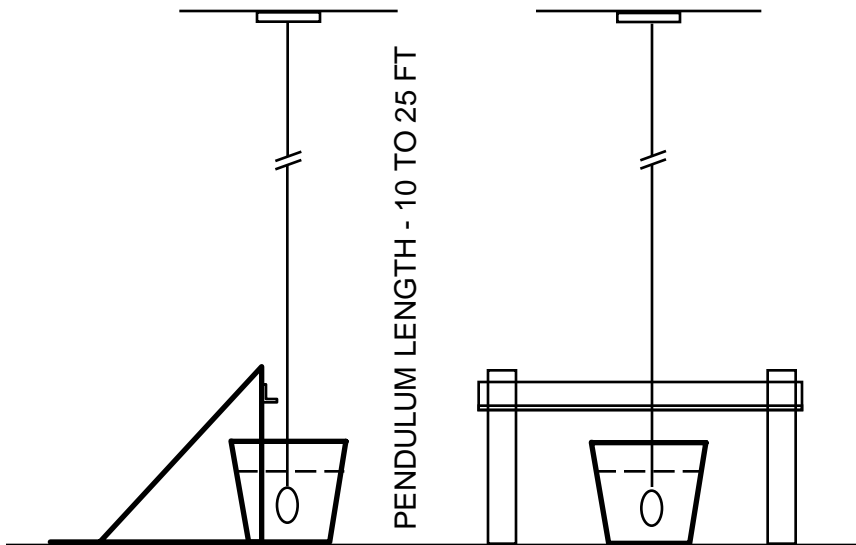
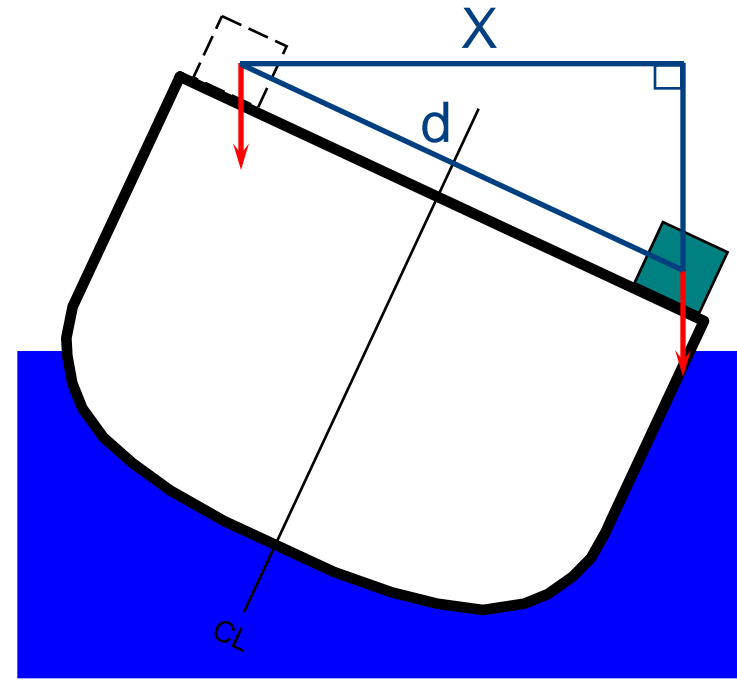


# Lesson 4.8

## Righting Ship



# References

- a) **NSTM 079 Volume 1**
- b) **NTTP 3-20.31**
- c) **Damage Control Book, section II (a)**
- d) **FXP-4**
- e) ***COMDTINST M9000.6D Appendix A  
(Naval Engineering Manual)***

# Enabling Objectives

- CALCULATE resulting list from MH1\* equation
- CALCULATE transverse moment to correct a known list.
- DESCRIBE inclining experiment and it's purpose.
- DESCRIBE Righting Ship Drill (MOB-D-6-SF)

Why hasn't this ship sunk  
yet...?



Have you had your V8  
today...?



# Class Topics

1. Definitions
2. Moment to Heel or List  $1^\circ$
3. Example Problems
4. Inclining Experiment
5. Righting Ship Drill

# DEFINITIONS

ROLL - The action of a vessel involving a recurrent motion (*Longitudinal Axis*).

