46	0.30	70
30	0.60	0.71	0.80	0.87	0.90	0.92	0.90	0.86	0.82	0.79	0.69	0.58	0.45	0.30	60
40	0.51	0.62	0.70	0.77	0.81	0.82	0.81	0.78	0.75	0.72	0.64	0.54	0.43	0.30	50
50	0.41	0.50	0.58	0.64	0.69	0.71	0.71	0.69	0.67	0.64	0.58	0.50	0.41	0.30	40
60	0.28	0.37	0.44	0.50	0.54	0.57	0.58	0.58	0.57	0.55	0.51	0.45	0.38	0.30	30
70	0.15	0.22	0.28	0.34	0.39	0.42	0.45	0.45	0.45	0.45	0.43	0.40	0.35	0.30	20
80	0.00	0.06	0.12	0.17	0.22	0.27	0.30	0.33	0.33	0.34	0.35	0.34	0.33	0.30	10
90	-0.15	-0.10	-0.05	0.00	0.05	0.10	0.15	0.19	0.21	0.23	0.26	0.28	0.30	0.30	0

Table 7.3 for $\mu = 0.2$

β for fy	α														β for fx
	-30	-20	-10	0	10	20	30	40	45	50	60	70	80	90	
0	0.77	0.87	0.95	1.00	1.02	1.01	0.97	0.89	0.85	0.80	0.67	0.53	0.37	0.20	90
10	0.75	0.86	0.94	0.98	1.00	0.99	0.95	0.88	0.84	0.79	0.67	0.52	0.37	0.20	80
20	0.71	0.81	0.89	0.94	0.96	0.95	0.91	0.85	0.81	0.76	0.64	0.51	0.36	0.20	70
30	0.65	0.75	0.82	0.87	0.89	0.88	0.85	0.79	0.75	0.71	0.61	0.48	0.35	0.20	60
40	0.56	0.65	0.72	0.77	0.79	0.79	0.76	0.72	0.68	0.65	0.56	0.45	0.33	0.20	50
50	0.46	0.54	0.60	0.64	0.67	0.67	0.66	0.62	0.60	0.57	0.49	0.41	0.31	0.20	40
60	0.33	0.40	0.46	0.50	0.53	0.54	0.53	0.51	0.49	0.47	0.42	0.36	0.28	0.20	30
70	0.20	0.25	0.30	0.34	0.37	0.39	0.40	0.39	0.38	0.37	0.34	0.30	0.26	0.20	20
80	0.05	0.09	0.14	0.17	0.21	0.23	0.25	0.26	0.26	0.26	0.26	0.25	0.23	0.20	10
90	-0.10	-0.07	-0.03	0.00	0.03	0.07	0.10	0.13	0.14	0.15	0.17	0.19	0.20	0.20	0

Table 7.4 for $\mu = 0.1$

β for fy	α														β for fx
	-30	-20	-10	0	10	20	30	40	45	50	60	70	80	90	
0	0.82	0.91	0.97	1.00	1.00	0.97	0.92	0.83	0.78	0.72	0.59	0.44	0.27	0.10	90
10	0.80	0.89	0.95	0.98	0.99	0.96	0.90	0.82	0.77	0.71	0.58	0.43	0.27	0.10	80
20	0.76	0.85	0.91	0.94	0.94	0.92	0.86	0.78	0.74	0.68	0.56	0.42	0.26	0.10	70
30	0.70	0.78	0.84	0.87	0.87	0.85	0.80	0.73	0.68	0.63	0.52	0.39	0.25	0.10	60
40	0.61	0.69	0.74	0.77	0.77	0.75	0.71	0.65	0.61	0.57	0.47	0.36	0.23	0.10	50
50	0.51	0.57	0.62	0.64	0.65	0.64	0.61	0.56	0.53	0.49	0.41	0.31	0.21	0.10	40
60	0.38	0.44	0.48	0.50	0.51	0.50	0.48	0.45	0.42	0.40	0.34	0.26	0.19	0.10	30
70	0.25	0.29	0.32	0.34	0.35	0.36	0.35	0.33	0.31	0.30	0.26	0.21	0.16	0.10	20
80	0.10	0.13	0.15	0.17	0.19	0.20	0.20	0.20	0.19	0.19	0.17	0.15	0.13	0.10	10
90	-0.05	-0.03	-0.02	0.00	0.02	0.03	0.05	0.06	0.07	0.08	0.09	0.09	0.10	0.10	0

