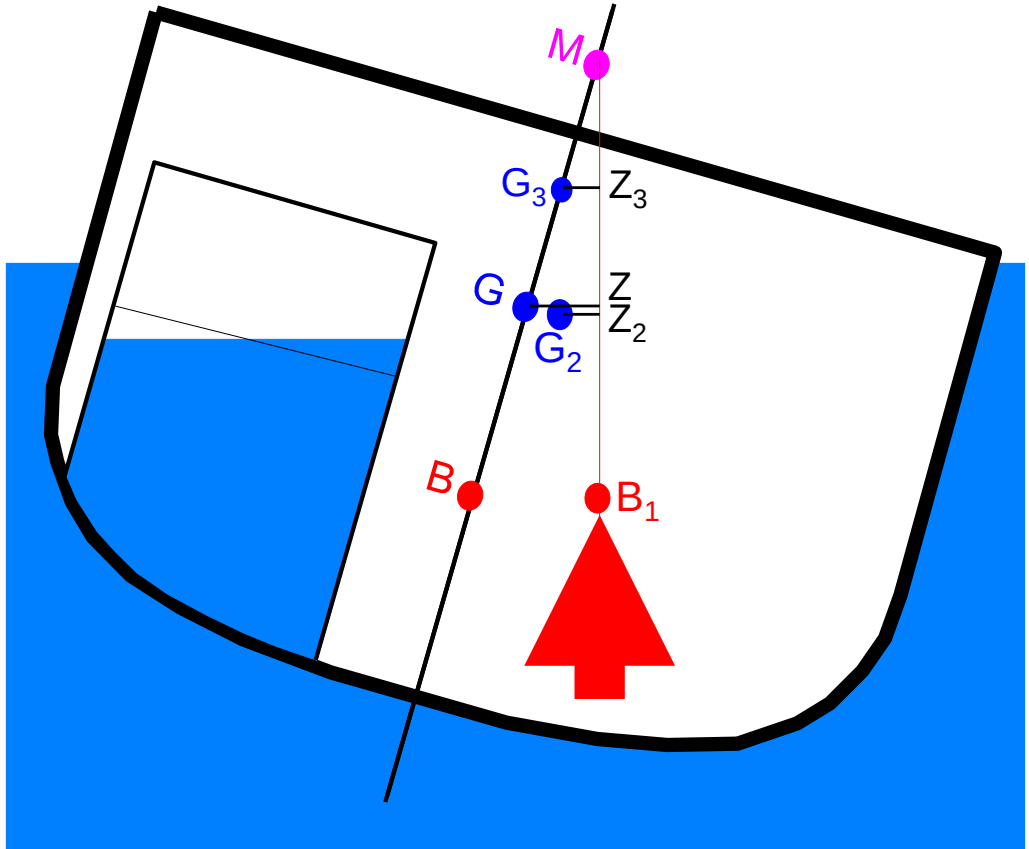
Lesson 4.3

Loose Water



References

- NSTM 079 Volume 1
- NTTP 3-20.31
- Damage Control Book, section II (a)

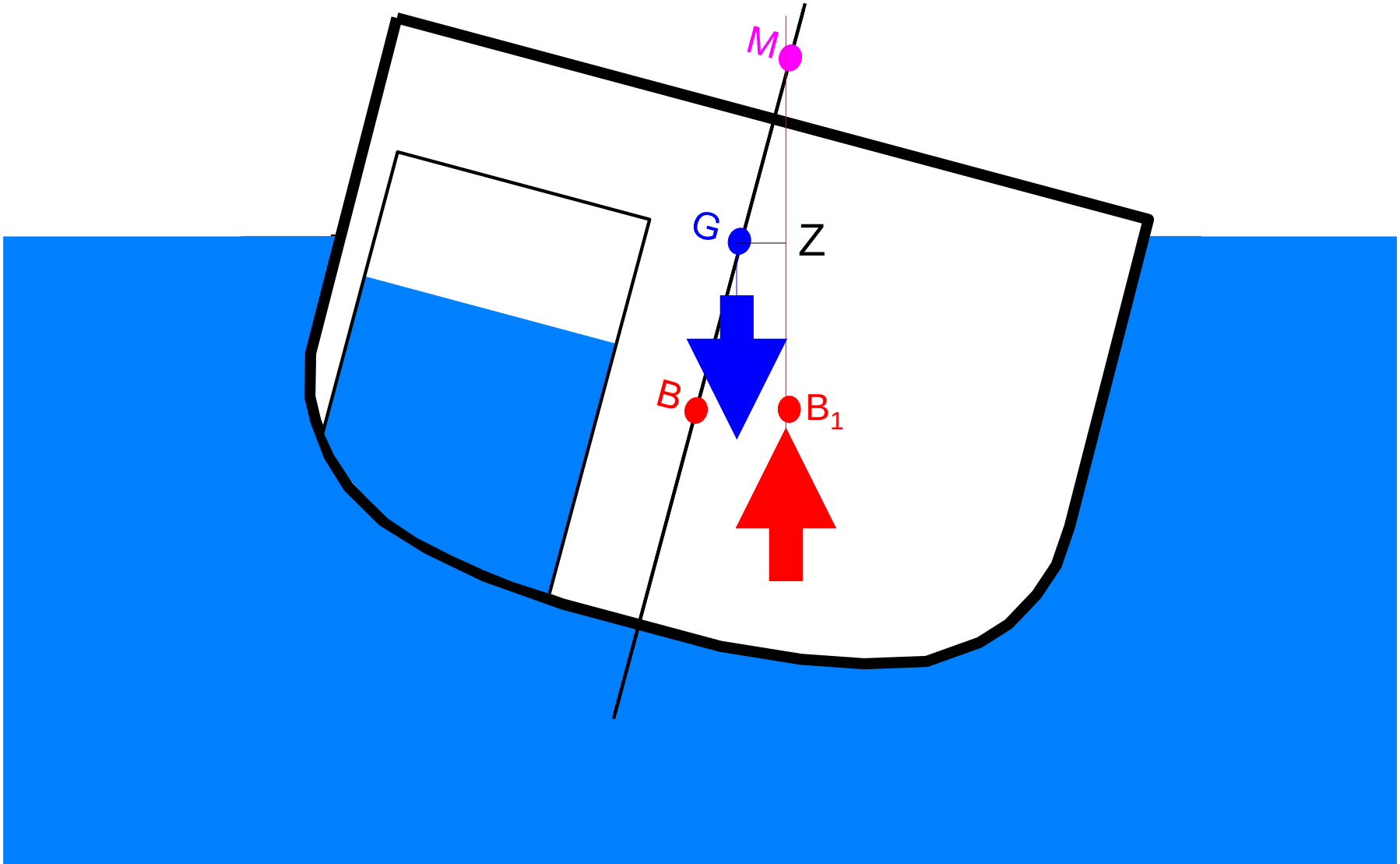
ENABLING OBJECTIVES

- **Explain why FSE impairs stability.**
- **Compute FSE.**
- **List methods to reduce FSE.**
- **Explain why FCE impairs stability.**
- **Compute FCE.**
- **Describe pocketing, surface permeability, size of hole, and venting on FSE and FCE.**
- **Correct stability curve for FSE and FCE.**

