

- 2 (a) State what is meant by the centre of gravity of an object.

[1]

- (b) A hollow plastic sphere is attached at one end of a bar. The sphere is partially submerged in water and the bar is attached to a fixed vertical support by a pivot P, as shown in Fig. 2.1.

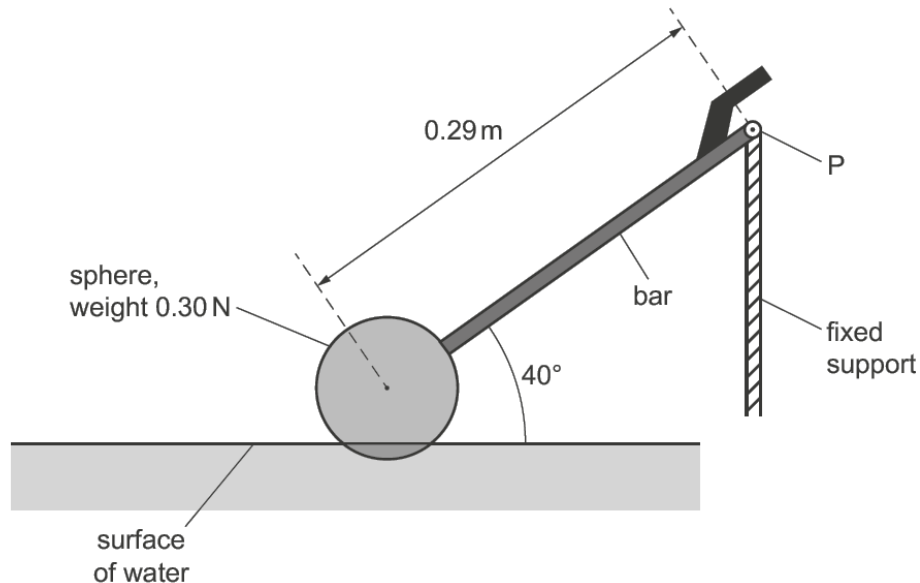


Fig. 2.1 (not to scale)

The sphere has weight 0.30 N. The distance from P to the centre of gravity of the sphere is 0.29 m. The weight of the bar is negligible.

The system shown in Fig. 2.1 is part of a mechanism that controls the amount of water in a tank. Water enters the tank and causes the sphere to rise. This results in the bar becoming horizontal as shown in Fig. 2.2.

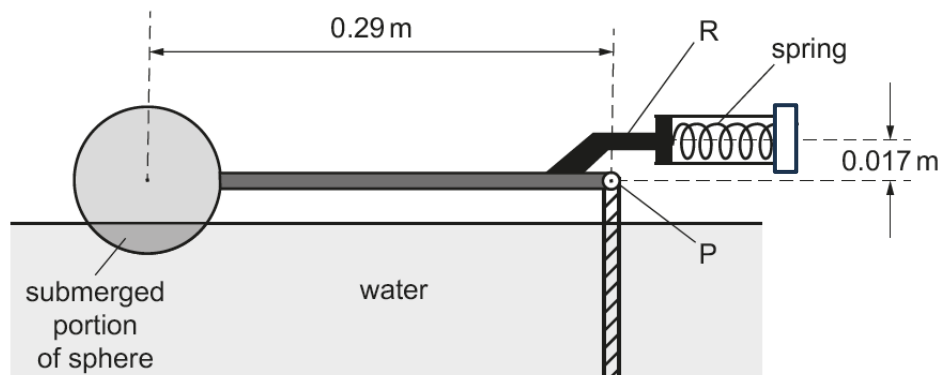


Fig. 2.2 (not to scale)

At the position shown in Fig. 2.2, the system is stationary and in equilibrium. The rod R exerts a force to compress a horizontal spring that controls the water supply to the tank. The spring has a spring constant of 2100 N m^{-1} . R is positioned at a perpendicular distance of 0.017 m above P.

- (i) The radius of the sphere is 0.0480 m and 26.0% of the volume of the sphere is submerged.

The density of water is $1.00 \times 10^3 \text{ kg m}^{-3}$.

Show that the upthrust on the sphere is 1.18 N.

[2]

- (ii) For the position shown in Fig. 2.2, by taking moments about P, determine the force exerted on the spring by the rod R.

force = N [2]

- (iii) Calculate the elastic potential energy E_P of the compressed spring.

E_P = J [2]

- (c) When the sphere moves from the position shown in Fig. 2.1 to the position shown in Fig. 2.2, the upthrust on the sphere does work. Assume that resistive forces are negligible.

Explain why the work done by the upthrust is not equal to the gain in elastic potential energy of the spring.

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