Table 7.5 for $\mu = 0.0$

β for fy	α													β for fx	
	-30	-20	-10	0	10	20	30	40	45	50	60	70	80		90
0	0.87	0.94	0.98	1.00	0.98	0.94	0.87	0.77	0.71	0.64	0.50	0.34	0.17	0.00	90
10	0.85	0.93	0.97	0.98	0.97	0.93	0.85	0.75	0.70	0.63	0.49	0.34	0.17	0.00	80
20	0.81	0.88	0.93	0.94	0.93	0.88	0.81	0.72	0.66	0.60	0.47	0.32	0.16	0.00	70
30	0.75	0.81	0.85	0.87	0.85	0.81	0.75	0.66	0.61	0.56	0.43	0.30	0.15	0.00	60
40	0.66	0.72	0.75	0.77	0.75	0.72	0.66	0.59	0.54	0.49	0.38	0.26	0.13	0.00	50
50	0.56	0.60	0.63	0.64	0.63	0.60	0.56	0.49	0.45	0.41	0.32	0.22	0.11	0.00	40
60	0.43	0.47	0.49	0.50	0.49	0.47	0.43	0.38	0.35	0.32	0.25	0.17	0.09	0.00	30
70	0.30	0.32	0.34	0.34	0.34	0.32	0.30	0.26	0.24	0.22	0.17	0.12	0.06	0.00	20
80	0.15	0.16	0.17	0.17	0.17	0.16	0.15	0.13	0.12	0.11	0.09	0.06	0.03	0.00	10
90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0

Remark: $f_x = \cos \alpha \cdot \sin \beta + \mu \cdot \sin \alpha$ $f_y = \cos \alpha \cdot \cos \beta + \mu \cdot \sin \alpha$

Answers

Answer: 1

1) With regard to Trading Certificates on board a vessel,

a) Explain how and why flag states delegate the responsibilities to Classification Societies for the purpose of maintain the safe operation of their vessels. **(12 marks)**

Flag state only delegate functions not responsibilities to the classification societies. Due to lack of manpower with the administration, administration has delegate certain functions such as surveying, endorsing and issuing certain certificates to vessels on behalf of the administration. Still supervisory function remains with the administration.

b) Explain the benefit of harmonizing the surveys on board from the viewpoint of ship owner, vessel's class and seafarer. **(10 marks)**

Off hire period is minimized due to surveys falling on same dates. Work duplication is minimized since items common to several certificates only check at one time. Proper organizing of surveys minimize additional expenses and extra work loads. Manpower requirement of classification society is reduced since extra surveyors are not required. Documentation maintenance is easy since no confusion between dates of surveys.

c) What main differences could you highlight in the trading certificates of a Bulk Carrier and a Passenger vessel ?**(08 marks)**

main certificate differences are passenger ships are provided with Passenger ship safety certificate which is three in one certificate and cargo ships under normal circumstances will maintain Cargo ship safety construction certificate, cargo ship safety equipment certificate and cargo ship safety radio certificate. Cargo ship certificates valid for 5 years and passenger ship certificates valid for 1 Year. There are provisions for cargo ship safety certificate which is all in one certificate under harmonized survey system.

ANSWER 2:

2) With regard to the IMDG Code,

a) Explain the objectives of the code. **(08 marks)**

Ans: The objective of the IMDG Code is to enhance the safe carriage of dangerous goods while facilitating the free unrestricted movement of such goods and prevent pollution to the environment. IMDG Code attained mandatory status from 1 January 2004.

b) Explain how a DG package of multiple hazards and a severe pollutant by nature is labeled before being placed on board a vessel. **(08 marks)**

Ans: THERE IS NO SEVERE POLLUTANT WITH CURRENT PRACTICES ONLY MARINE POLLUTANT. Severe marine pollutant is obsolete According to multiple hazards identified by DG declaration CTU needed to be labeled.

c) Explain the importance of entries under the following columns in the Dangerous Cargo manifest.

(i) Subsidiary Risk (ii) Limited Quantities (iii) Packing group **(09 marks)**

- **Subsidiary Risk**

Many dangerous goods present the hazards of more than one Class or Division. Such goods are assigned to a Class according to their primary hazard. The other hazard or hazards are referred to as Subsidiary Risks.

- **Limited Quantities**

The limited quantity is the maximum quantity per inner packaging or article for transporting dangerous goods as limited quantities. It can be found in the column 7a of Dangerous Goods List.

- **Packing group**

Dangerous goods are assigned into 3 packing groups (also known as **UN Packing Group**) in accordance with **the degree of danger** they present:

Packing Group I: high danger

Packing Group II: medium danger

Packing Group III: low danger

The packaging requirements for dangerous goods assigned to UN packing group I are much higher than the dangerous goods assigned to packing group II and III. In this article, we will show you how to assign packing groups for dangerous goods.