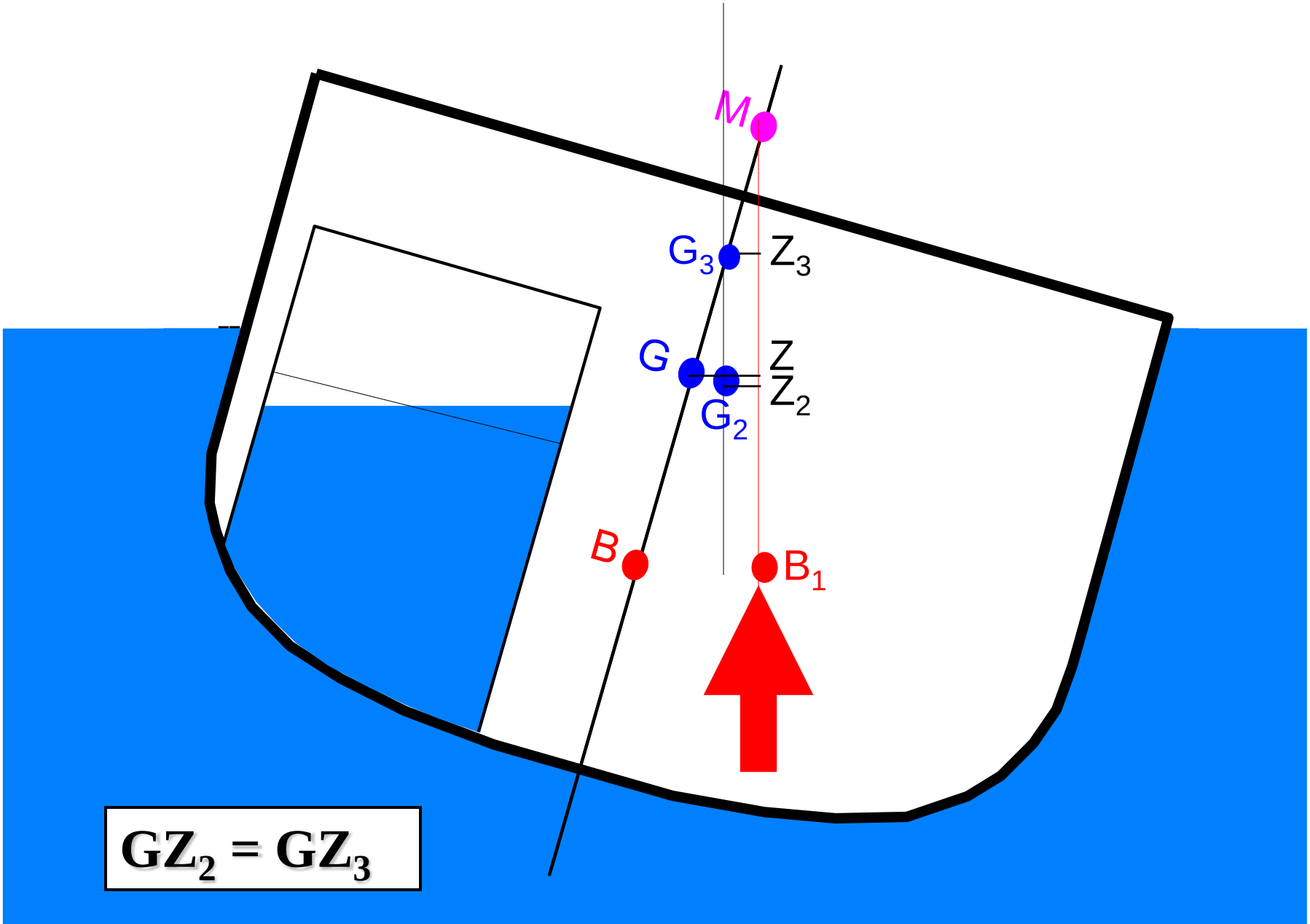
CLASS TOPICS

1. Free Surface Effect
2. Example
3. Free Communication Effect
4. Example

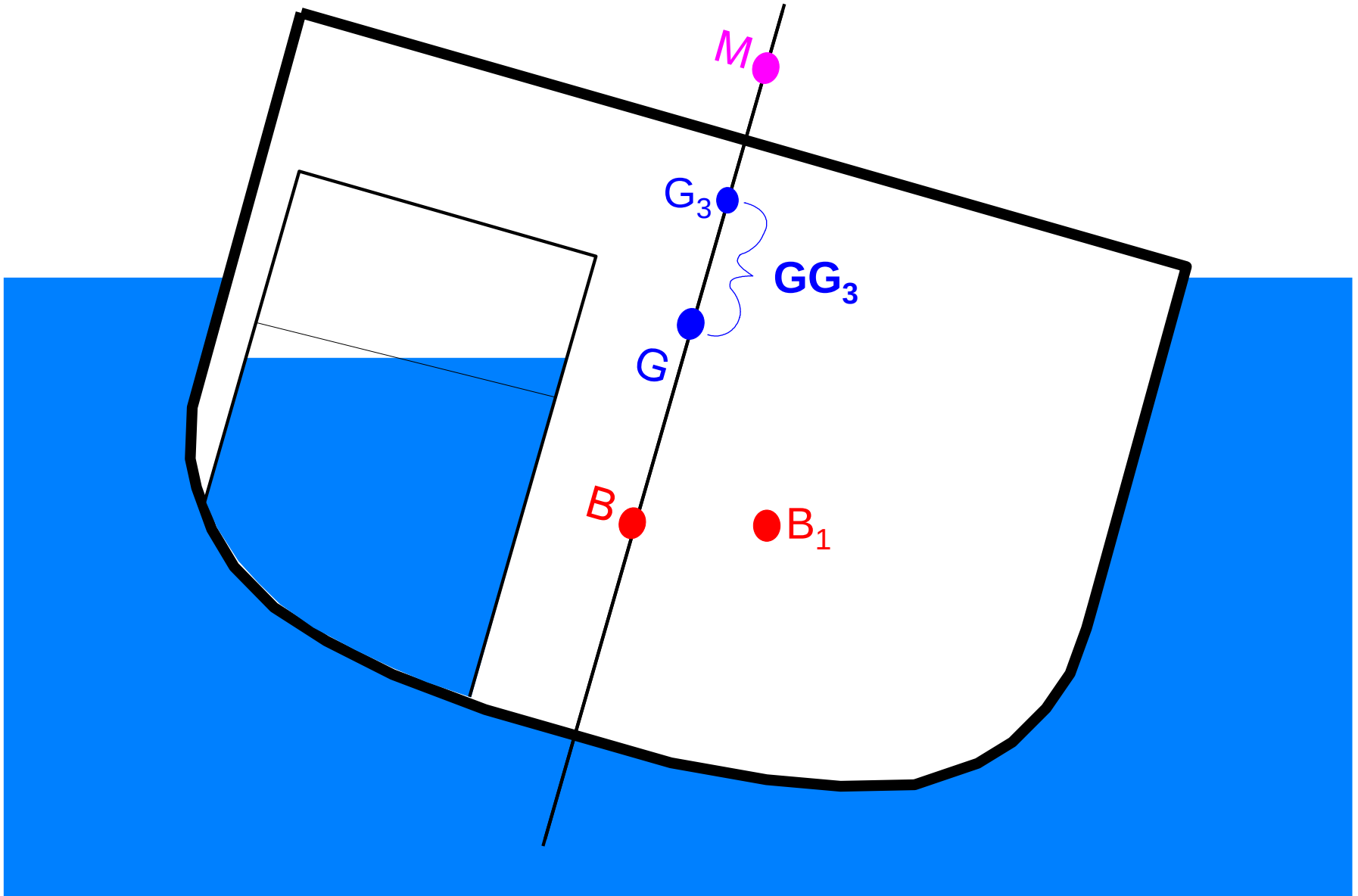
FREE SURFACE EFFECT



FREE SURFACE EFFECT



$GZ_2 = GZ_3$


M
G3
GG3
G
B
B1

FREE SURFACE EFFECT

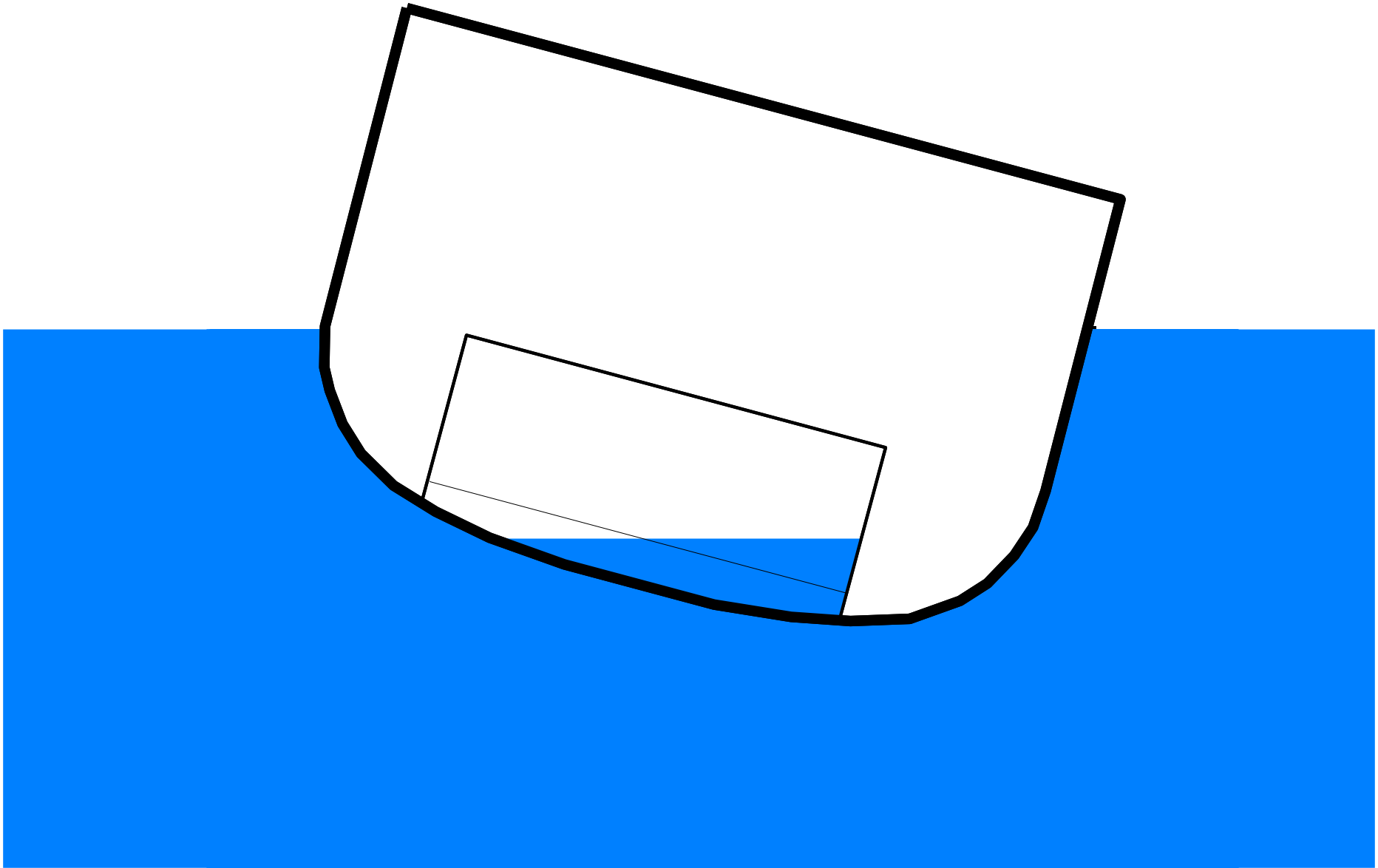
$$FSE = \frac{B^3 \times L}{12 \times 35 \times W_f}$$

