At departure the ship has a displacement of 6000 tons and has two full fuel oil tanks side by side, located in the double bottom. (one tank SB and one tank PS)
The metacentric height corrected for free surface effect, has been found to: GMc = 4,50 m

Each tank has the following measurements 18 m long, 8 m wide, and 2,2 m deep.
The density of the fuel oil: 947 kg/m^3

Somewhere on the voyage, half of the fuel has been used, equally form both tanks.
4.4 **Calculate** the reduction of the GMt and the new GMc, from the two 50% filled tanks.

$GM_c := 4.5\ m$ $\quad$ $\Delta := 6000\ tonne$

$l := 18\ m$ $\quad$ $w := 8\ m$ $\quad$ $d := 2.2\ m$ $\quad$ $\rho_{oil} := 947\ \frac{kg}{m^3}$

New displacement:

$q := l \cdot w \cdot d \cdot \rho_{oil} = 300\ tonne$

$\Delta_2 := \Delta - q = 5700\ tonne$

Meta center heights:

$KM_t := 7.008\ m$ $\quad$ at $\Delta = 6000\ tonne$

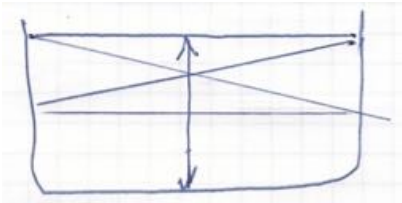
$KM_{t2} := 6.995\ m$ $\quad$ at $\Delta_2 = 5700\ tonne$

KG':

$GM_c = 4.5\ m$ $\quad$ $KM_t = 7.008\ m$

$KG' := KM_t - GM_c = 2.51\ m$ $\quad$ - inserted in table on next page

Centre of gravity of used oil:



$d = 2.2\ m$

$KG_{oil} := \frac{3}{4} \cdot d = 1.65\ m$

- inserted in table on next page

Continuing on the next page...

4.4 continued

Moment table KG

Parti	Vægt (t)	Lodret (VCG el. KG)	
		Arm (m)	Moment (mt)
Δ_0	6.000,00	2,51	15.048,00
q1	-300,00	1,65	-495,00
Δ_2 =	5.700,00	M_{K2} =	14.553,00

$M_{K2} := 14553\ tm$ $\Delta_2 = 5700\ tonne$

New KG':

$$KG'_2 := \frac{M_{K2}}{\Delta_2} = 2.55\ m$$

New GMt:

$KM_{t2} = 6.995\ m$

$GM'_{t2} := KM_{t2} - KG'_2 = 4.44\ m$

Reduction of GMt:

$GM_c = 4.5\ m$

$GM'_{t2} = 4.44\ m$

$GG_2 := GM_c - GM'_{t2} = 0.06\ m$

New GMc:

$l = 18\ m \qquad w = 8\ m$

$i := \frac{1}{4} \cdot \frac{1}{12} \cdot l \cdot (2 \cdot w)^3 = 1536\ m^4$

$\rho_{oil} = 947\ \frac{kg}{m^3} \qquad \Delta_2 = 5700\ tonne$

$GG_2' := \frac{i \cdot \rho_{oil}}{\Delta_2} = 0.255\ m$

$GM'_{t2} = 4.442\ m$

$GM_{c2} := GM'_{t2} - GG_2' = 4.19\ m$

4.5 Explain the influence of dividing the fueltanks in two, with a mid-mount center bulkhead (slingerskot), instead of just having one big tank in the full with of the Vessel.

It reduces the moment of inertia of the free surface by 75% bacuase the center sheet devids the fueltank in two:

Without center sheet:

$$i = \frac{1}{12} \cdot l \cdot b^3$$

With center sheet:

$$i = 2 \cdot \frac{1}{12} \cdot l \cdot \left(\frac{b}{2}\right)^3 = \frac{1}{4} \cdot \frac{1}{12} \cdot l \cdot b^3$$