HEEL - **Semi-permanent** angle of inclination, caused by external forces.

LIST - **Permanent angle** of inclination caused by **G off CL**, **-GM**, or a **combination** of the two.

# Class Topics

- ~~1. Definitions~~
2. Moment to Heel or List  $1^\circ$
3. Example Problems
4. Inclining Experiment
5. Righting Ship Drill

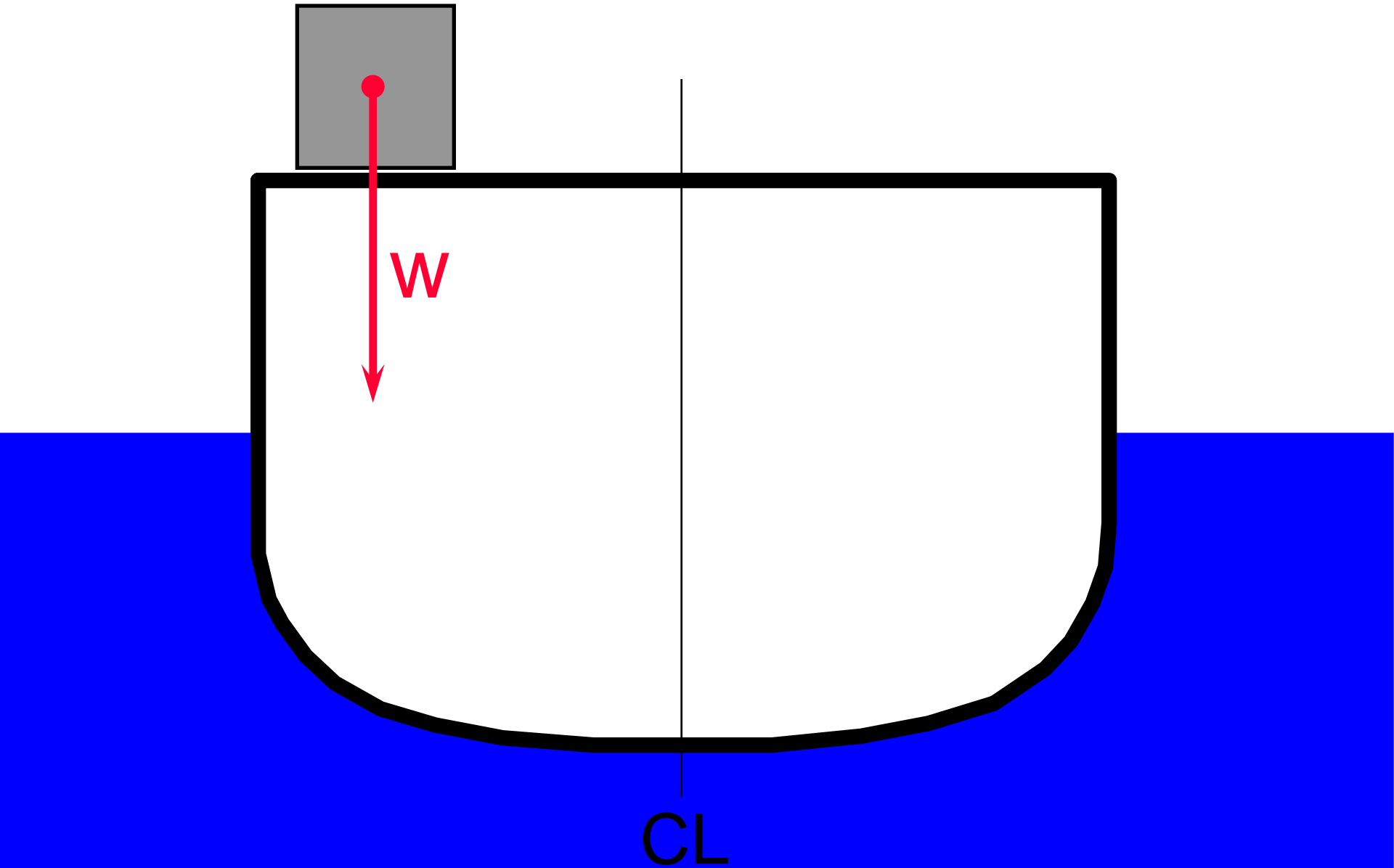


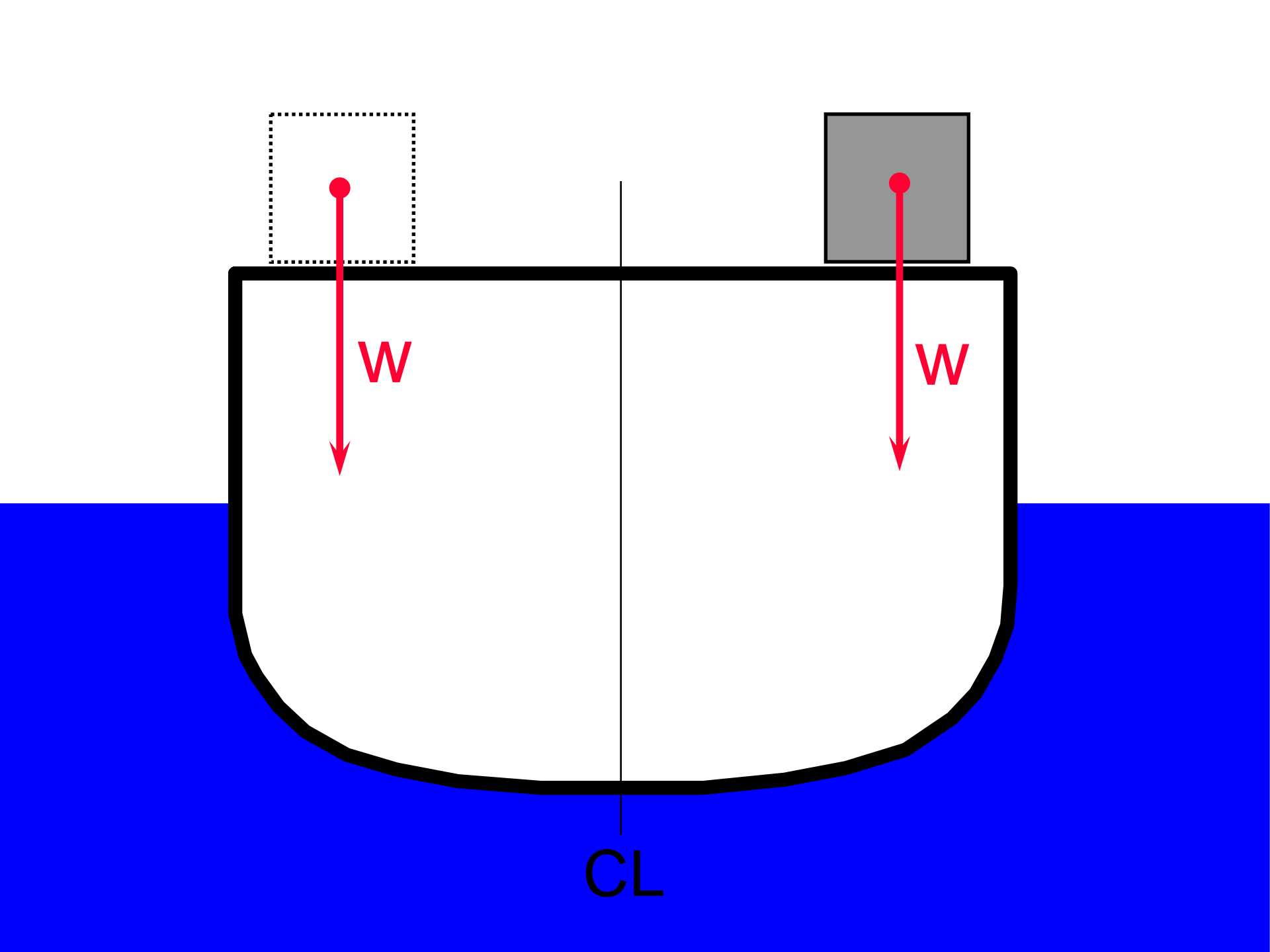
A ship will heel or list until the  
Righting Moment is equal to the  
Inclining Moment

