2 A sphere is attached by a metal wire to the horizontal surface at the bottom of a river, as shown in Fig. 2.1.

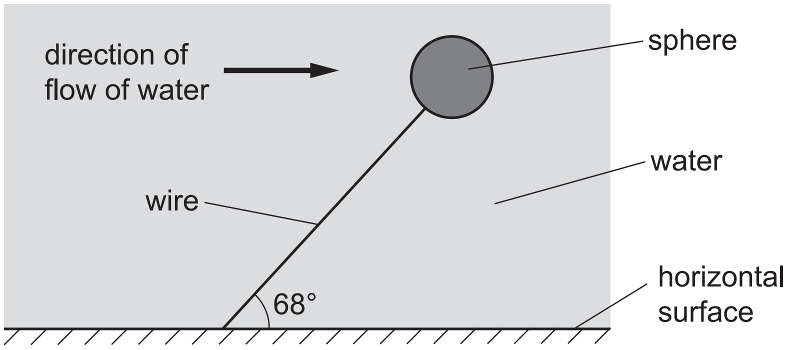

Fig. 2.1 (not to scale)

The sphere is fully submerged and in equilibrium, with the wire at an angle of 68° to the horizontal surface. The weight of the sphere is 32 N. The upthrust acting on the sphere is 280 N. The density of the water is $1.0 \times 10^3\,\text{kg}\,\text{m}^{-3}$.

Assume that the force on the sphere due to the water flow is in a horizontal direction.

(a) By considering the components of force in the vertical direction, determine the tension in the wire.

tension = ... N [2]

(b) For the sphere, calculate:

(i) the volume

volume = ... m^3 [1]

(ii) the density.

density = ... $\text{kg}\,\text{m}^{-3}$ [2]

(c) The centre of the sphere is initially at a height of 6.2 m above the horizontal surface. The speed of the water then increases, causing the sphere to move to a different position. This movement of the sphere causes its gravitational potential energy to decrease by 77 J.

Calculate the final height of the centre of the sphere above the horizontal surface.

height = ... m [3]

(d) The extension of the wire increases when the sphere changes position as described in **(c)**. The wire obeys Hooke's law.

(i) State a symbol equation that gives the relationship between the tension T in the wire and its extension x. Identify any other symbol that you use.

....

.... [1]

(ii) Before the sphere changed position, the initial elastic potential energy of the wire was 0.65 J. The change in position of the sphere causes the extension of the wire to double.

Calculate the final elastic potential energy of the wire after the sphere has changed position.

final elastic potential energy = ... J [2]

[Total: 11]