8. A mass of 40 tonnes is located centrally on board ship. It is moved 5 m across the deck of a vessel of 32500 tonnes.

Determine the angle of heel created by the move. (8)

*Note: KM = 6.1 m, KG = 5 m, and m*d = Δ GM tan θ*

10.

(a) A barge has a displacement of 4520 tonne. When a mass of 5 tonne, already on board, is moved 4 m across the deck the barge heels by an angle of 1.2°.

Determine the value of GM given that $m \times d = \Delta GM tan\theta$; (4)

(b) What is meant by the following terms as applied to a box shaped vessel:

(i) centre of buoyancy; (2)

(ii) metacentre; (2)

(iii) centre of gravity. (2)

10. Determine the distance a container of mass of 29 tonne, already on board, must be moved from port to starboard to cause a ship of 6500 tonne displacement to heel 1.75°.

Given KM = 6.2 m, KG = 5.1 m and that $\times d = \Delta GM tan\theta$ (8)

9. A vessel has an underwater volume of 6829 m^3 when floating in water of density 1025 kg/m^3. A mass of 40 tonne is now loaded on the centreline and is then moved 5 m to port.

Calculate the angle of heel generated to the nearest degree, given that m x d = Δ GM tan θ and KG = 6.5 m and KM = 7.3 m. (8)

10. A mass of 50 tonnes is loaded on board ship 4 m off the centreline creating a heel angle of 1.5°. Determine the mass of the vessel before the load is added.

*Take : KM = 6 m, KG = 4.9 m, and m * d = Δ GM tan θ* (8)

(9) A ship has a displacement of 35500 tonne.

Determine the distance a mass of 71 tonne, already on board, must be moved off the centreline to cause the ship to heel by exactly 1°. (8)

Given

$m \times d = \Delta GM \tan\theta$ *and that* $KM = 6.2$ *m, and* $KG = 5.3$ *m.*

9. A vessel has a displacement of 2480 tonne and a KG of 4.3 m.
A mass of 5 tonne, already on board, when moved 4 m across the deck causes the vessel to heel by 0.95°.

Calculate the value of KM. (8)

Note: Given $m \times d = \Delta GM \tan\Theta$

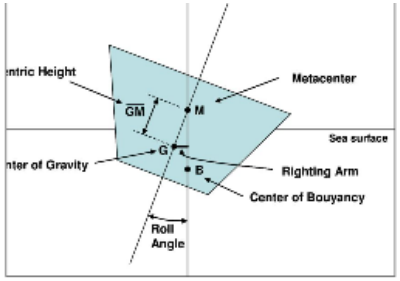
9. A vessel has a displacement of 4238 tonne and when a mass of 4 tonne, already on board, is moved 6.2 m across the deck, it causes the vessel to heel by 1.05°.

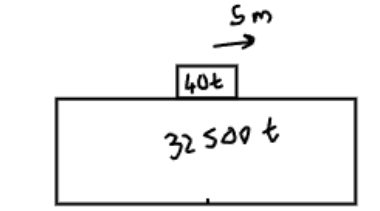
Calculate the distance from the keel to the metacentre M given that KG = 3.63 m and that $m \times d = \Delta GM \tan\theta$. (8)

8. A mass of 40 tonnes is located centrally on board ship. It is moved 5 m across the deck of a vessel of 32500 tonnes.

Determine the angle of heel created by the move. (8)

*Note: KM = 6.1 m, KG = 5 m, and m*d = Δ GM tan θ*





$GM = KM - KG$

$6.1 - 5 = 1.1$

$md = \Delta GM \tan\theta$

m = object = 40 t

d = distance = 5 m

Δ = Ship = 32500 t

θ = angle = x

$GM = KM - KG = 1.1$ m

$40 \times 5 = 32500 \cdot 1.1 \times \tan x$

$$\frac{40 \times 5}{32500 \times 1.1} = \tan x$$

$$\frac{4}{715} = \tan x$$

$$\tan^{-1}\left(\frac{4}{715}\right) = x = 0.320^{\circ}$$

10.

(a) A barge has a displacement of 4520 tonne. When a mass of 5 tonne, already on board, is moved 4 m across the deck the barge heels by an angle of 1.2°.

Determine the value of GM given that $m \times d = \Delta GM \tan\theta$; (4)

(b) What is meant by the following terms as applied to a box shaped vessel:

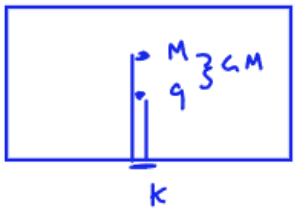
(i) centre of buoyancy; (2)

(ii) metacentre; (2)

(iii) centre of gravity. (2)

$m d = \Delta GM \tan\theta$

$GM = KM - KG$



$\Delta = 4520$

$m = 5$

$d = 4$

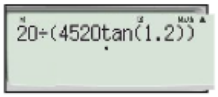
$\theta = 1.2$

$GM = x$

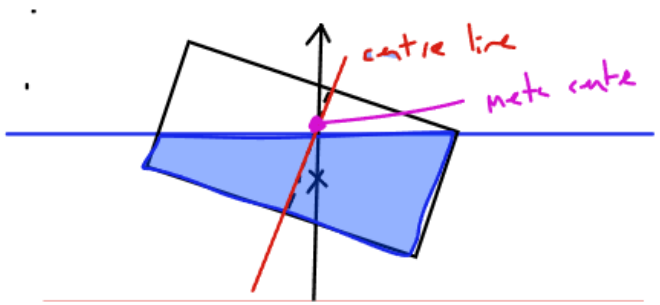
$5 \cdot 4 = 4520 - x \cdot \tan(1.2)$

$\frac{20}{4520\tan(1.2)} = x$

$GM = 0.211\ m$



centre of buoyancy: The point through which the upthrust acts. This is the centre of gravity of the water displaced



Meta centre, if you draw a line through the centre line of the ship, it will intersect the centre of buoyancy, this is the metacentre

centre of gravity, this is the centre of gravity of the ship itself

10. Determine the distance a container of mass of 29 tonne, already on board, must be moved from port to starboard to cause a ship of 6500 tonne displacement to heel 1.75°.

