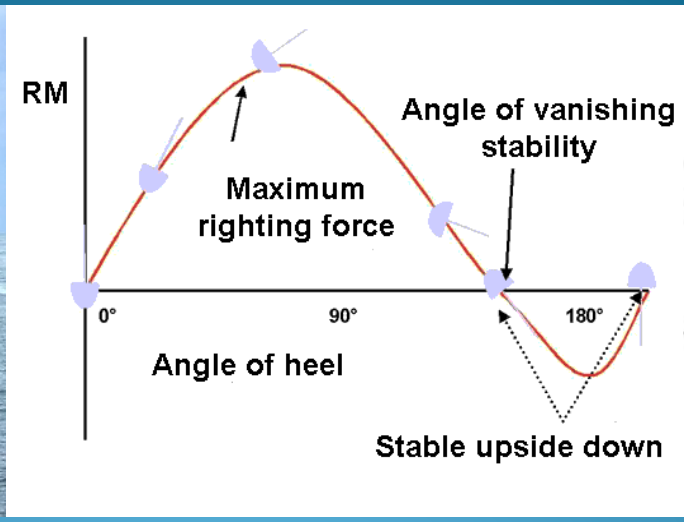
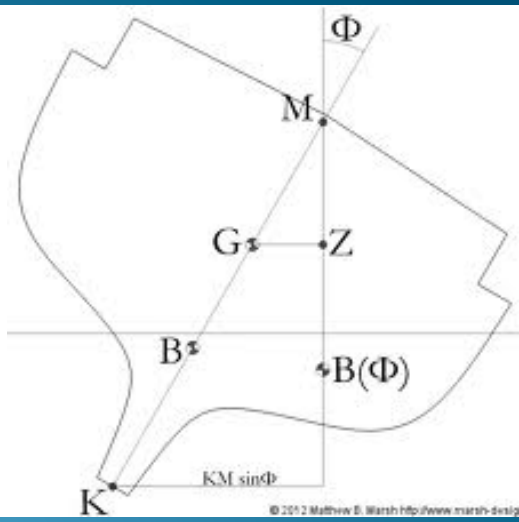
What's the link?

Vessel Stability

What is it and why is it so important?





Objectives

We Are Learning To…

- Identify key principles in vessel stability theory
- Combine key principles to understand theory of stability
- Explain the difference between form and weight stability
- Relate stability theory to practical examples
- Demonstrate the ability to explain vessel stability

Outcomes

You Should Leave This Session…

- With an ability to relate stability to practical applications and a working knowledge of how it impacts leisure boat users
- With ideas on how to teach and explain stability to students and how teaching aids can help

Importance of Stability


REALWORLDSURVIVOR

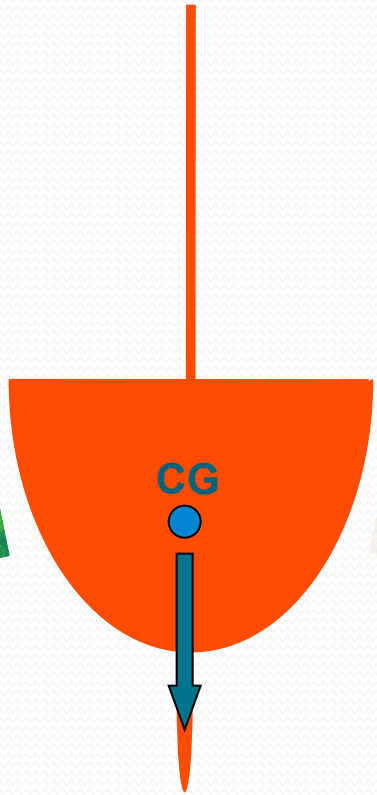
Stability: Who's responsibility is it?

Obviously designers and surveyors play an important part but once they've done their bit it's over to you!...

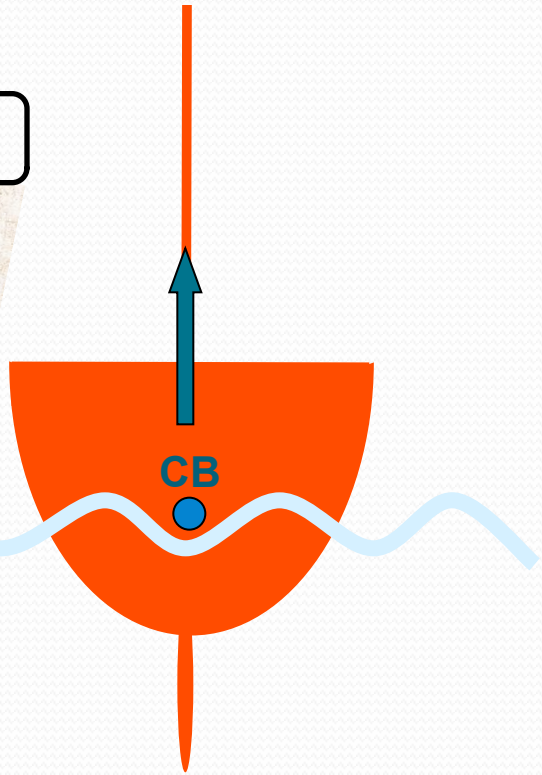
...So how do we keep the balance?