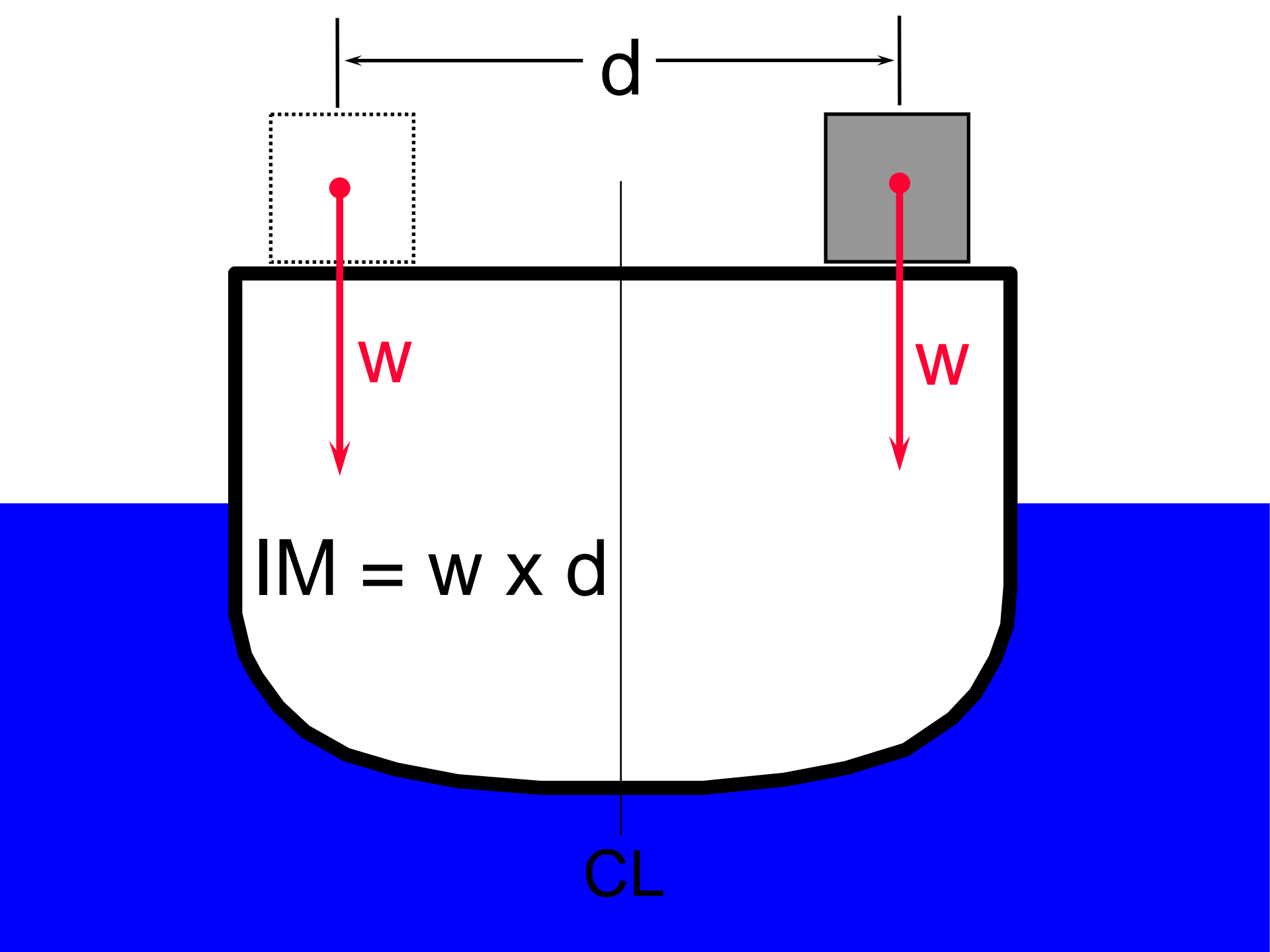
$$IM = RM$$

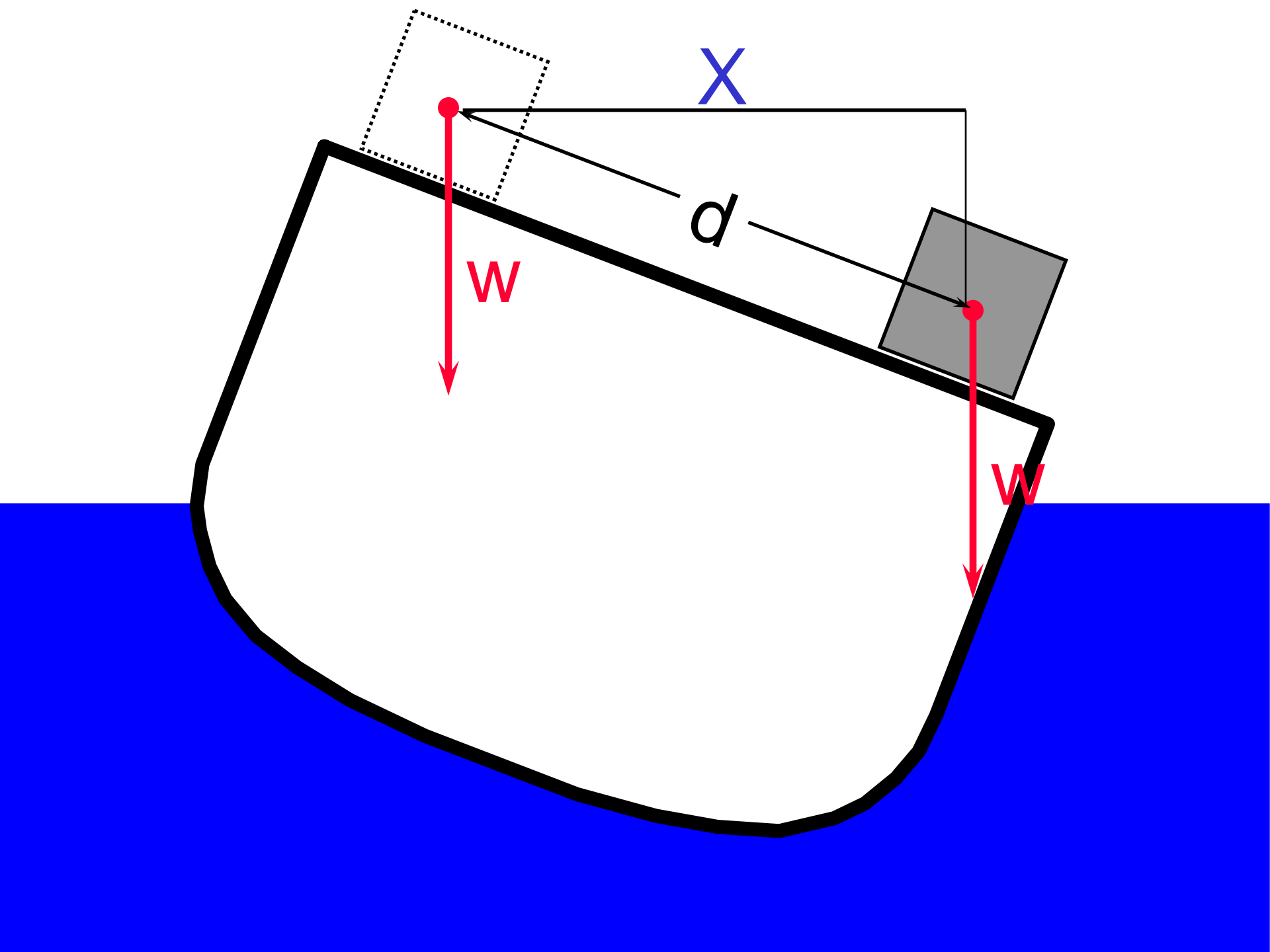
The inclining moment is a force (w)  
multiplied by some distance (d)