$B^3 \times L$ = **MOMENT OF INERTIA**

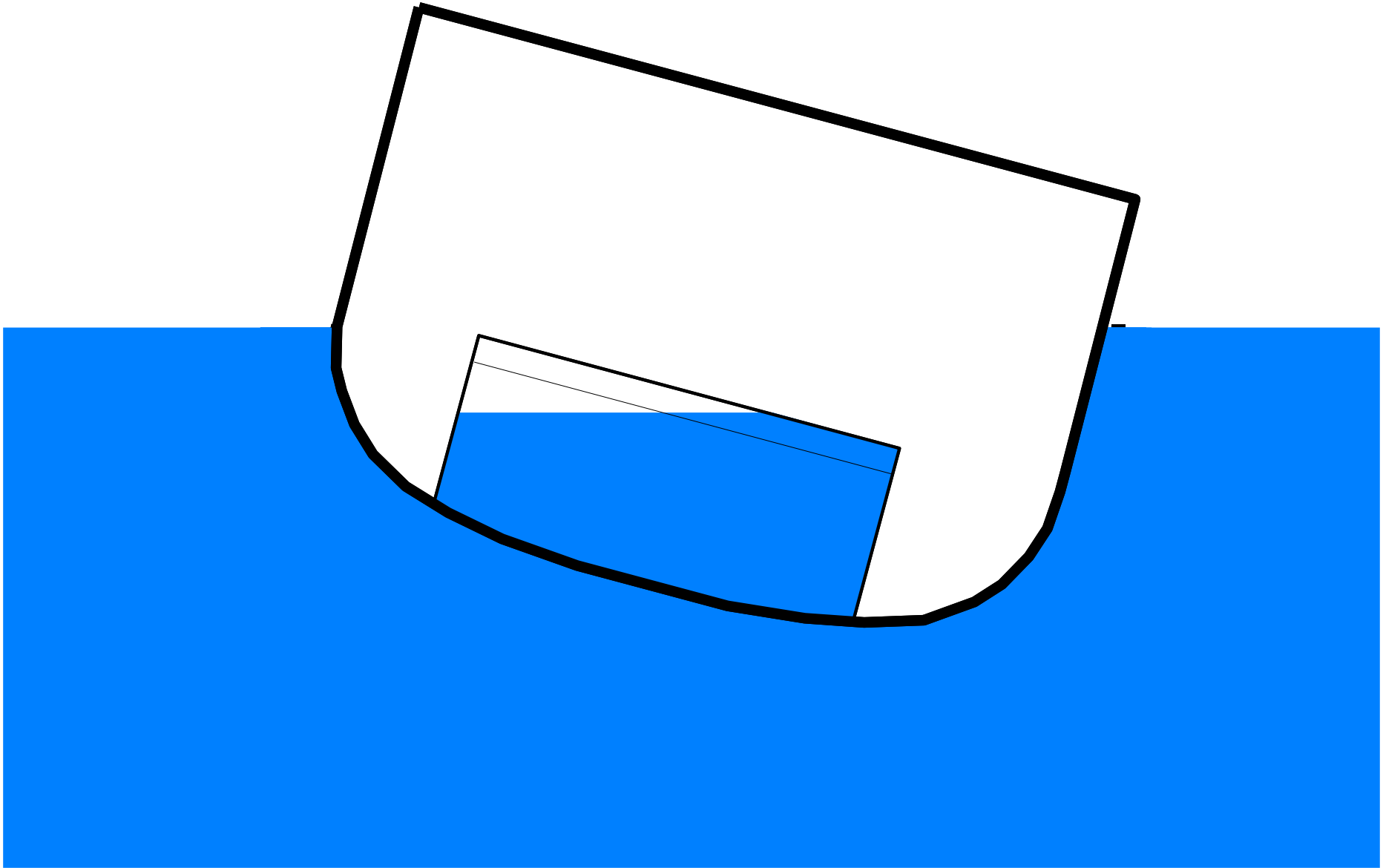
$35 \times W_f$ = **SHIP'S DISPLACED VOLUME**