Principles of Stability

Centre of Gravity (CoG)



Centre of Buoyancy (CoB)



Objective: Identify key principles in stability theory

Form (Design) Stability

Characteristics:

- Wide shallow hulls
- High (but not excessive freeboard)
- High beam to length ratio

Objective: Explain the difference between form and weight stability

Ultimate (Weight) Stability

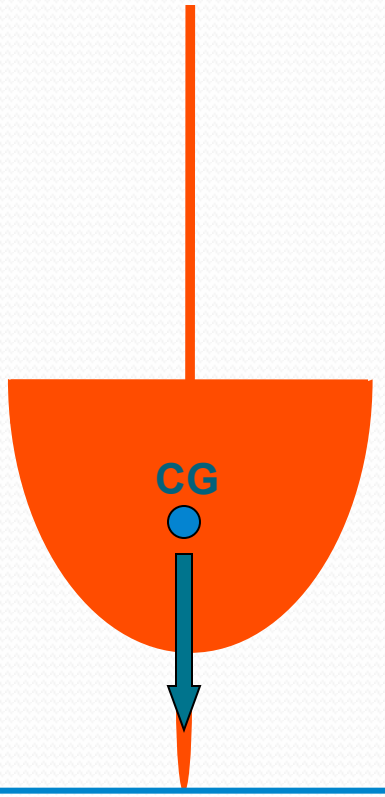
Characteristics:

- Narrow deep hulls
- Low CoG
- Low beam to length ratio
- Large underwater profile

Objective: Explain the difference between form and weight stability

CG - Centre of Gravity

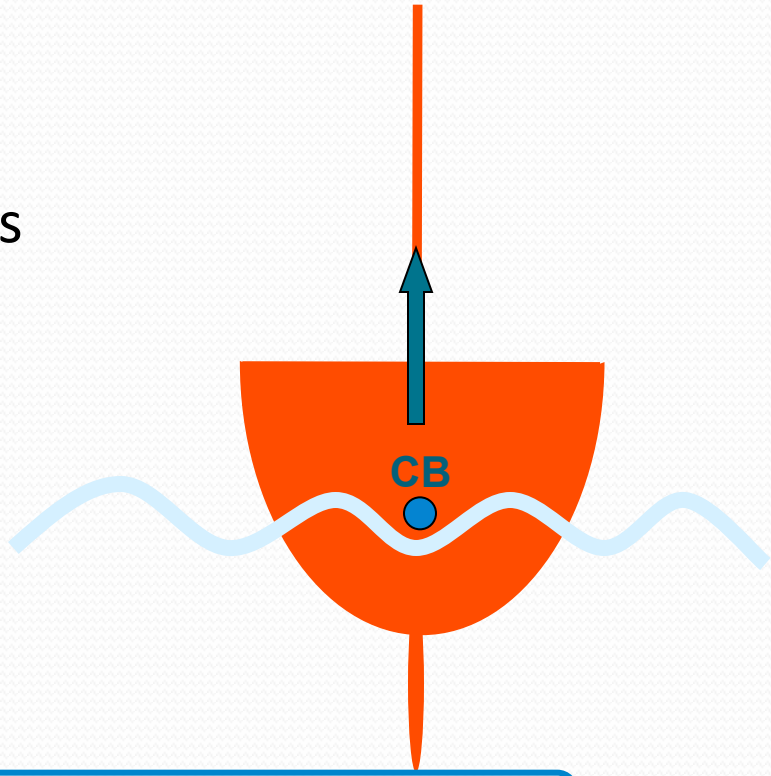
- Determined by structure and weight distribution of boat
- Best when it is low down