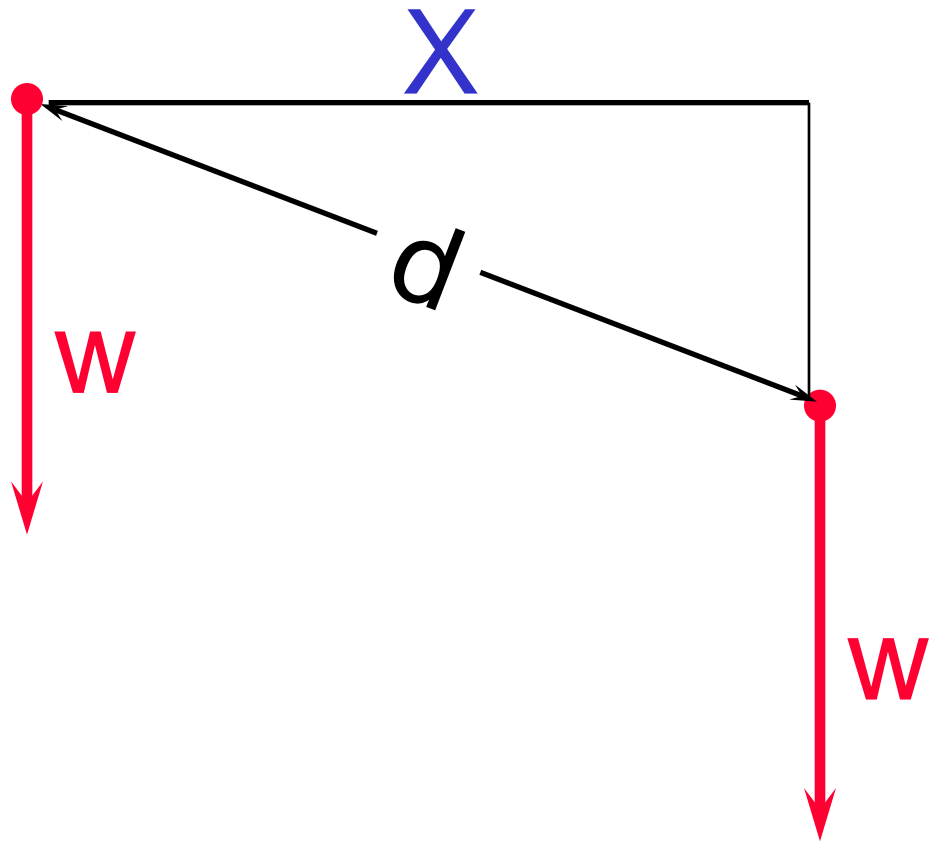
$$IM = w \times d$$

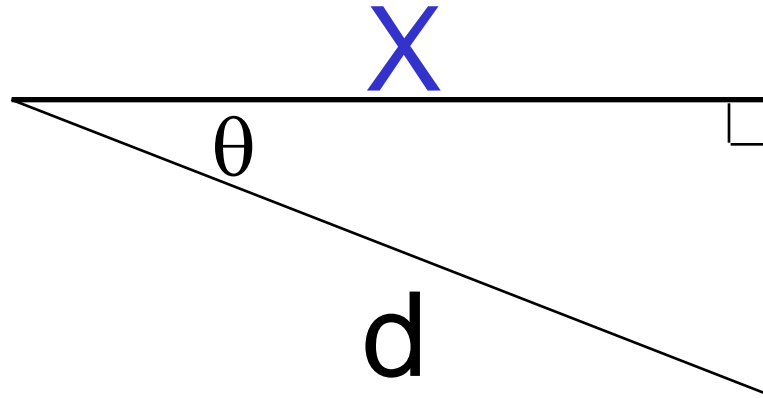












To find the distance  $X$ :

$$\cos \theta = \frac{\text{adjacent}}{\text{hypotenuse}} \text{ or } \frac{X}{d}$$

$$\text{Thus } X = d \times \cos \theta$$

$$IM = w \times d$$

$$IM = w \times d \times \cos \theta$$

$$IM = RM$$

A **Righting Moment** is the moment that a ship creates to keep itself upright. It is also equal to a weight ( $W_f$ ) multiplied by some distance (GZ)

