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 BOARD OPERATIONS
DATE : 17th November 2016

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 ship of L = 180 m ; B = 25 m ; GM = 3.2 m ; Speed = 18 knots is to load at 126m from AP on tween deck. Specification of cargo unit of m = 48 t; dimensions = 8 x 8 x 8 m. With the aid of attached tables (Shipboard Operations Formulas and Tables to be used for Lashing Calculations) find the minimum required number of lashing if following lashings is to use.

   Securing material:

   Wire rope (single Use): breaking strength = 125 kN ,
   Shackles, turnbuckles, deck rings: breaking strength = 180 kN
   Stowage on dunnage boards: μ=0.3 (Steel – timber)

   (30 marks)

2) Answer the following questions with regard to ship's stability:

   a) During the process of loading the main aim of the ships master and/or the chief officer is to complete the loading operation of the vessel in upright condition. If it is unable to achieve upright condition upon completion of the loading then to correct the list by ballasting or by internal transfer of weights. Explain reasons behind the above statement in detail using diagrams and drawings if applicable why it is necessary to maintain upright condition at all times.

   (20 marks)

   b) Briefly explain following:
      i. Statical Stability
      ii. Dynamical stability

   (05 marks each)

3) Answer following questions with regard to reefer cargo:

a) Cargo related information supplied by the shipper is very essential in refer trade for proper stowage, carriage and discharging of refer cargo. Enumerate and describe the information required to be supplied by the shipper in relation to cargo carried by an ordinary refer vessel.

(10 marks)

b) New generation refer vessels are fitted with controlled atmosphere (CA) type refrigeration plats. Explain how does the extended cargo preservation achieved by CA system compared to ordinary refrigeration system.

(10 marks)

c) During the carriage of cargo, preservation of cargo achieved by various means. Temperature control is one of the main methods used to preserve certain cargoes. Explain with suitable examples main reasons for temperature control.

(10 marks)

4) Answer the following questions with regard to ballast water operations:

a) Ballast water convention was held years ago. Now it is in force. But not yet enforced. Describe the reasons for this delay.

(10 marks)

b) What certificates, documents and records, vessels engaged in international trade shall carry to comply with the requirements.

(05 marks)

c) Describe the dangers faced by some parts of the world due to ballast water movement by sea trade since the convention was not in force.

(10 marks)

d) Describe at least three methods that you can use as chief officer to comply with the requirement.

(05 marks)

5) Answer the below questions with regard to tanker cargo operations:

a) Explain the following,
   i. Lower Flammable Limit
   ii. Upper flammable limit
   iii. Flash point

(05 marks each)

b) Describe why any liquid cargo is not filled to 100% of the tank capacity for normal carriage by sea

(05 marks)

c) A tanker loads 3200 MT of crude oil at 30 C and SG of 0.8942. What would be the change in Ullage at discharge port where the temperature is 15 C and SG of 0.8959? Consider a change 3 m^3 by volume corresponds to a change of 0.1 cm in Ullage as per calibration tables.

(10 marks)

6) With reference to grain regulation explain,

a) What is the minimum criterion to comply for a vessel to set out to sea with a consignment of grain?
b) How the heeling arm due to grain shift is derived and what are the parameters for the vessel to remain seaworthy?
c) What action you could take to improve the situation if the vessel is found not complying with the requirements?

(10 marks each)

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 : $\mathbf{Fy} \leq \mu \cdot m \cdot g + fy_1 \cdot CS_1 + \ldots + fy_n \cdot CS_n$

Longitudinal sliding : $\mathbf{Fx} \leq \mu(m \cdot g - Fz) + fx_1 \cdot CS_1 + \ldots + fx_n \cdot CS_n$

Transverse tipping : $\mathbf{Fy} \cdot a \leq b \cdot m \cdot g + 0.9(CS_1 \cdot c_1 + CS_2 \cdot c_2 + \ldots + CS_n \cdot c_n)$

MSLs for different securing devices (Table 1)

Material	MSL
Shackles, deckeyes, 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 μ = 0.4

β for	α														β for
fy	**-30**	**-20**	**-10**	**0**	**10**	**20**	**30**	**40**	**45**	**50**	**60**	**70**	**80**	**90**	fx
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 μ = 0.3

β for	α														β for
fy	**-30**	**-20**	**-10**	**0**	**10**	**20**	**30**	**40**	**45**	**50**	**60**	**70**	**80**	**90**	fx
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 μ = 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 μ = 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 μ = 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: $fx = \cos\alpha \cdot \sin\beta + \mu \cdot \sin\alpha$ $fy = \cos\alpha \cdot \cos\beta + \mu \cdot \sin\alpha$

Answers

Answer – 1

Fx=73Kn , Fy=258Kn , Fz=227Kn (rounded values)
Fwd/Aft Lashing : 1 Lashing each side or to be compensate with transverse lashings
Transverse Lashings: 2 Lashings each side
Vertical Lashings: Not required

Answer – 5(c)

Amount of oil to load	= 3200 MT @ 30 C with SG =0.8942	
Therefore amount to load in volume	= 3200/0.8942	=3578.62 m^3
Conditions in discharging port	=3200 MT @ 15C with SG = 0.8959	
Volume of the cargo at dis port	= 3200/0.8959	= 3571.8 m^3
Reduction in volume at D/Port	= 3578.62 – 3571.83	= 6.79 m^3
Tabulated change in ullage	= 0.1 cm per 3 m^3	
Change in ullage at D/port	**= 0.1/3 X 6.79**	**= 0.226 cm (10 marks)**