A2-2008 Q3

Would you expect the centre of mass and the centre of gravity of the Empire State Building (a tall skyscraper) to coincide precisely? Explain.

(2 marks)

A2-2010 Q1(a)

A long rowing boat, shown in Fig.1, has to be weighed using only a single bathroom scales. The boat will sag if it is supported only in the middle, and so the scales must be put first at position A with a wooden support at B, and then at position B with the wooden support at A. The readings on the scales are 45 kg and 52 kg respectively. What is the mass of the boat?

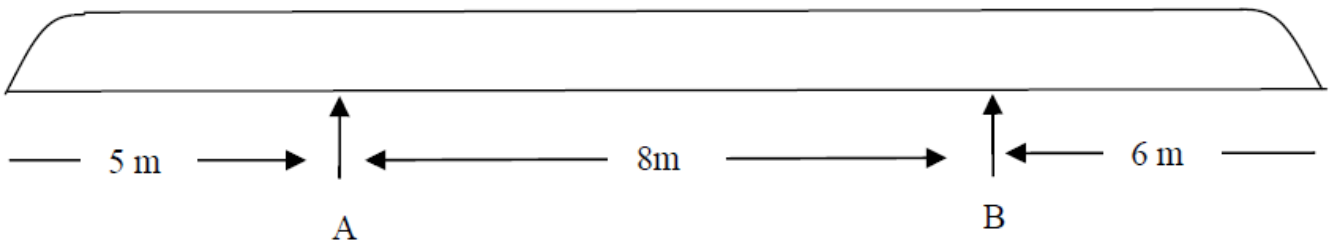

Fig. 1

(2 marks)

A2-2010 Q1(g)

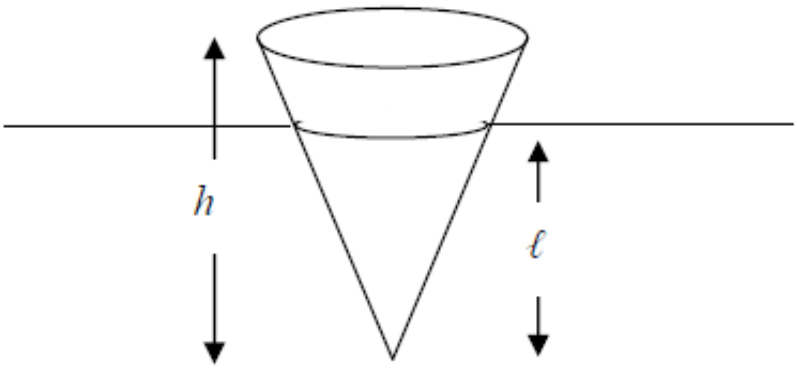

Fig. 3

i) Explain what force keeps the cone from sinking.

ii) Sketch a diagram of the forces acting on the cone.

iii) The radius of the circular cross section of the cone at the top of the diagram is R and the radius at the level of the liquid is r. Write down the relation between R, r, h and ℓ.

iv) From the forces acting on the cone in its equilibrium position, show that

$$\frac{\rho_c}{\rho_w} = \left(\frac{\ell}{h}\right)^3$$

The volume of a cone of height h and radius of base, r, is $\frac{1}{3}\pi r^2 h$

(6 marks)

A2-2012 Q5

There are several factors which determine the maximum height of a mountain. Everest at only 8 km is not very high in terms of the maximum height that can be attained given the strength of the rock. All mountains on Earth suffer from erosion which reduces their height significantly. The maximum height is limited by the rock flowing under the enormous weight above it, which is related to the Young's Modulus value for the rock, E. We can suggest that an equation for the maximum height of a mountain would depend upon the density of the rock, ρ, Young's Modulus, E, and the strength of Earth's gravity, g. An insight into the solution of a problem can often be made by looking at the dimensions of the relevant physical quantities.

a) E is a measure of how much the rock deforms when a load is applied to it. E has units of $N\ m^{-2}$. Write down the units of E, ρ and g in terms of meters, kilograms and seconds (m, kg, s).

b) If the height of the mountain is given by the formula h = constant x E x ρ^{α} x g^{β}, by comparing the units on the left and right hand sides of the equation (the constant has no units), determine the values of α and β and write down the equation for h.

c) If the value of E for rock is 10^{10} Pa, the density of rock is 3×10^{3} kg m^{-3} and the value of the constant is 1, estimate to one significant figure the height of a mountain that will be given by the formula. (Such a mountain is to be found on Mars).

(9 marks)