Objective: Identify key principles in stability theory

CB - Centre Of Buoyancy

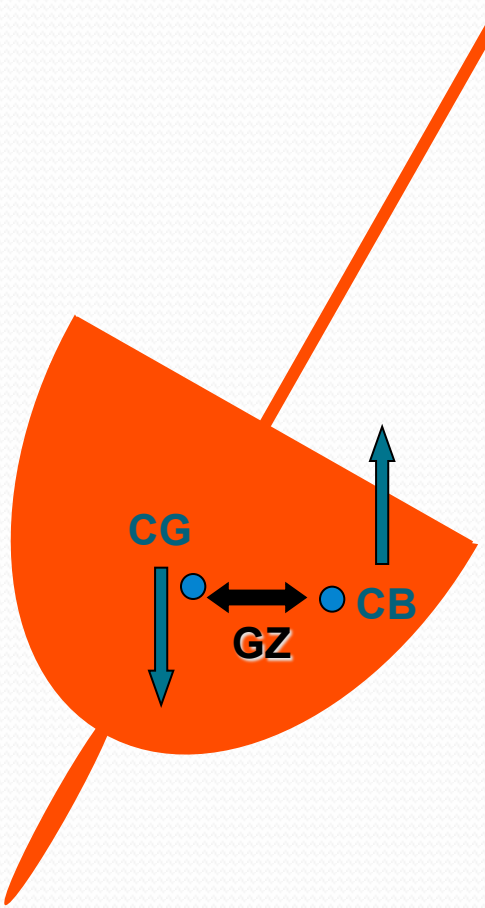
- Force generated by boat displacing water
- CB is point of concentration of this force
- Changes with HEEL ANGLE, TRIM and LOADING



Objective: Identify key principles in stability theory

GZ - The Righting Lever

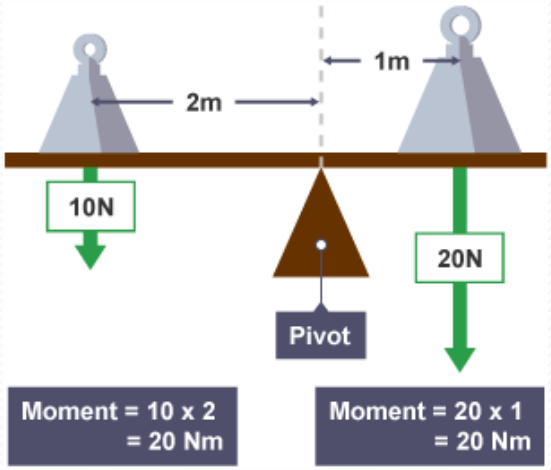
Force that combination of CG and CB make, to return boat to the upright.

