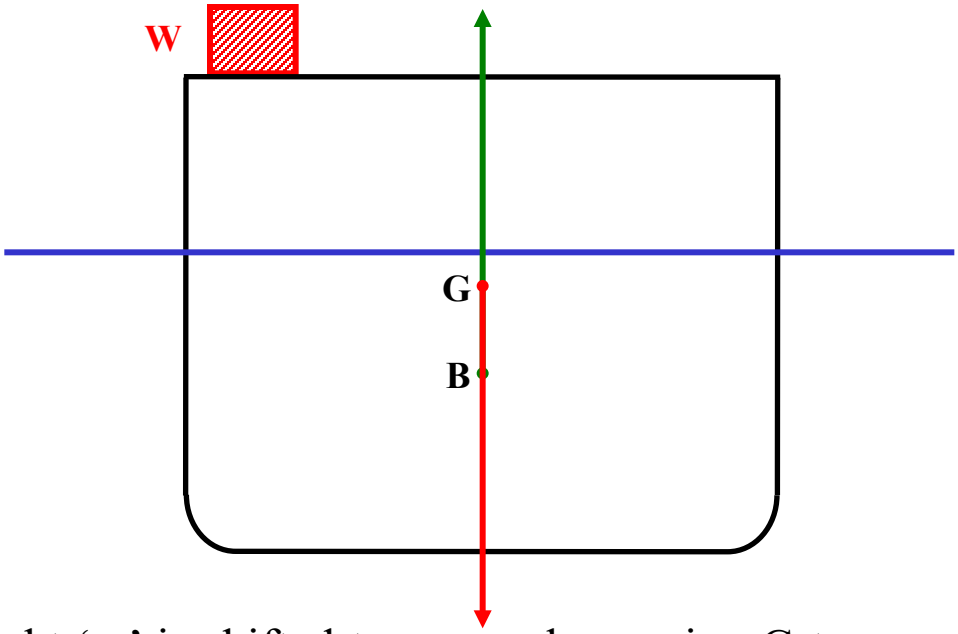
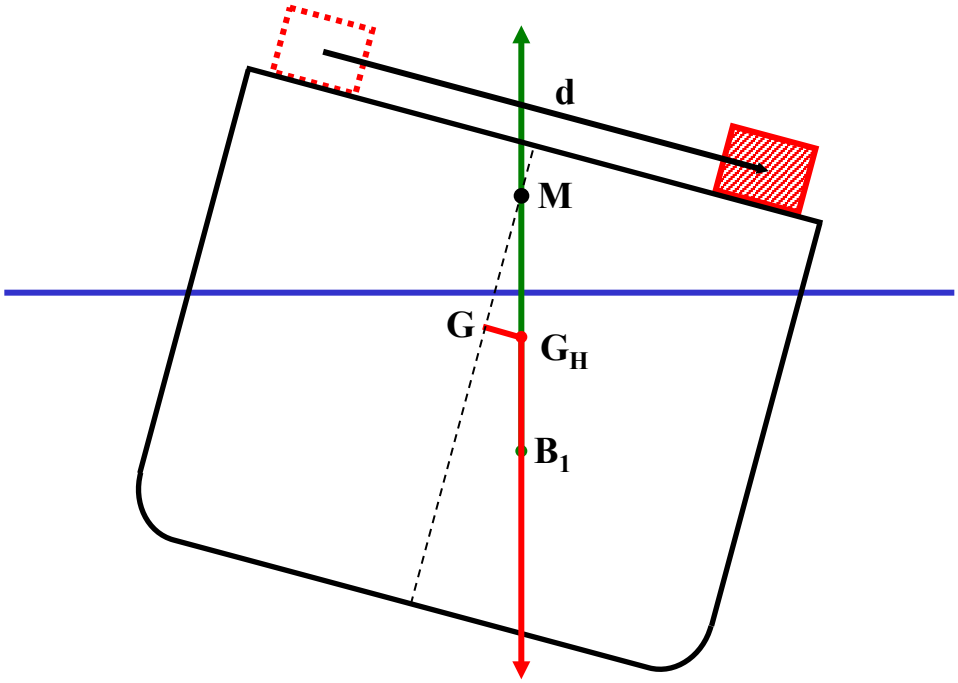
LIST

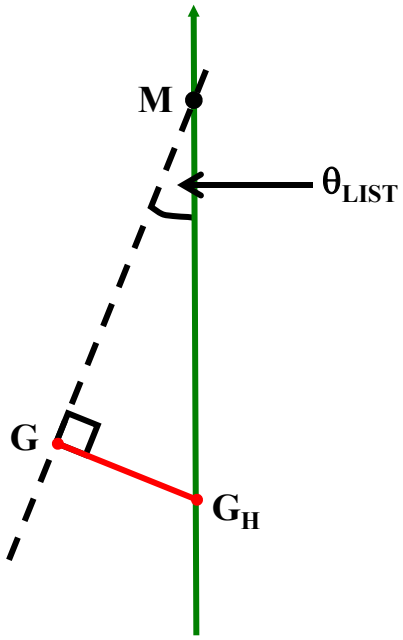
Consider a ship floating upright, G and B on the centreline with a weight ‘w’ on one side.