B = BREADTH OF COMPT
L = LENGTH OF COMPT
W_f = SHIP'S DISPLACEMENT

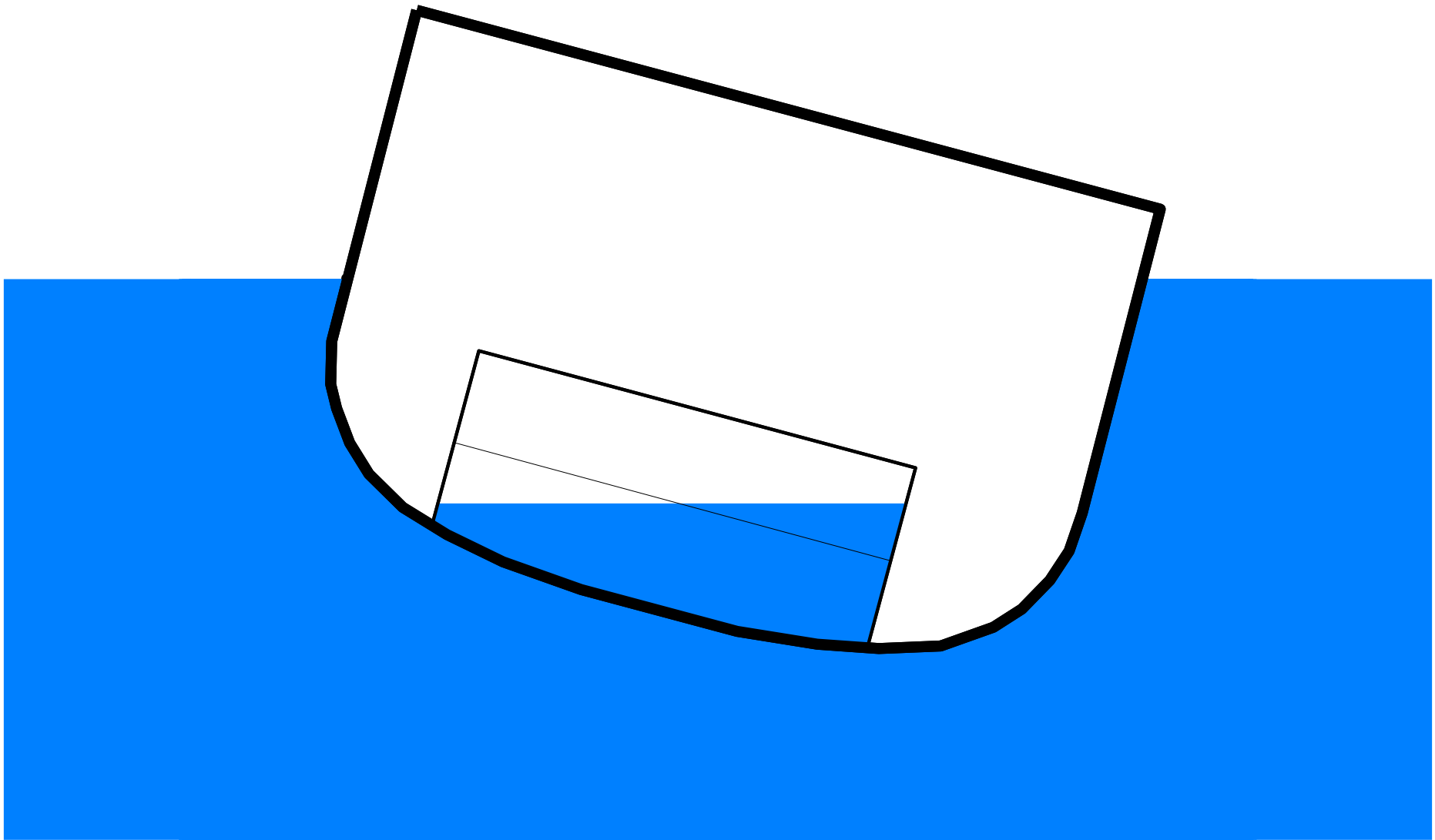
POCKETING - SHALLOW



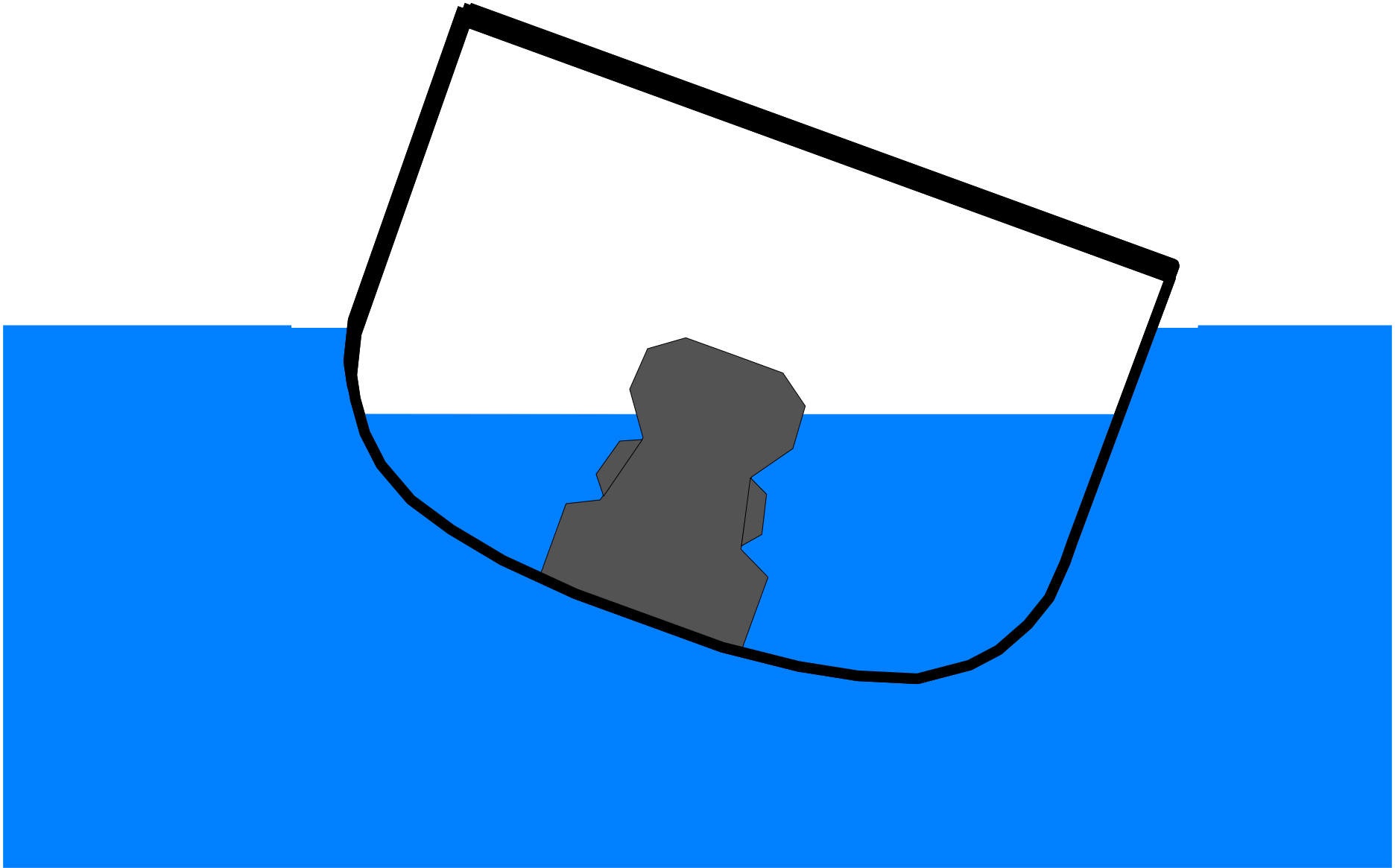
POCKETING - ALMOST FULL



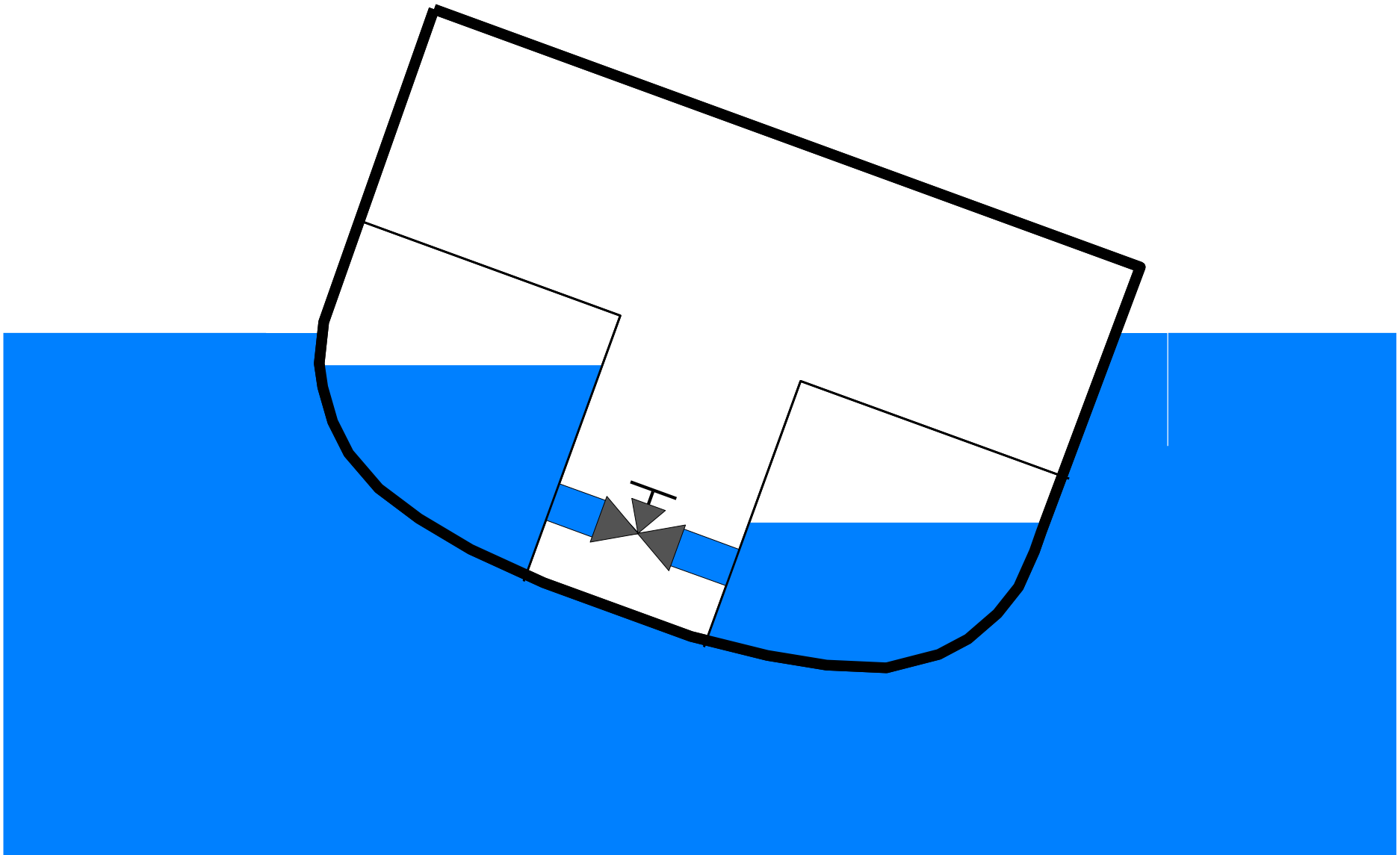
POCKETING
(NO POCKETING EXISTS)



