

Assignment 2

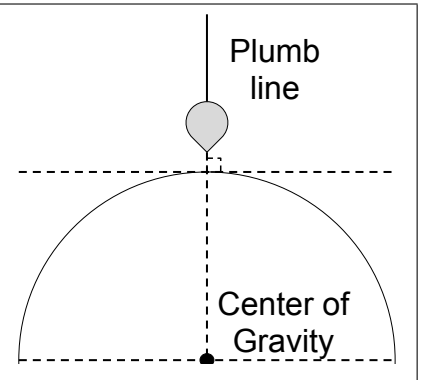
Due Date: 5:00p.m., April 27, 2012 (Friday)

Please answer the following questions within the word limit stated in the **square bracket**.

1 Surveying in India (25 marks)

In the old days when India was surveyed, the measurements were reportedly slightly inaccurate especially in the Northern part of India. The inaccuracy is due to the alignment of the plumb lines are not exactly along the vertical, an error of several arc seconds has been found.

A plumb line is a vertical reference line that is formed when you suspend a plumb bob (A weight with a pointed tip on the bottom) with a string. If the Earth is a perfect solid sphere, the plumb line is pointed directly into the geocenter of Earth which defines a normal to the Earth surface. People used hanging plumb bobs to determine the vertical lines in the past. However, the fact is that the Earth is **not** a perfect solid sphere and there are different landscape features within a place.



What do you think a possible direction that a hanging plumb bob will be slightly deflected to when we place it in the Northern part of India. Could you suggest a possible reason and explain briefly. (Hints: You may consider the landscape configurations around India and ignore the Earth rotation) [80 words]

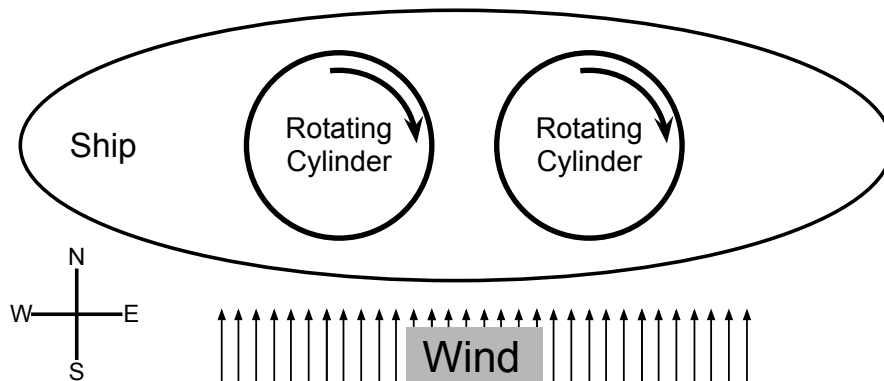
2 A Buoyancy problem (25 marks)

In the following video, a small fish-shaped bottle (small bottle) is attached to a hook and filled with water such that it is just submerged in the water. The tail of the small bottle is above the water surface while the inner part is below the water surface. The small bottle is placed in a larger plastic bottle (large bottle) filled with water with solid objects that can be hooked. Initially, the small bottle stayed at the water surface. When the large bottle is squeezed, the small bottle sank to the bottom and stayed at the bottom. With shaking, the small objects will be hooked. When you stop squeezing it, the small bottle with a hooked small object rises to the water surface again. Can you explain this phenomenon briefly? [80 words]

<http://www.youtube.com/watch?v=VCWzS20spA0>

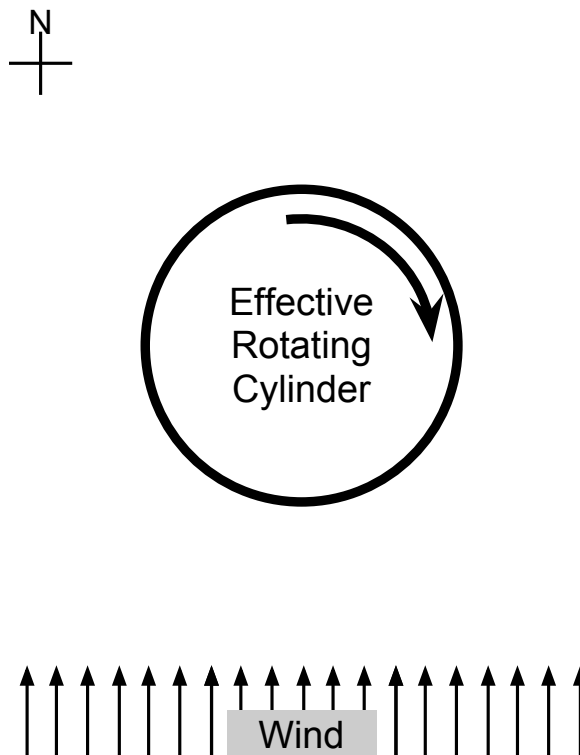
3 Flettner ship (45 marks)

