HYDROSTATICS

IFoS PYQs

[SOURCE: HYDROSTATICS BOOK BY KRISHNA SERIES]

1. 8c 2020

A sphere of radius 'a', and having density half of that of water, is completely immersed at the bottom of a circular cylinder of radius 'b', which is filled with water to depth 'd'. The sphere is set free and takes up its position of equilibrium. Show that the loss of potential energy this way is

$$W\left(d - \frac{11}{8}a - \frac{a^3}{3b^2}\right),$$

where W is the weight of the sphere. *15*

2. 7b 2019

(b) A vessel is in the shape of a hollow hemisphere surmounted by a cone held with the axis vertical and vertex uppermost. If it is filled with a liquid so as to submerge half the axis of the cone in the liquid and height of the cone be double the radius (*r*) of its base, find the resultant downward thrust of the liquid on the vessel in terms of the radius of the hemisphere and density (ρ) of the liquid. 15

3. 5d 2018

(d) From a semi-circle whose diameter is in the surface of a liquid, a circle is cut out, whose diameter is the vertical radius of the semi-circle. Find the depth of the centre of pressure of the remainder part. *8*

4. 8a 2018

(a) A solid hemisphere floating in a liquid is completely immersed with a point of the rim joined to a fixed point by means of a string. Find the inclination of the base to the vertical and tension of the string. *15*

5. 7c 2017

(c) A semi-ellipse bounded by its minor axis is just immersed in a liquid, the density of which varies as the depth. If the minor axis lies on the surface, then find the eccentricity in order that the focus may be the centre of pressure. *10*

6. 6c 2016

(c) Water is flowing through a pipe of 80 mm diameter under a gauge pressure of 60 kPa, with a mean velocity of 2 m/s. Find the total head, if the pipe is 7 m above the datum line. *10*

7. 8a 2016

(a) A body immersed in a liquid is balanced by a weight P to which it is attached by a thread passing over a fixed pulley and when half immersed, is balanced in the same manner by weight 2P. Prove that the density of the body and the liquid are in the ratio 3 : 2. *10*

8. 5d 2015

(d) A cylindrical vessel on a horizontal circular base of radius a is filled with a liquid of density w with a height h. If a sphere of radius c and density greater than w is suspended by a thread so that it is completely immersed, determine the increase of the whole pressure on the curved surface. 8

9. 8a 2015

8. *(a)* An ellipse is just immersed in water with its major axis vertical. If the centre of pressure coincides with the focus, determine the eccentricity of the ellipse. 15

10. 5d 2014

5(d) A hollow weightless hemisphere filled with liquid is suspended from a point on the rim of its base. Show that the ratio of the thrust on the plane base to the weight of the contained liquid is $12:\sqrt{73}$. 8

11. 8b 2014

8(b) A body floating in water has volumes V_1, V_2 and V_3 above the surface when the densities of the surrounding air are ρ_1, ρ_2, ρ_3 respectively. Prove that :

$$\frac{\rho_2-\rho_3}{V_1}+\frac{\rho_3-\rho_1}{V_2}+\frac{\rho_1-\rho_2}{V_3}=0.$$ 10

12. 5d 2013

5(d) A triangular lamina ABC of density ρ floats in a liquid of density σ with its plane vertical, the angle B being in the surface of the liquid, and the angle A not immersed. Find ρ/σ in terms of the lengths of the sides of the triangle. 8

13. 7b 2013

7(b) A body floating in water has volumes v_1, v_2 and v_3 above the surface, when the densities of the surrounding air are respectively ρ_1, ρ_2, ρ_3. Find the value of :

$$\frac{\rho_2-\rho_3}{v_1}+\frac{\rho_3-\rho_1}{v_2}+\frac{\rho_1-\rho_2}{v_3}.$$ 13

14. 5d 2012

(d) A triangle ABC is immersed in a liquid with the vertex C in the surface and the sides AC, BC equally inclined to the surface. Show that the vertical C divides the triangle into two others, the fluid pressures on which are as $b^3+3ab^2 : a^3+3a^2b$ where a and b are the sides BC & AC respectively. 8

15. 7c 2012

(c) A semicircular area of radius a is immersed vertically with its diameter horizontal at a depth b. If the circumference be below the centre, prove that the depth of centre of pressure is

$$\frac{1}{4}\frac{3\pi\left(a^2+4b^2\right)+32ab}{4a+3\pi b}.$$ 13.

16. 8c 2011

(c) A stream is rushing from a boiler through a conical pipe, the diameter of the ends of which are D and d; if V and v be the corresponding velocities of the stream and if the motion is supposed to be that of the divergence from the vertex of cone, prove that

$$\frac{v}{V} = \frac{D^2}{d^2} e^{\left(v^2 - V^2\right)/2K}$$

where K is the pressure divided by the density and supposed constant. *13*

17. 5e 2010

(e) Prove that the horizontal line through the centre of pressure of a rectangle immersed in a liquid with one side in the surface, divides the rectangle in two parts, the fluid pressure on which, are in the ratio, 4 : 5. *8*