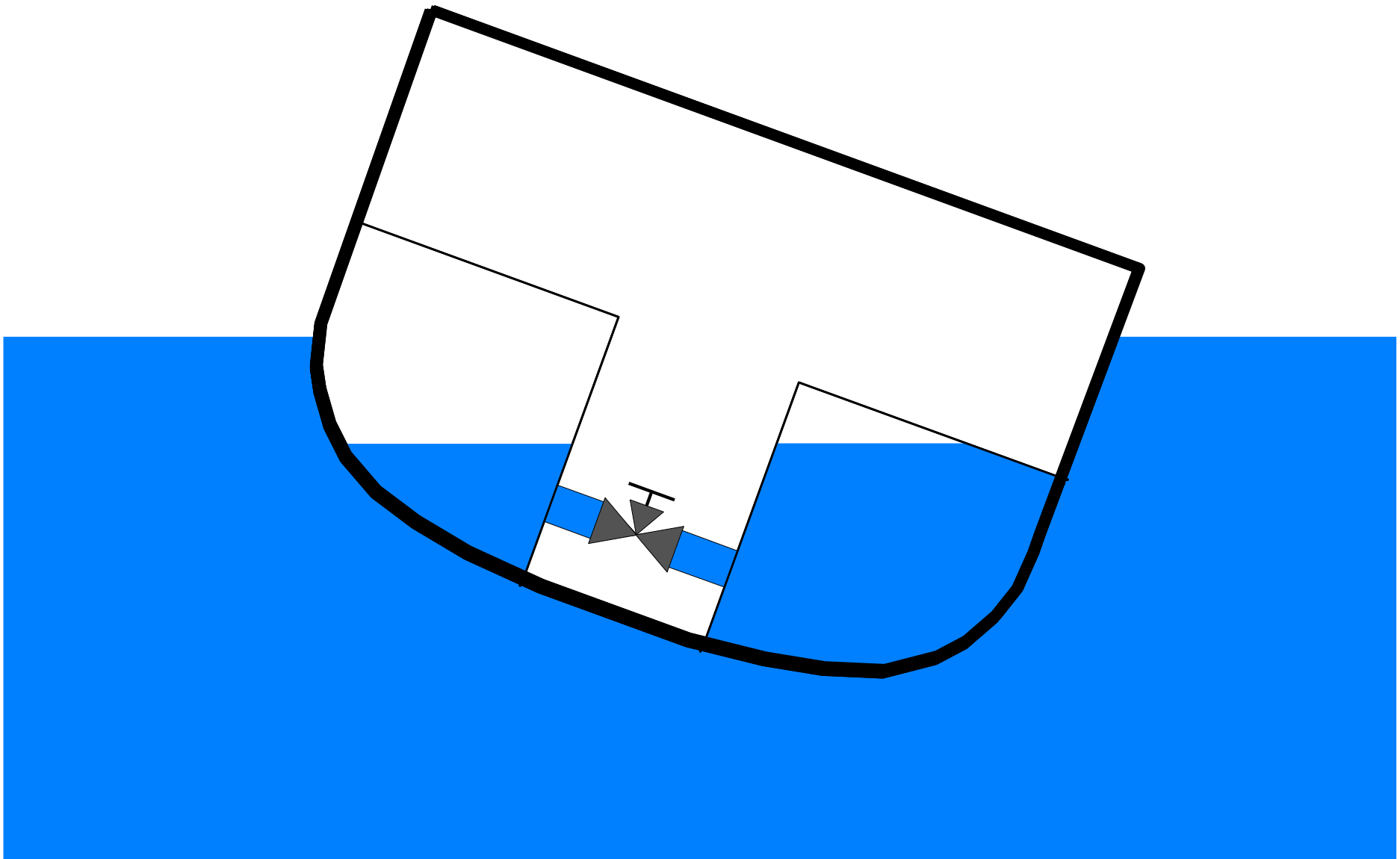
SURFACE PERMEABILITY



SLUICE VALVES - Closed



SLUICE VALVES - Open



FREE SURFACE EFFECT

- **Independent of the depth of the liquid**

- Greater w/ increased length and width of the compartment

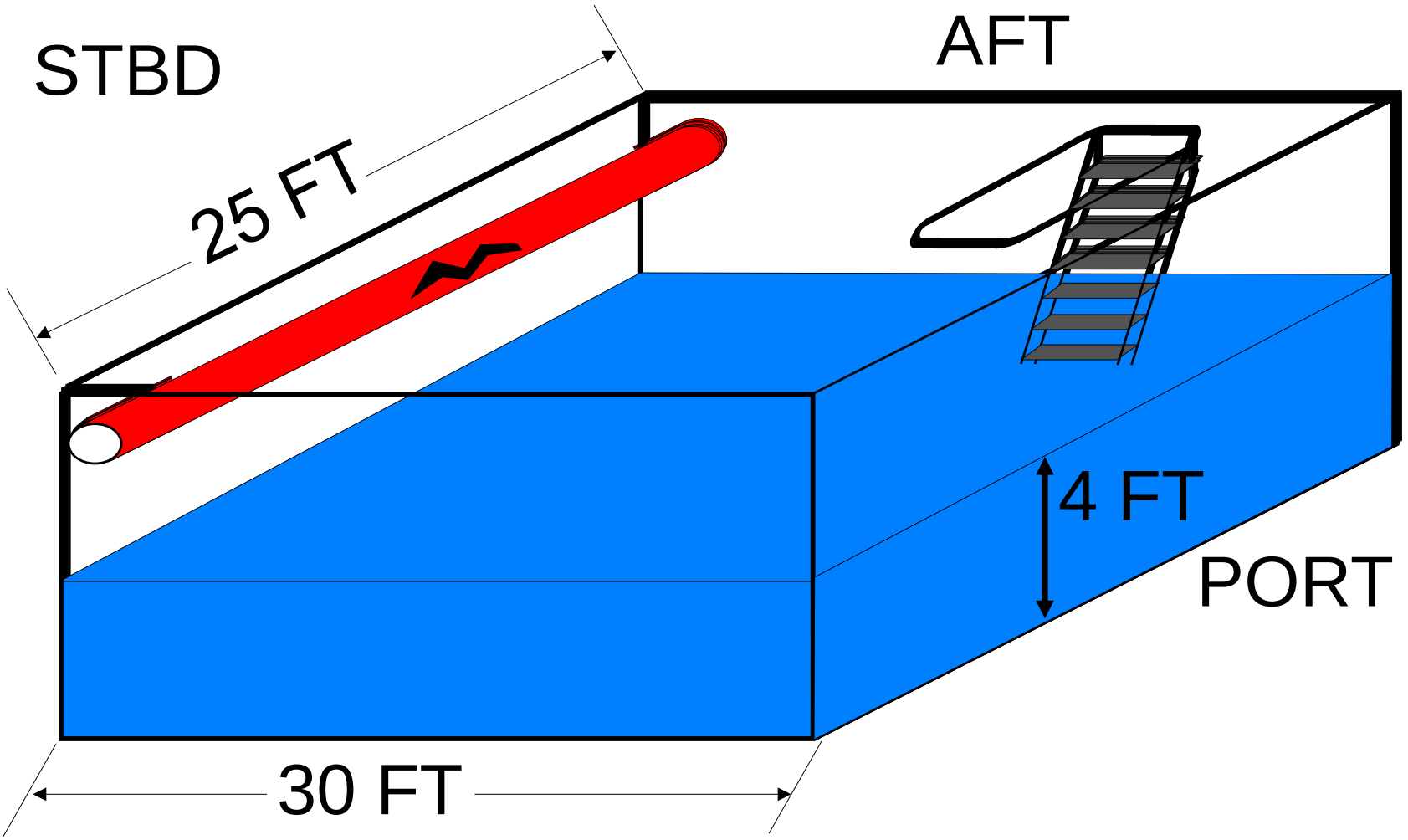
- Increases as draft decreases (de-ballasting)

- Can be reduced by pocketing

CLASS TOPICS

1. ~~Free Surface Effect~~
2. Example
3. Free Communication
4. Example

W_o = 3500 LT



FSE?