The flettner ship or a rotor ship is a kind of ship that is designed to move without any marine propelling engine. It contains giant vertical cylinders that can be rotated by motors. The number of cylinders can be more than one and they share the same basic principle. The fluid dynamics between the rotating cylinders is not the scope of this problem. For simplicity, you can consider an effective rotating cylinder (which combines the two cylinders as a single cylinder). In the following video, a model of a flettner ship is demonstrated. The diagram shows the schematic diagram of the ship. http://www.youtube.com/watch?v=__8-QSXgupA



(a) Could you briefly describe the relationship between the motion of the ship and the wind direction in the video? [50 words]

(b) Can you explain how this kind of ships work using your knowledge about Magnus Effect? The diagram below shows the effective rotating cylinder. You may draw the streamlines in the diagram to explain. [130 words]



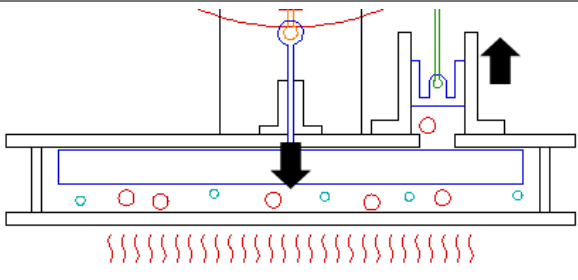
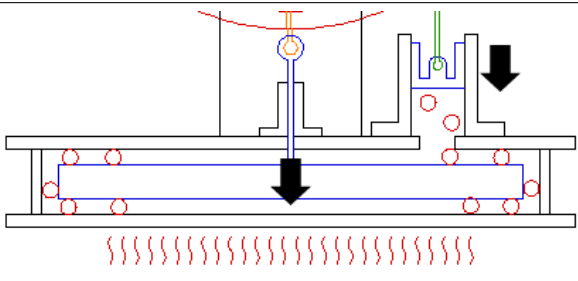
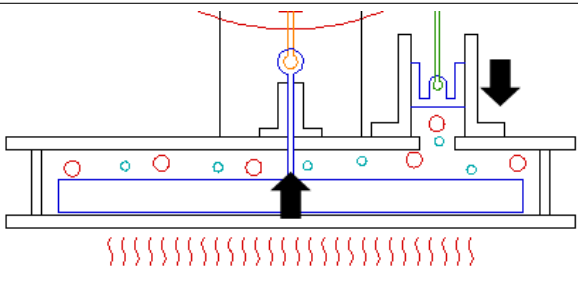
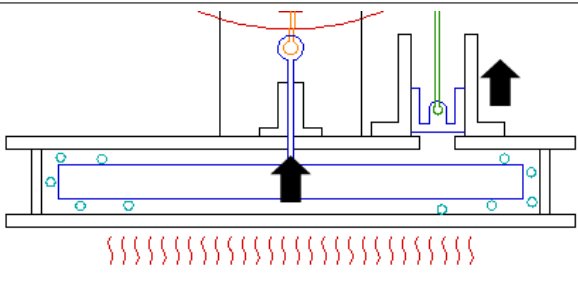
4 Stirling Engine (45 marks)

In this video, this machine is put on a wifi router. With a slight push, the wheel continue to move for a long time without stopping. Is this a perpetual machine? If this is not, where is the energy source? [10 words]. <http://www.youtube.com/watch?v=duNNtU2uyi4>

This machine consists of a flywheel, a chamber, a piston and a displacer.

- The flywheel is **heavy** which contains rotational momentum and driving the displacer.
- The chamber is air-tight which provides a closed system for expansion of gas.
- The piston is **light** and touch the wall of the chamber, it drives the flywheel.
- The displacer is **light** and does not touch the wall of the chamber, it pushes gas from bottom to top or from top to bottom.

The table below shows a series of diagrams about the stages that how this machine performed, the **arrow** shows the next motion of the piston and displacer, the **big red circle** indicates hot air while the **small blue circle** indicates cold air. Can you briefly describe the physics in each stages? [30 words each]

1		[30 words]
2		[30 words]
3		[30 words]
4		[30 words]

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