Given KM = 6.2 m, KG = 5.1 m and that $\times d = \Delta GM tan\theta$ (8)

$md = \Delta GM \tan\theta$

$GM = KM - KG$

$GM = 6.2 - 5.1 = 1.1\ m$

$m = 29\ t$

$\Delta = 6500\ t$

$d = x$

$\theta = 1.75$

$$29x = \frac{6500(1.1)\tan 1.75}{29}$$

$x = 7.53\ m$

9. A vessel has an underwater volume of 6829 m^3 when floating in water of density 1025 kg/m^3. A mass of 40 tonne is now loaded on the centreline and is then moved 5 m to port.

Calculate the angle of heel generated to the nearest degree, given that m x d = Δ GM tan θ and KG = 6.5 m and KM = 7.3 m. (8)

$\Delta = 6829 \times 1025 = 6,999,725\ kg$

$\Delta = 6\,999.725\ t$

$m = 40\ t$

$GM = KM - KG$

$GM = 7.3 - 6.5 = 0.8\ m$

$\theta = x$

$d = 5$

$m\,d = \Delta\, GM \tan\theta$

$5 \times 40 = 6999.725 \times 0.8 \tan\theta$

$$\frac{5 \times 40}{6999.725 \times 0.8} = \tan\theta$$

$$\tan^{-1}(0.035715688) = \theta$$

$$\theta = 2.04$$

$$2^{\circ}$$

10.

(a) A barge has a displacement of 4520 tonne. When a mass of 5 tonne, already on board, is moved 4 m across the deck the barge heels by an angle of 1.2°.

Determine the value of GM given that $m \times d = \Delta GM tan\theta$; (4)

(b) What is meant by the following terms as applied to a box shaped vessel:

(i) centre of buoyancy; (2)

(ii) metacentre; (2)

(iii) centre of gravity. (2)

$md = \Delta GM \tan\theta$

$\frac{md}{\tan\theta} = \Delta GM$

$m = 5$

$d = 4m$

$\theta = 1.2$

$\Delta = 4520$

$\frac{5 \times 4}{4520 \tan 1.2} = GM$

$\frac{20}{94.68} = 0.211\ m$

10. Determine the distance a container of mass of 29 tonne, already on board, must be moved from port to starboard to cause a ship of 6500 tonne displacement to heel 1.75°.

Given KM = 6.2 m, KG = 5.1 m and that $\times d = \Delta GM tan\theta$ (8)

$GM = KM - KG$

$GM = 6.2 - 5.1 = 1.1$

$md = \Delta GM \tan\theta$

$m = 29$

$d = x$

$\Delta = 6500$

$\theta = 1.75$

$GM = 1.1$

$29x = 6500 \times 1.1 \times \tan 1.75$

$x = 7.53284\,m$

10. A mass of 50 tonnes is loaded on board ship 4 m off the centreline creating a heel angle of 1.5°. Determine the mass of the vessel before the load is added.

Take : $KM = 6\,m$, $KG = 4.9\,m$, *and* $m * d = \Delta GM \tan\theta$ (8)

$md = \Delta GM \tan\theta$

$GM = KM - KG$

$GM = 6 - 4.9 = 1.1$

$m = 50$

$d = 4$

$\Delta = x$

$GM = 1.1$

$\theta = 1.5$

$\Delta = 6963.4$ tonnes

(9) A ship has a displacement of 35500 tonne.

Determine the distance a mass of 71 tonne, already on board, must be moved off the centreline to cause the ship to heel by exactly 1°. (8)

Given

$m \times d = \Delta GM \tan\theta$ and that $KM = 6.2$ m, and $KG = 5.3$ m.

$md = \Delta GM \tan\theta$

$m = 71$

$d = x$

$\Delta = 35500$

$GM = 6.2 - 5.3 = 0.9$

$\theta = 1°$

9. A vessel has a displacement of 2480 tonne and a KG of 4.3 m.
A mass of 5 tonne, already on board, when moved 4 m across the deck causes the vessel to heel by 0.95°.

Calculate the value of KM. (8)

Note: Given m x d = Δ GM tan Θ

$md = \Delta GM \tan\theta$

$m = 5$

$d = 4$

$\Delta = 2480$

$GM = x$

$\theta = 0.95°$

$5 \times 4 = 2480\, x \tan 0.95$

$$\frac{20}{2480 \tan 0.95} = x = 0.486377$$

$GM = KM - KG$

$0.486377 + 4.3 = KM$

$4.786377\ m = KM$

9. A vessel has a displacement of 4238 tonne and when a mass of 4 tonne, already on board, is moved 6.2 m across the deck, it causes the vessel to heel by 1.05°.

Calculate the distance from the keel to the metacentre M given that KG = 3.63 m and that $m \times d = \Delta GM \tan\theta$. (8)

$m d = \Delta GM \tan\theta$

$GM = KM - KG$

$m = 4$

$d = 6.2$

$\Delta = 4238$

$GM = x$

$\theta = 1.05°$

$$\frac{4 \times 6.2}{4238 \tan(1.05)} = 0.3192827$$

$KM = 3.63 + 0.3192827$

$KM = 3.94928\ m$