$$FSE = \frac{B^3 \times L}{12 \times 35\ FT^3/LT \times W_F}$$

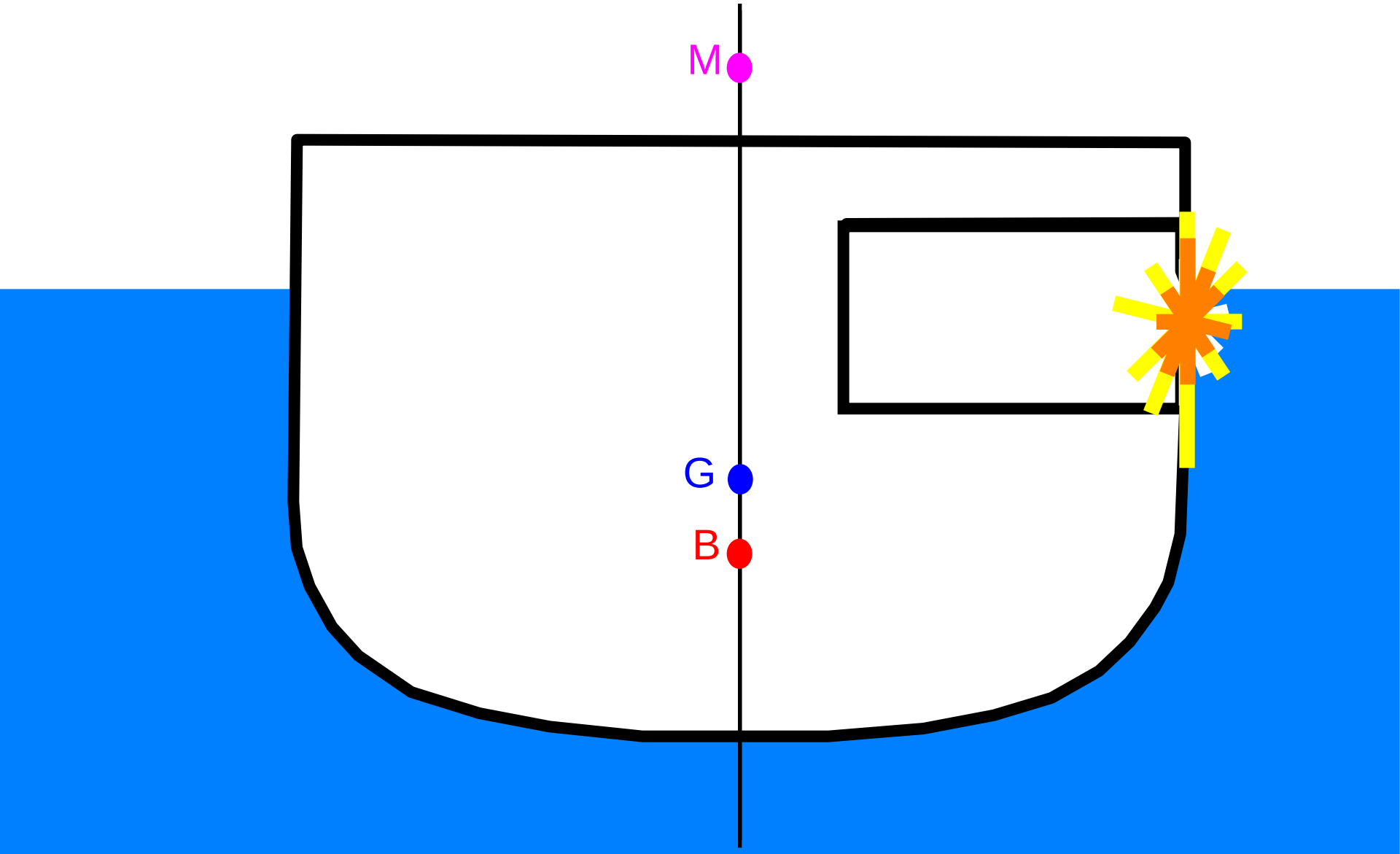
$$FSE = \frac{(30\ FT)^3 \times 25\ FT}{12 \times 35\ FT^3/LT \times 3585.71\ LT}$$