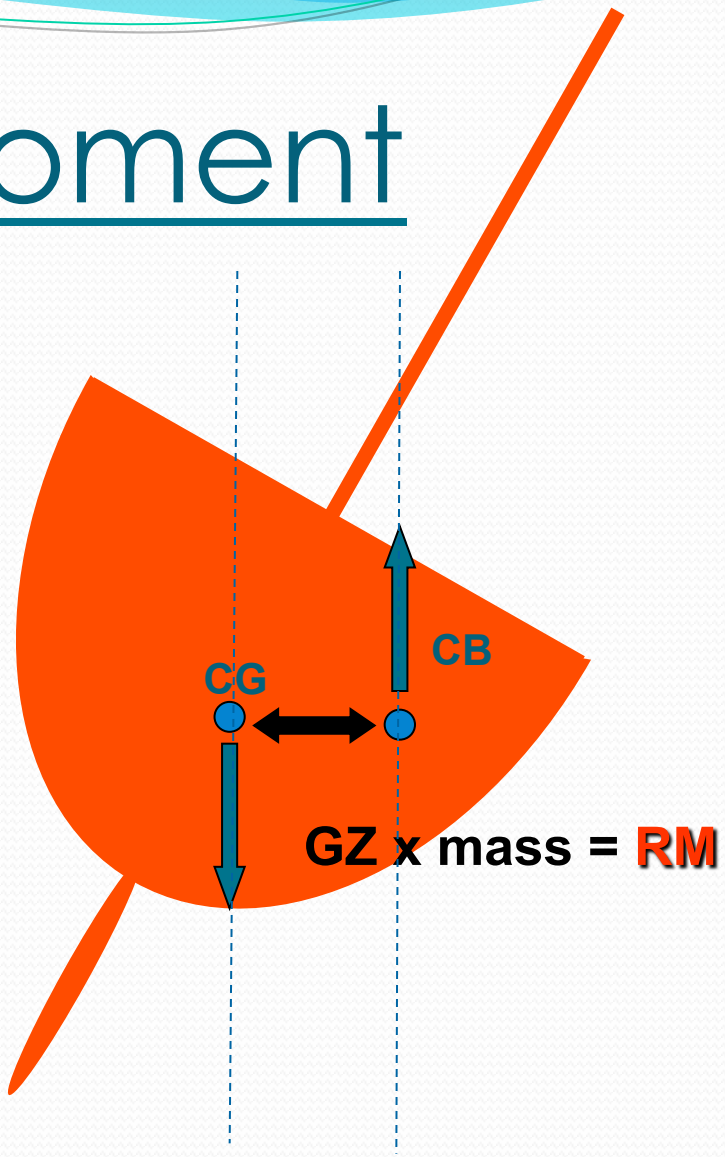


Objective: Combine key principles to understand theory of stability

RM - Righting Moment

- Mass of a vessel affects stability
- When multiplied with GZ it gives RM