$$RM = GZ \times W_f$$

From Lesson 4.01:  $GZ = GM \times \sin \theta$

Therefore:  $RM = GM \times W_f \times \sin \theta$



$$IM = RM$$

$$IM = w \times d \times \cos \theta$$

$$RM = GM \times W_f \times \sin \theta$$

$$w \times d \times \cos \theta = GM \times W_f \times \sin \theta$$

$$w \times d = GM \times W_f \times \tan \theta \quad (\tan 1^\circ = 0.01746)$$

$$MH1^\circ = GM \times W_f \times 0.01746$$

$$IM = RM$$

$$IM = w \times d \times \cos \theta$$

$$RM = GM \times W_f \times \sin \theta$$

$$w \times d \times \cos \theta = GM \times W_f \times \sin \theta$$

$$w \times d = GM \times W_f \times \tan \theta \quad (\tan 1^\circ = 0.01746)$$

$$MH1^\circ = GM \times W_f \times 0.01746$$

$$MH1^\circ = GM \times W_f \times 0.01746$$

$$\text{List} = \frac{w \times d}{MH1^\circ}$$

# Example Problem

7.5° list to STBD. How far must 35 *LT* be shifted to correct the list?  $KM = 20 \text{ FT}$   $KG = 16.5 \text{ FT}$   $W_o = 1900 \text{ LT}$

$$GM = KM - KG = 20 - 16.5 = 3.5 \text{ FT}$$

$$MH1^\circ = GM \cdot W_f \cdot 0.01746$$

$$MH1^\circ = 3.5 \text{ FT} \cdot 1900 \text{ LT} \cdot 0.01746$$

$$= 116.11 \text{ FT} \cdot \text{LT}$$

$$\text{LIST} = \frac{w \cdot d}{MH1^\circ}$$

$$7.5^\circ = \frac{35 \text{ LT} \cdot d}{116.11 \text{ FT} \cdot \text{LT} / ^\circ}$$

$$= 24.88 \text{ FT}$$

**to PORT**

# Class Topics

~~1. Definitions~~

~~2. Moment to Heel or List  $1^\circ$~~

~~3. Example Problems (4.8.5)~~

4. Inclining Experiment

5. Righting Ship Drill

# INCLINING EXPERIMENT

Completed upon commissioning, and following each major overhaul or shipalt.

**It is done to verify the exact location of the ship's center of gravity (KG).**

Basis for updates to Section II(a) of the DC book and for changes to weight and moment compensation status

# WHO GETS INVOLVED?

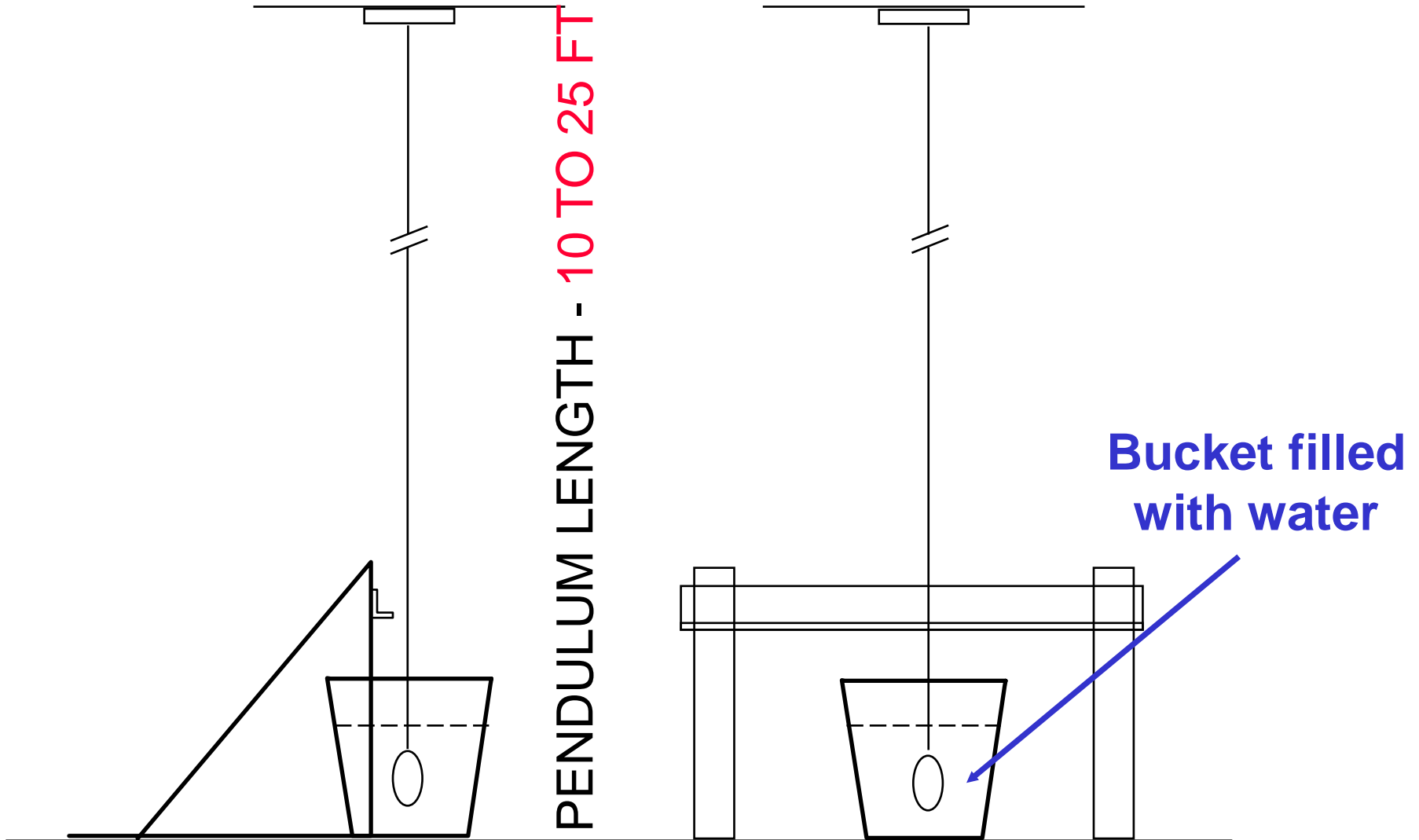
1. DCA
2. NAVSEA/HQ
3. F/O AND WATER KING
4. YARD NAVAL ARCHITECT
5. SUPSHIP/NESU
6. RIGGERS
7. CHENG
8. EVERYONE ELSE IS OFF SHIP