$$FSE = \frac{675000\ FT^4}{1505998.2\ FT^3} = \mathbf{.45\ FT}$$

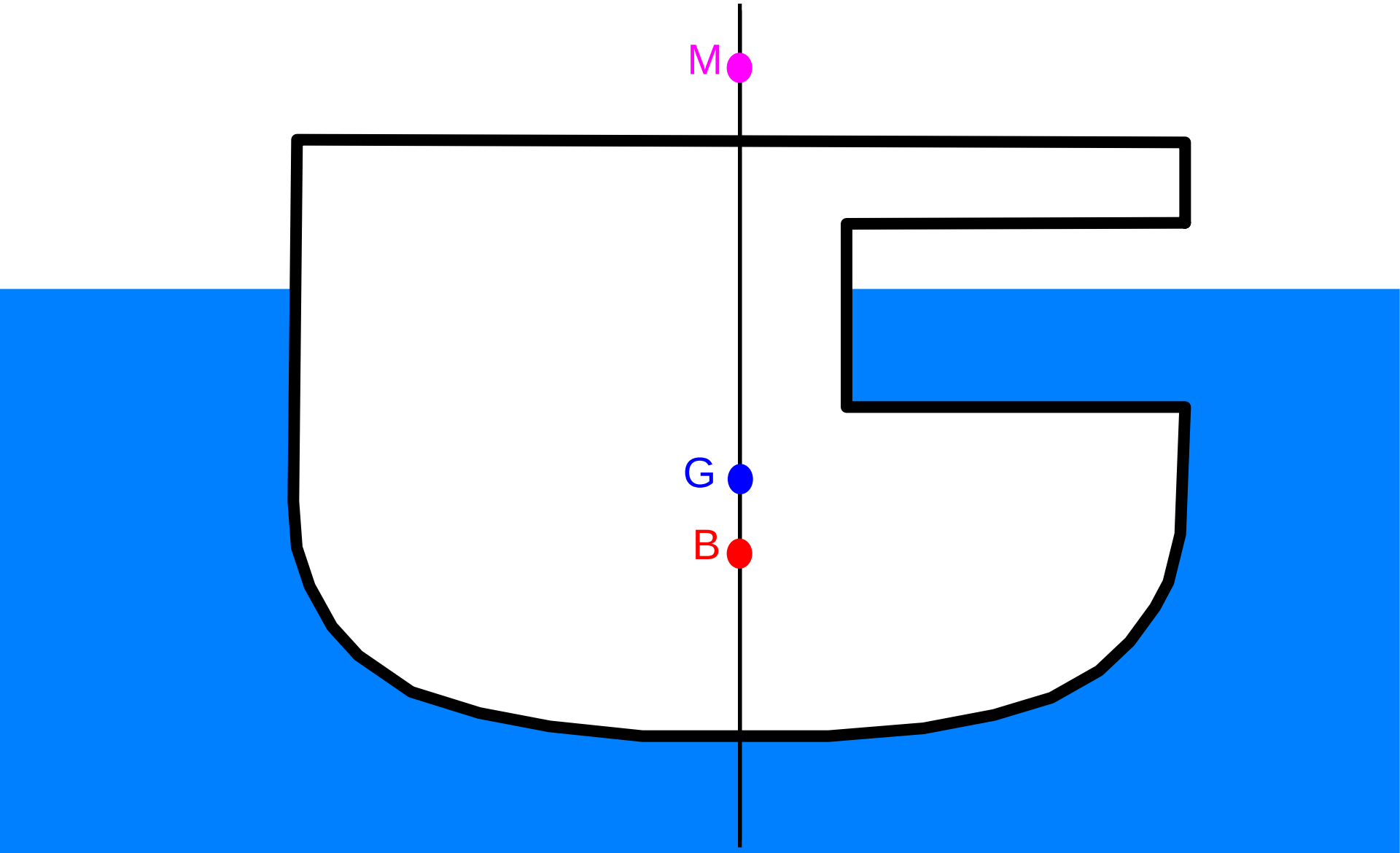
CLASS TOPICS

1. ~~Free Surface Effect~~
2. ~~Example~~
3. Free Communication
4. Example

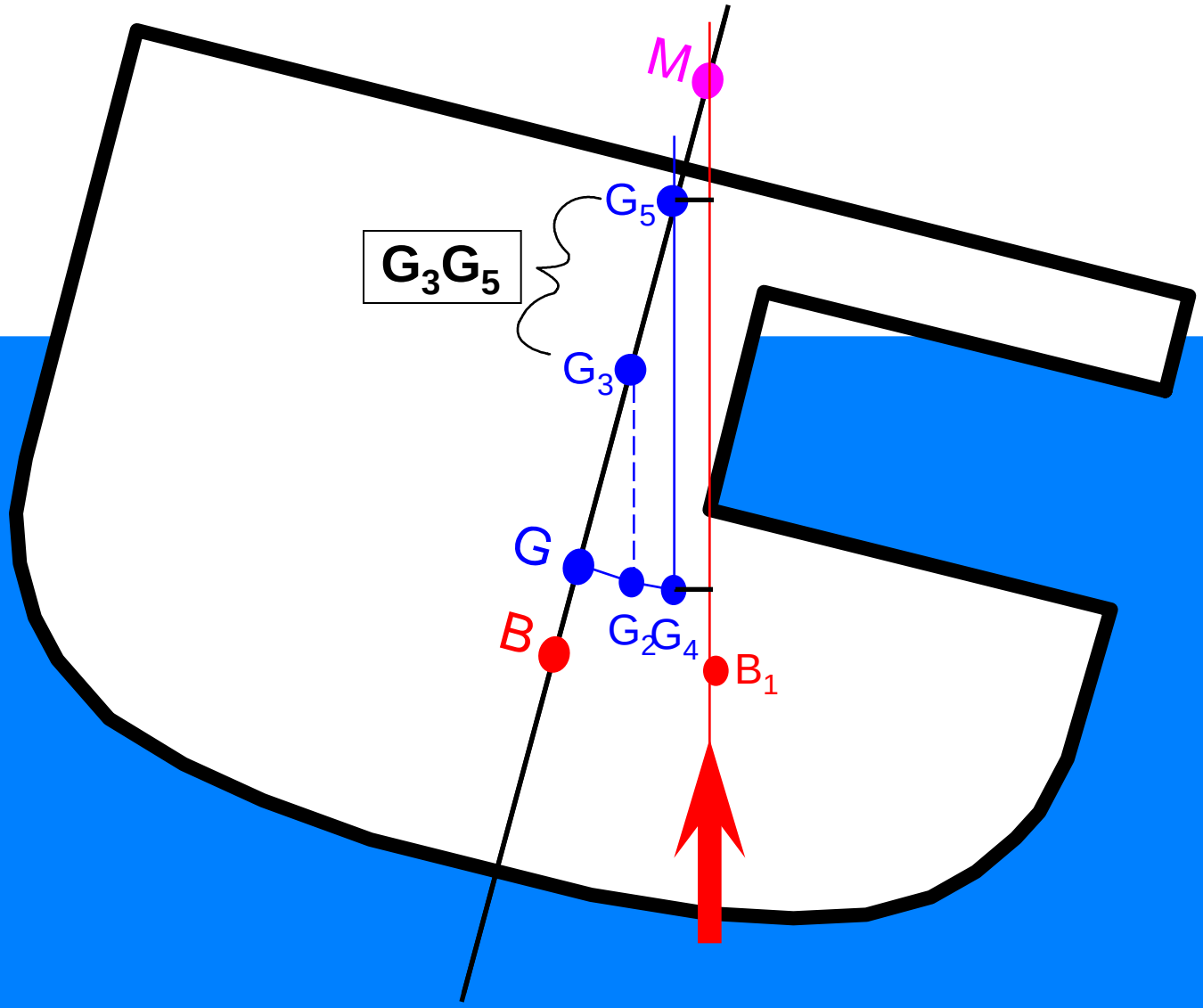
FREE COMMUNICATION EFFECT



FREE COMMUNICATION EFFECT



FREE COMMUNICATION EFFECT



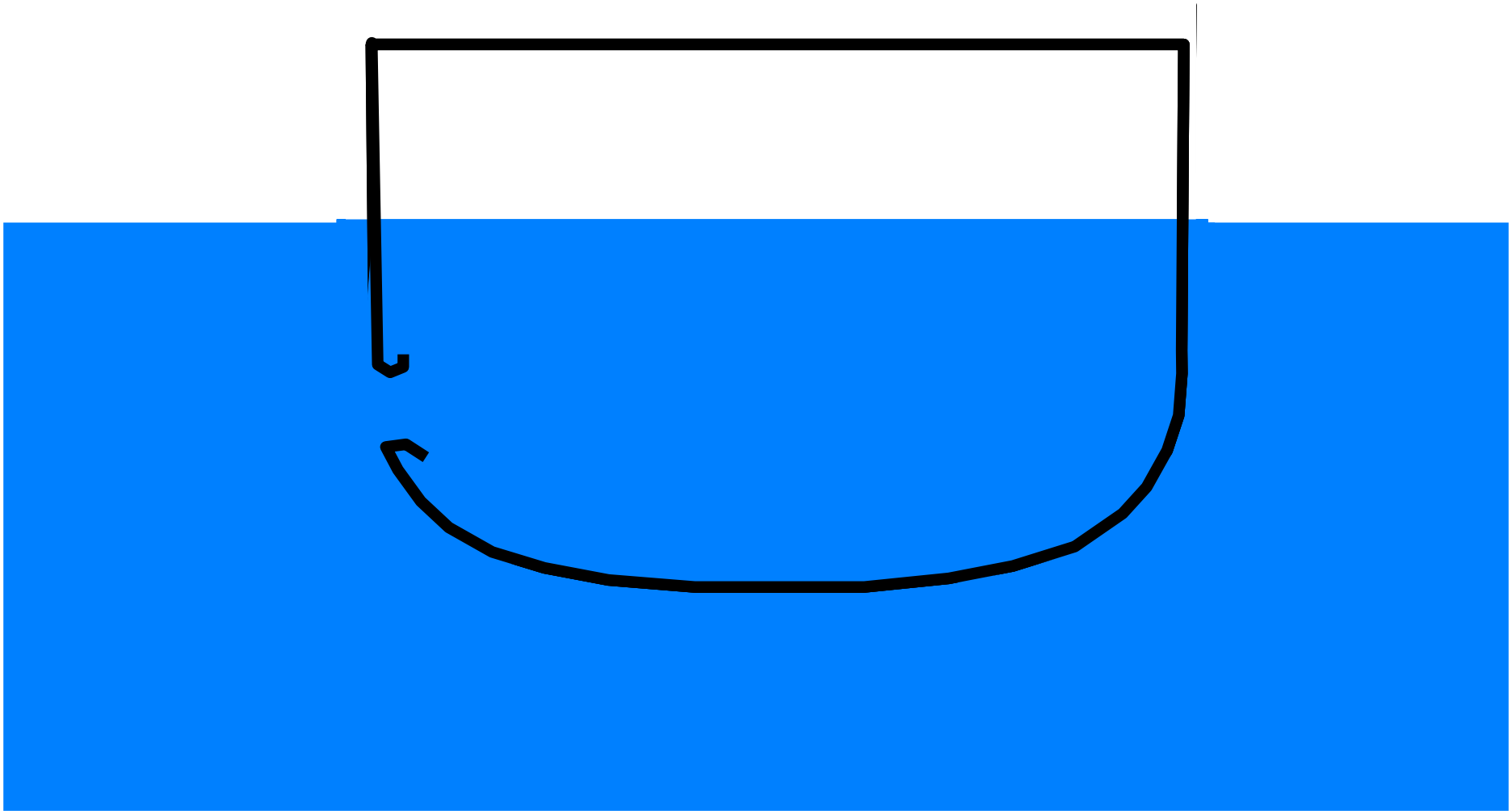
FREE COMMUNICATION EFFECT

$$FCE = \frac{B \times L \times Y^2}{35 \times W_f}$$

B = BREADTH OF COMPT
L = LENGTH OF COMPT
Y = DIST FM SHIP C/L TO COMPT COG.
W_f = SHIP'S DISPLACEMENT

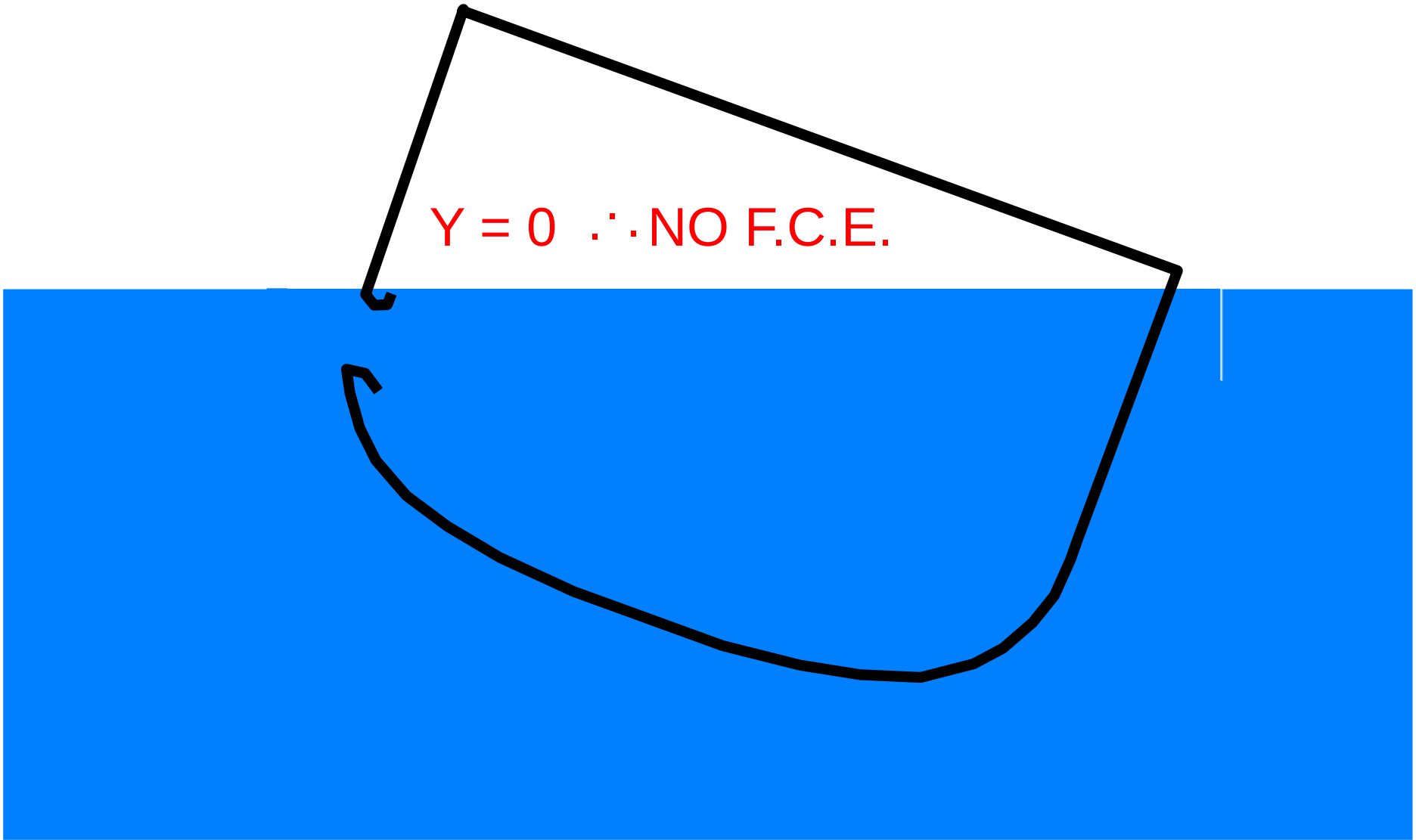
FREE COMMUNICATION EFFECT
(All 3 must exist)

- COMPARTMENT OPEN TO THE SEA
- COMPARTMENT PARTIALLY FLOODED
- COMPARTMENT OFF-CENTERLINE OR "UNEVEN" ABOUT THE CENTERLINE



✓ COMPARTMENT OPEN TO SEA

✓ COMPARTMENT PARTIALLY FLOODED



Free Communication Effect

- **Size of the hole will reduce FCE. (Formula assumes entire skin of ship is “open to sea”)**

- Venting will reduce FCE. (More air transfer = more water “communicating” into the compartment.)

- Increases as draft decreases (de-ballasting)

- Can be reduced by pocketing

CLASS TOPICS

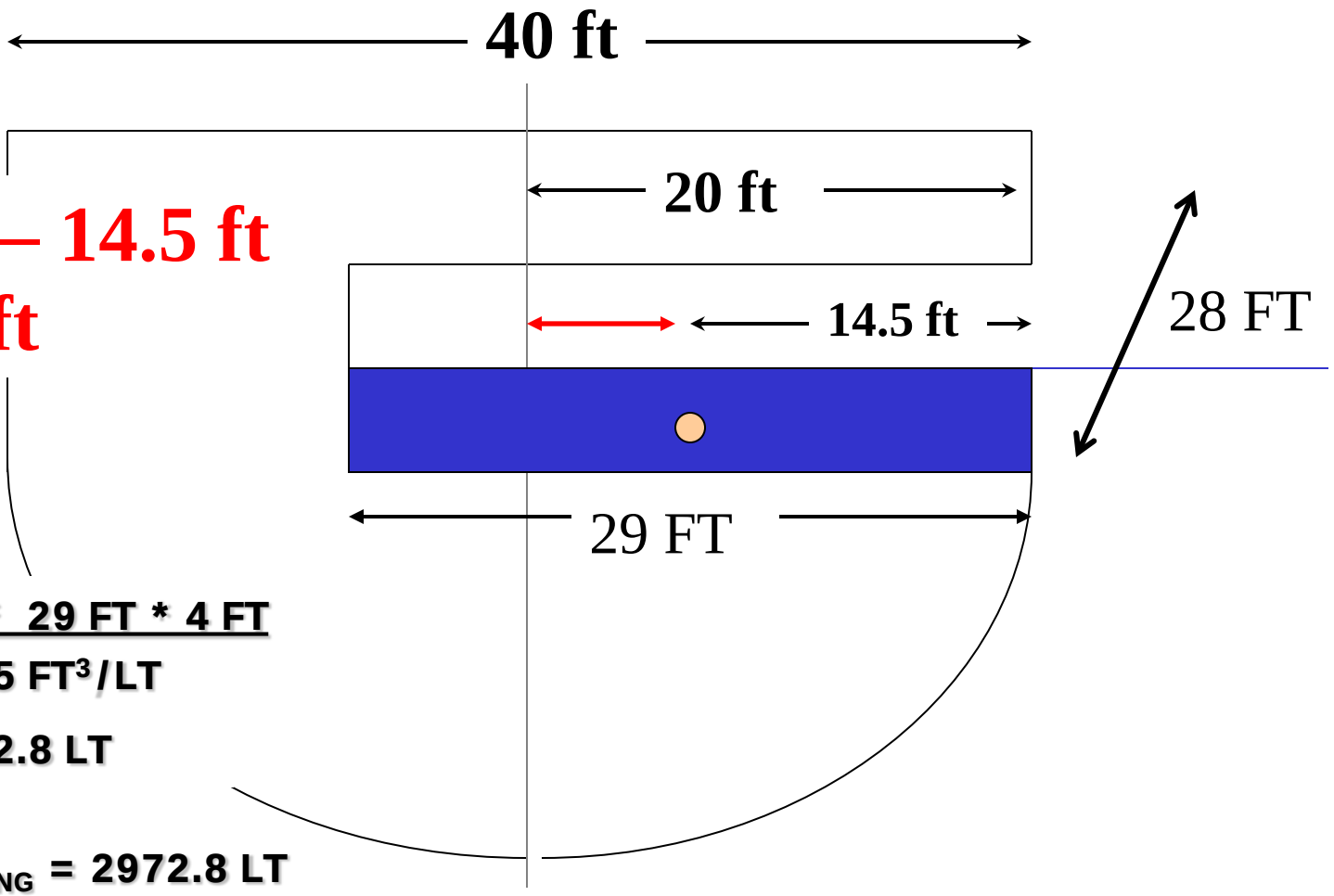
1. ~~Free Surface Effect~~
2. ~~Example~~
3. ~~Free Communication~~
4. Example