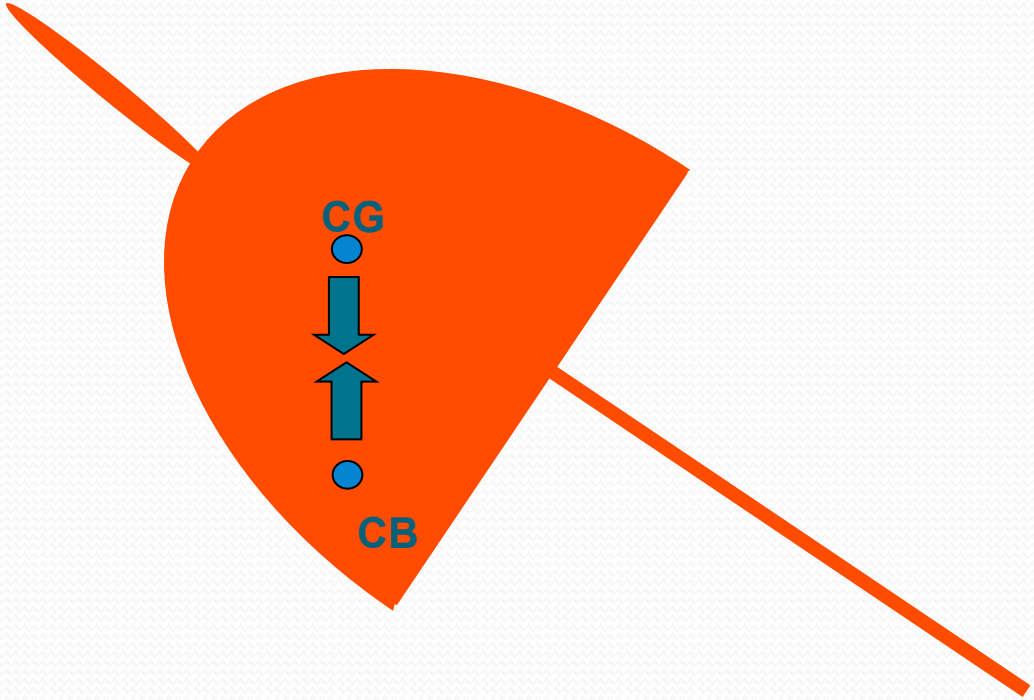




Objective: Combine key principles to understand theory of stability

AVS - ANGLE OF VANISHING STABILITY

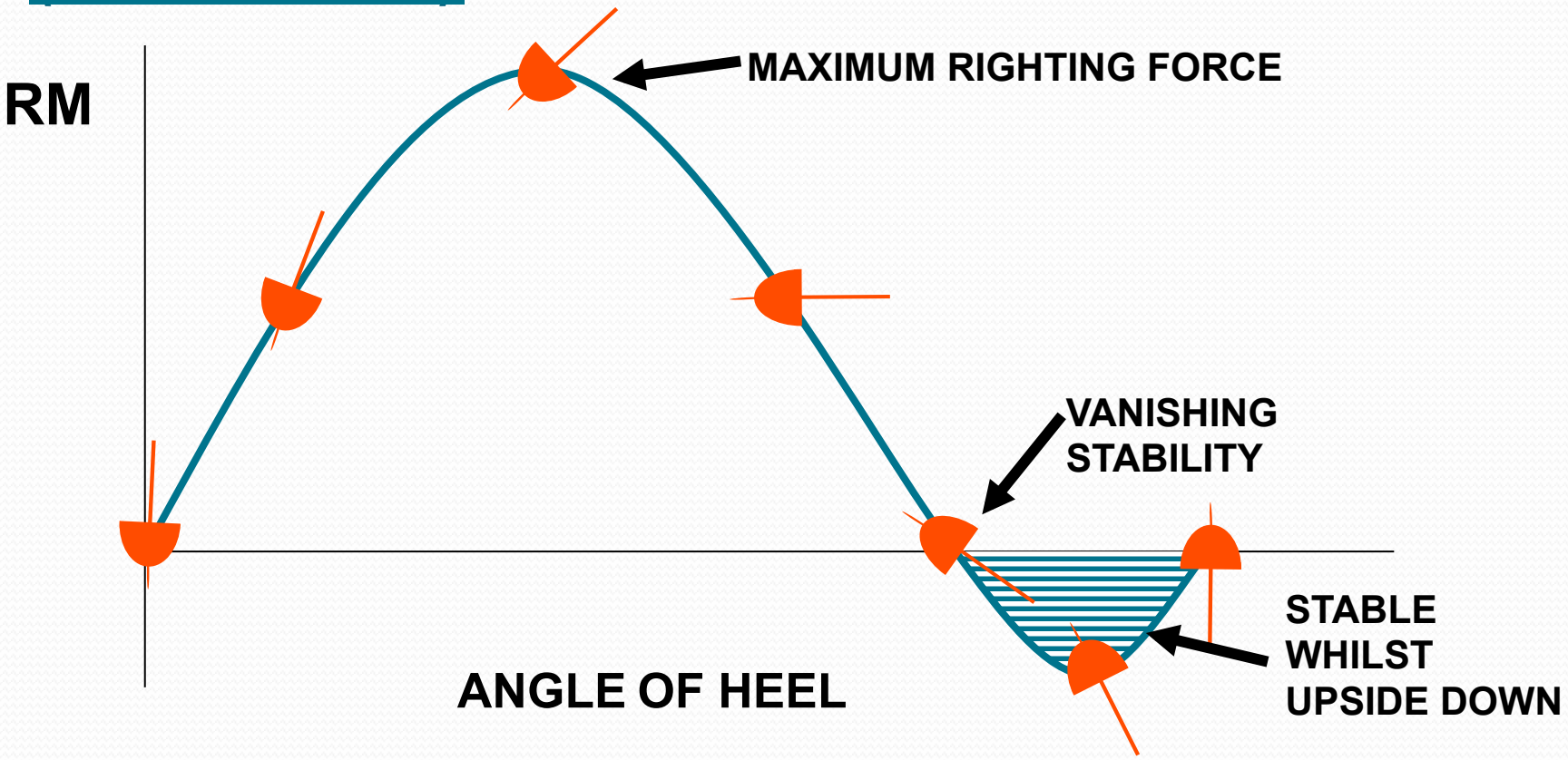
- RM is ZERO
- BOAT INVERTS BEYOND THIS POINT