# PROCEDURE

1. REMOVE ALL “abnormal” OBJECTS
2. RECORD ALL TANKS (Empty/Full)
3. VERIFY LOAD-OUTS
4. PLACE WEIGHTS ON CL
5. MEASURE FREEBOARD
6. TAKE PHOTO OF DRAFTS
7. TAKE H<sub>2</sub>O SAMPLE
8. RIG PENDULUMS (3 MIN)
9. MOVE WTS OFF-CL EXACT DIST
10. RECORD INCLINATION



# Minimum of 3 Pendulums



# INACCURACIES

1. UNACCOUNTED FOR FSE
2. MOVEMENT OF PERSONNEL
3. INACCURATE WEIGHTS
4. TAUGHT LINES / ENVIRONMENT
5. POOR WEIGHT VERIFICATION  
WALK THROUGH

# Class Topics

~~1. Definitions~~

~~2. Moment to Heel or List  $1^\circ$~~

~~3. Example Problems~~

~~4. Inclining Experiment~~

5. Righting Ship Drill

# MOB-D-6-SF Righting Ship

**Conducted:** Every 18 Months (SEMI annual for CG)

**Purpose:** To train the **damage control organization** in correcting a list.

**Requirements:** Condition 1 and zebra set. Liquid loading may be varied to put an actual list or trim on the ship if desired.

**Drill Conditions:** One or more compartments have been flooded or are open to the sea. Flooding boundaries are established; flooding is under control. Emergency patching, plugging, or shoring have been completed. Correction of the ship's list has been ordered.

**Evaluation:** As per FXP-4

# Summary

- List equation and  $MH1^\circ$  are two *VERY VALUABLE* Equations
  - We can determine amount to correct list
  - We can work backwards to find KG (inclining experiment)
- MOB-D-6-SF evaluates DCA in correcting a **LIST** and watchstanders in “Knowing their ship”

# Quiz...

- Inclining experiment is conducted to determine what value?
- **KG** = “The exact location of G.”
- What is the point where an **INCLINING MOMENT (IM)** is equal to the **RIGHTING MOMENT (RM)**?
- The angle of **LIST!**

# Homework #4

## Practice problems thru #13

Continue to Read Student Guide.... *Start  
Quizing **YOURSELF** for exam!*

*Remember: 50% Theory 50% Calculations*