3 Fig. 3.1 shows a thick glass cup submerged in water. The glass has a density of 2200 kg m^{-3} and displaces 6.8×10^{-5} m^3 of water when it is submerged as in Fig 3.1. Water has density 1000 kg m^{-3}.

The glass cup is held stationary by an external force *F*.

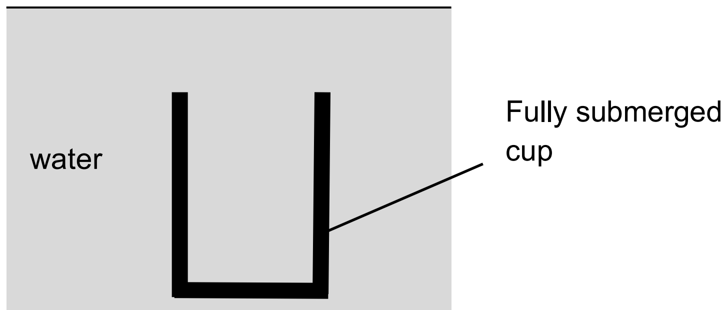

Fig. 3.1

(a) (i) Explain why the liquid exerts an upthrust on the cup.

……………………………………………………………………………………………………..

……………………………………………………………………………………………………..   [2]

……………………………………………………………………………………………………..

(ii) By considering the forces acting on the cup, show that the external force *F* needed to keep the cup stationary is 0.80 N.

[2]

(iii) The cup is pushed further down into the water.

Explain how the upthrust acting on the cup will change.

…………………………………………………………………………………………

…………..

[1]

…………………………………………………………………………………………

…………..

(b) Fig. 3.2 shows the same glass cup now inverted and held right at the surface of the water. When placed this way, 5.50×10^{-4} m^3 of air is contained within the cup at atmospheric pressure of 1.0×10^5 Pa.

The cup is then pushed slowly into the water, trapping and compressing the air within the cup, as shown in Fig. 3.3. The cup is again held stationary by an external force such that the water surface is at a distance *d* above the water level in the cup.

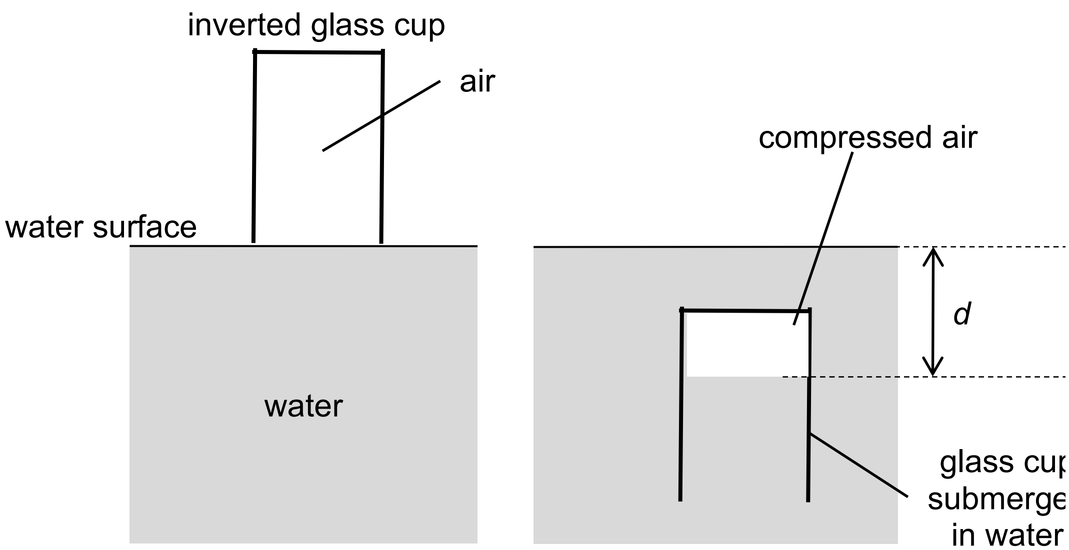

Fig. 3.2 **Fig. 3.3**

Assuming that air is an ideal gas that is insoluble in water, and that the temperature of the trapped air remains unchanged, calculate the volume of the compressed air within the cup in Fig. 3.3 when d = 30.0 cm.

volume = ... m^3 [3
]

[Total: 8]