Objective: Combine key principles to understand theory of stability

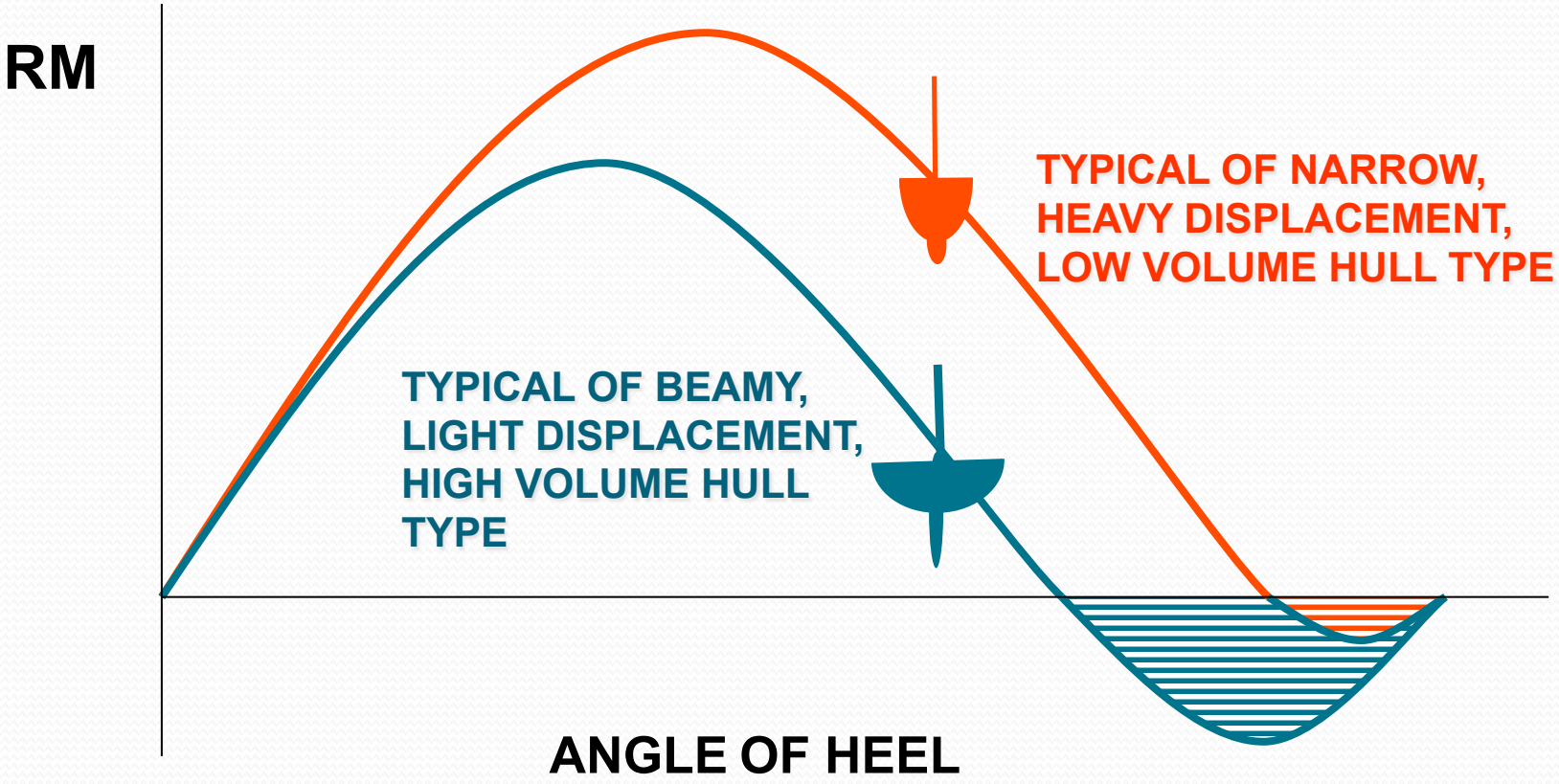
RIGHTING MOMENT CURVE

(Flat Water)



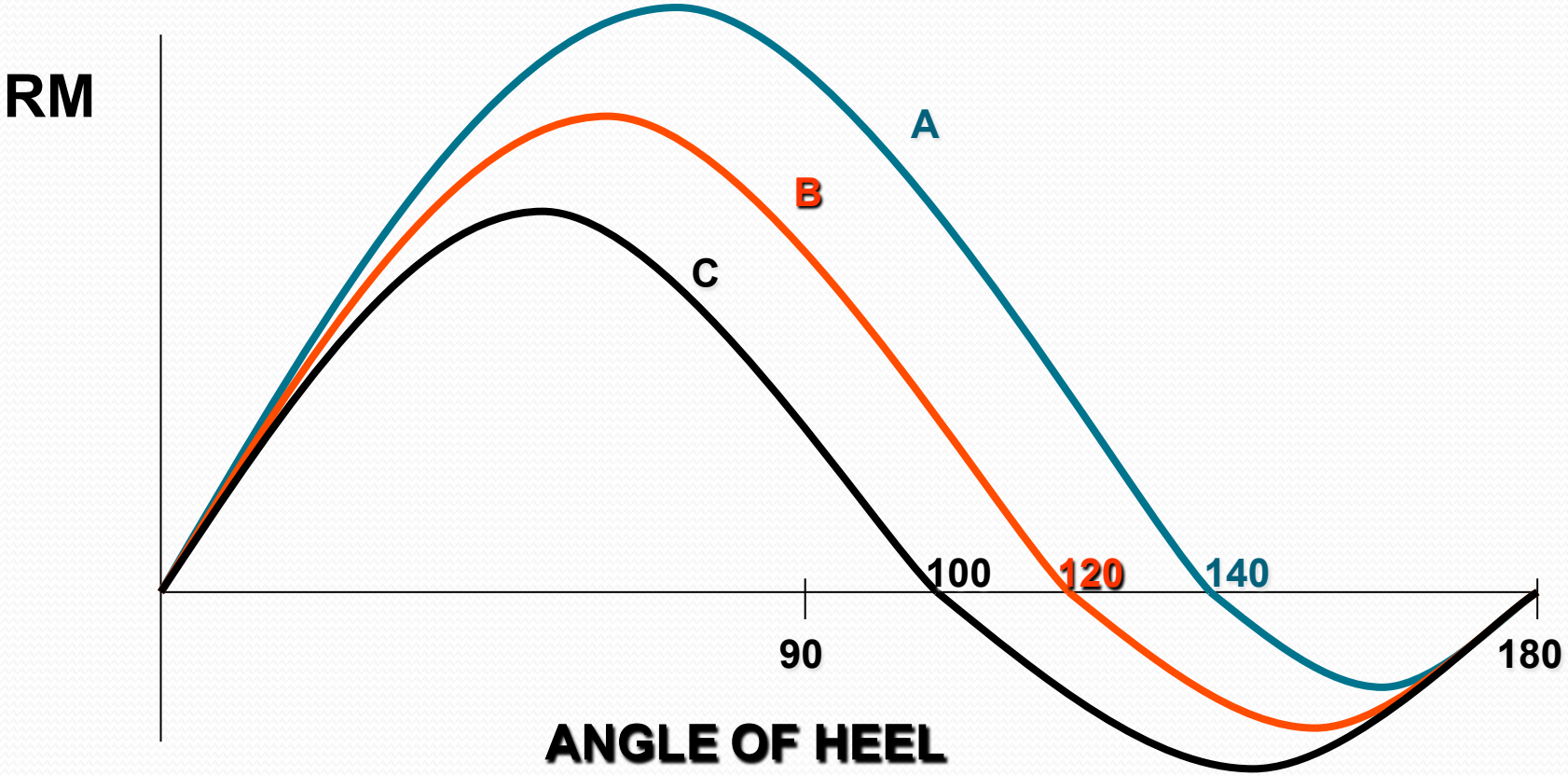
Objective: Combine key principles to understand theory of stability