W_o = 2880 LT

L = 28 FT

Depth = 4 ft

B = 29 FT



$y = 20\ ft - 14.5\ ft$

$y = 5.5\ ft$

$$w_{FLOODING} = \frac{28\ FT * 29\ FT * 4\ FT}{35\ FT^3/LT}$$

$w_{FLOODING} = 92.8\ LT$

$W_F = W_0 + w_{FLOODING} = 2972.8\ LT$

$$\textbf{FCE} = \frac{B \times L \times (y)^2}{35\ FT^3/LT \times W_F}$$

$$\textbf{FCE} = \frac{29\ FT \times 28\ FT \times (5.5\ FT)^2}{35\ FT^3/LT \times (2880\ LT + 92.8\ LT)}$$

$$\textbf{FCE} = \frac{24563\ FT^4}{104048\ FT^3} \quad \textbf{.24 FT}$$

Quiz…

- **Why does FSE impair stability?**
- ➢ **ANS: Horizontal weight shifts off centerline cause a "virtual rise" in G, reducing GM.**
- **Factors that reduce FSE?**
- ➢ **ANS: Compartment size, pocketing, baffle plates, surface permeability, sluice valves, venting.**
- **Which variable is the "determining factor" in the FCE equation?**
- ➢ **ANS: "Y" the distance from the ship's centerline to the compartments center… it is squared.**

Quiz…

- **What three factors must be present for FCE to exist?**

➢ **ANS: 1) Off centerline or Uneven about centerline. 2) Open to the sea 3) Partially flooded.**

Instructor will now…

- Assign Practice Problems for lesson 4.3 (Stability Problems #4, #7. Try problems #8, #11)
- **Read Student Guide!!**
- **Homework # 2 Due end of class TODAY!**