d) What are the content of the dangerous goods declaration form? **.(05 marks)**

- Shipper
- Transportation Document Number
- Shipper's Reference
- Consignee
- Freight Forwarder's Reference
- Carrier (to be declared by the Carrier)
- SHIPPER'S DECLARATION
- Additional Handling Information 1
- Vessel/Flight and Date
- Port/Place of Loading
- Port/Place of Discharge
- Destination
- Shipping Marks Number and Kind of Packages, Description of Goods (GW (kg) Net Mass (kg) Cube (m³))
- CTU ID No.
- Seal Numbers
- CTU Size and Type
- Tare Mass (kg)
- Total Gross Mass (kg)
- CONTAINER/VEHICLE PACKING CERTIFICATE
- Receiving Organization
- RECEIVING ORGANIZATION REMARKS:
- Name of Company Hauler's Name
- Name of Company Preparing Note Name/Status of Declarant Vehicle Registration No. Name/Status of Declarant Place and Date Driver Name and Date Place and Date Signature of Declarant Driver's Signature Signature of Declarant

Answer 3a:

- During the convention, conditions were set to bring it into force. Required numbers of ratification countries were not less than 30 and required amount of world tonnage was set to 35% and both conditions had to be met.
- The conditions were met only in 8th September 2016 with the ratification of above numbers.
- Even after the ratification conditions were met, one-year grace period was allowed to comply with the requirement.
- Therefore, it had been delayed enforcing.
- Many countries could not ratify early due to their own legal systems or their facilities were not ready to comply with the requirement.

Answer 3b:

- Ballast water management plan approved by the administration
- International Ballast water certificate
- Ballast water record book with all the required entries as per the convention

Answer 3c:

- Since the convention was not in force some countries could not stop uncontrolled ballast water movement in the world when they did not have even local rules.
- Therefore, many type of unwanted alien species were discharged in their environment
- This led to change in ecological pattern in the region and damage or to endanger local species.
- On some countries endemic species were completely destroyed.
- Fish breeding grounds were destroyed and fishermen faced economic problems due to depleting fishing harvest.
- Fishing export income lost to some countries.
- Therefore, government faced socio economic problems and political chaos.

Answer 3d:

a) In special areas:

1. Vessel shall be en-route
2. The oily mixture shall process through an oil filtering equipment

3. On all ships, an alarm and auto stopping device shall be fitted
4. The oily content in affluent without dilution does not exceed 15 ppm

Out- side special areas:

1. Ensure the vessel is proceeding en-route
2. The oily mixture is processed through an oil filtering equipment
3. If the vessel is more than 10,000 GT ensure filtering equipment is fitted with ODM with auto alarm and shut down system if exceed 15 ppm.

Answer 4(a)

Answer should contain information required to consider prior preparing stowage plan such as ships and cargo information.

Answer 4(b)

Answer should contain separation and segregation measures to minimise short landing and over carriage of cargo.

Answer 4(c)

Answer should contain main purposes of ventilation and examples in each identified situations.

Answer 5

$F_x=161\text{Kn}$, $F_y= 350\text{Kn}$, $F_z=290\text{Kn}$ (rounded values)

Fwd/Aft Lashing :3 Lashing each side or to be compensate with transverse lashings

Transverse Lashings: 6 Lashings each side

Vertical Lashings: Not required

Answer 6

a)

1)The angle of heel, due to the shift of grain shall not be greater than 12 degrees or the angle at which the deck edge is immersed, whichever is lesser.

2) In the statical stability diagram, the net or residual area between the heeling arm curve and the righting arm curve up to the angle of heel 40 or deck edge submerge, whichever is less shall be not less than 0.075 meter radians at all conditions of loading.

- 3) The initial meta-centric height, after correcting for the free surface effects of liquids in tanks, shall be not less than 0.30m.
- 4) After completion of loading, vessel shall sail in upright condition.
- 5) Vessel must have a DOA or otherwise shall meet the conditions required for a vessel without DOA
- 6) Master must demonstrate that the vessel can comply with the requirement at all stage of the voyage.

b)

- 1 **Find** or calculate pre-planned displacement of the vessel
- 2 **From** the grain heeling/Stability information book obtain volumetric healing moment for each hold
- 3 **Multiple** VHM of each hold by 1.06 for a filled compartment to compensate for vertical shift of cargo and by 1.12 for a partly filled compartment.
- 4 Total up corrected VHM and divide by SF of cargo to obtain Weight heeling moment
- 5 Compare the WHM with the maximum permissible WHM for the loaded displacement
- 6 If permitted proceed ahead
- 7 Draw statical stability curve for the loaded displacement
- 8 Draw heeling arm curve after finding λ_0 and λ_{40}
- 9 To find λ_0 : Total WHM/Displacement and mark as A
- 10 To find $\lambda_{40} = \lambda_0 \times \cos 40$ and mark as B
- 11 Join AB and AB indicate heeling arm curve

c)

- If the load line permit, increase displacement by adding some ballast into DB tanks. By doing so, λ_0 can be reduced.
- If load line does not permit transfer oil and water to lower tank to increase KG. By doing so, initial GM and area under the righting arm curve can be increased.
- If above two not possible or not sufficient, consider to change loading procedure by reducing partly loaded compartment.
- If all above fails consider more expensive systems like securing partly filled compartments and filled compartments.