DIFFERENT TYPES OF CURVE



Objective: Relate stability theory to practical examples

CATEGORIES



The GZ curve

Transverse stability relations:

$\overline{BM} = \frac{I_T}{\nabla}$ (Fundamental stability formula) [1.722 m]

$\overline{GM} = \overline{BM} - \overline{BG}$ (G above B) [1.452 m]

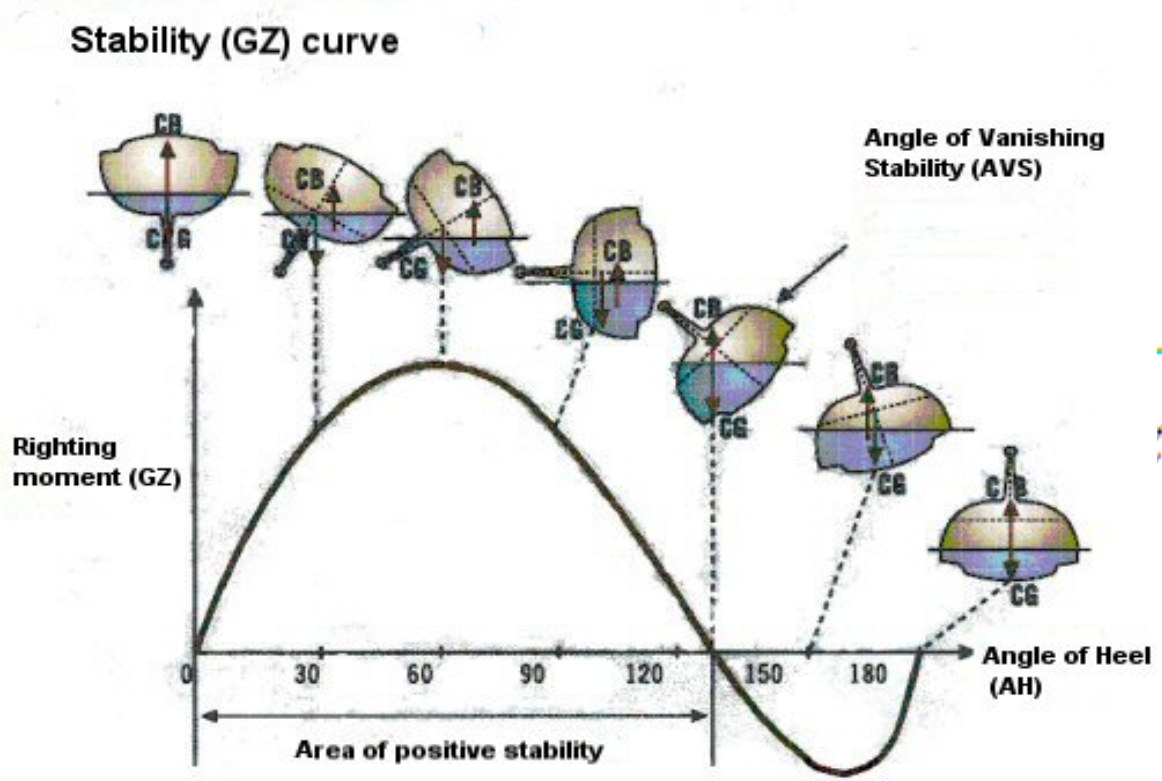
$\overline{GZ} = \overline{GM} \cdot \sin\phi$ (ϕ = heel angle)