The weight ‘w’ is shifted transversely causing G to move off the centre-line as shown. The ship lists over, coming to rest with the centre of buoyancy, B, vertically below the centre of gravity, now G_H.



The angle at the metacentre in the right angled triangle GG_HM is the ***list*** (termed θ).



$$\text{Tan } \theta_{LIST} = \frac{OPP}{ADJ} = \frac{GG_H}{GM}$$

Therefore:

$$\text{Tan } \theta_{LIST} = \frac{GG_H}{GM}$$

For the above formula to be true, the list must be restricted to a ***small angle***, i.e. the metacentre is assumed to be in a fixed position within small angles of inclination.

SAQ

A ship initially upright displaces 12000 t and has KG 6.7 m and KM 7.3 m. A weight of 60 t already on board is shifted 14 m horizontally across the deck. Calculate the resulting angle of list.

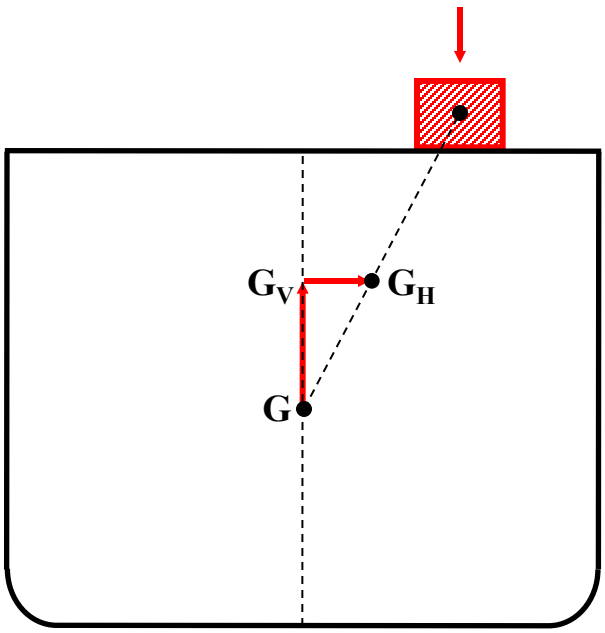
Answer

KM 7.3 m
KG 6.7 m
GM 0.6 m

$GG_H = \frac{w \times d}{W}$ $\quad GG_H = \frac{60 \times 14}{12000} = 0.07\ m$

$Tan\ \theta_{LIST} = \frac{GG_H}{GM} = \frac{0.07}{0.6} = 0.11666$ $\quad$ ***List = 6.65°***

If a weight is loaded or discharged then both the vertical and horizontal components of the shift of G must be considered and the final GM must be used to calculate the final list.



1. Calculate GG_V, and hence the final GM.
2. Calculate GG_H.
3. Calculate the list.

SAQ

A ship displaces 6400 t and has KG 4.6 m and KM 6.5 m. A weight of 80 t is loaded on deck at Kg 10.2 m, 6.2 m off the centre-line to starboard. Calculate the final list.

Answer

$$GG_V = \frac{w \times d}{W + w} \qquad GG_V = \frac{80 \times (10.2 - 4.6)}{6400 + 80} = 0.069 \text{ m}$$

KM =	*6.500 m*
Initial KG	*4.600 m*
Initial GM	*1.900 m*
GG_V (up)	*0.069 m*
Final GM	*1.831 m*

$$GG_H = \frac{w \times d}{W + w} \qquad GG_V = \frac{80 \times 6.2}{6400 + 80} = 0.077 \text{ m}$$

$$\text{Tan } \theta_{LIST} = \frac{GG_H}{GM_{FINAL}} = \frac{0.077}{1.831} = 0.04205 \qquad \text{List} = 2.4° \text{ Stbd.}$$

It is easier to solve list problems using ***moments***.

1. Take moments about the keel to determine the final KG:

$$\textbf{Final KG} = \frac{\textbf{Sum of moments about keel (t-m)}}{\textbf{Final Displacement (t)}}$$

2. Calculate the final GM: **GM = KM - KG**

3. Take moments about the centre-line to calculate the final distance that G is off the centre-line, GG_H:

$$GG_H = \frac{\text{Sum of moments about centre-line (t-m)}}{\text{Final Displacement (t)}}$$

4. Calculate the list:

$$\text{Tan } \theta_{LIST} = \frac{GG_H}{GM_{FINAL}}$$

SAQ

A ship displaces 8000 tonnes, KG 7.60 m and is initially upright. The following cargo is worked:

Load:	***300 t at Kg 0.60 m, 6.1 m to port of CL;***
	250 t at Kg 6.10 m, 7.6 m to stbd of CL;
Disch:	***50 t from Kg 1.20 m, 4.6 m to port of CL;***
	500 t from Kg 12.60 m, 4.6 m to stbd of CL.

Calculate the final angle of list on completion of cargo if the KM for Final Condition is 9.36m.

Answer : ***FINAL list 6.1° to Port***