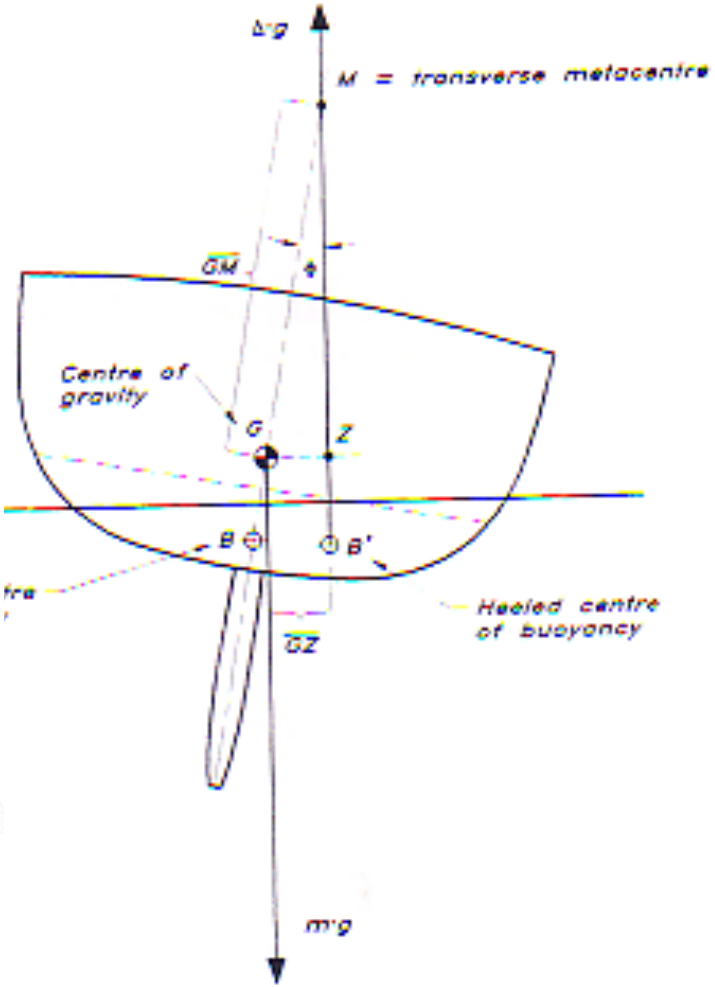
[$\overline{BG}$ = 0.27 m]

[∇ = 7.9 m^3]

Transverse righting moment: [Nm]

$\overline{RM} = m \cdot g \cdot \overline{GZ}$





TASK:

- Split yourself into groups of 5 or 6.

  1. Discuss what factors you feel may cause a vessel to capsize and write them on the pink post-its.

  2. Now discuss what factors help improve vessel stability and write them on the green post-its.

- Extension: What guidance would you give to skippers in rough weather in relation to vessel stability?

Objective: Relate stability theory to practical examples

Factors that can cause capsize

- SWAMPING OR FLOODING
- FREE- SURFACE EFFECT
- LARGE BREAKING WAVES
- CG MOVED UPWARDS
- RESONANT ROLLING
- BROACHING

Objective: Relate stability theory to practical examples

FACTORS WHICH CAN IMPROVE STABILITY

- INCREASED LENGTH
- HEAVY DISPLACEMENT FOR SIZE
- HIGH PROPORTION OF OVERALL WEIGHT AS BALLAST
- HIGH ANGLE OF VANISHING STABILITY
- HIGH RE-RIGHTING FACTOR
- GOOD RM AT 90° OF HEEL
- MODEST BEAM IN RELATION TO LENGTH

Objective: Relate stability theory to practical examples

FACTORS WHICH CAN IMPROVE STABILITY

- GOOD BUT NOT EXCESSIVE FREEBOARD
- MINIMAL TOPSIDE FLARE
- ABSENCE OF LARGE NEARLY FLAT AREAS OF DECK
- LARGE ANGLE OF HEEL BEFORE FLOODING CAN OCCUR
- INCREASED KEEL PROFILE AREA
- ABSENCE OF BULWARKS

Objective: Relate stability theory to practical examples

IN ROUGH WEATHER DO

- CLOSE HATCHES, WASH BOARDS ETC.
- PUMP OUT BILGE REGULARLY
- WATCH OUT FOR GUSTY CONDITIONS
- AVOID BEING CAUGHT BEAM ON TO LARGE, BREAKING WAVES
- BE AWARE OF CATEGORY AND CAPABILITY OF YOUR BOAT

Objective: Relate stability theory to practical examples

IN ROUGH WEATHER DO NOT

- SAIL IN CONDITIONS THAT ARE OUTSIDE THE CAPABILITY AND CATEGORY FOR WHICH YOUR BOAT WAS DESIGNED
- DELIBERATELY SAIL THROUGH KNOWN TIDAL RIPS, RACES, OVERFALLS OR WHERE THE BOTTOM SHOALS RAPIDLY

Objective: Relate stability theory to practical examples

TASK:

- In your groups, using the materials supplied as inspiration discuss how you could produce teaching aids to help explain stability to Day Skipper students. Nominate a spokesperson from your group to give a brief (30 seconds to 1 minute) summary of your inventions!

Objective: Demonstrate the ability to explain vessel stability

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QUESTIONS?

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