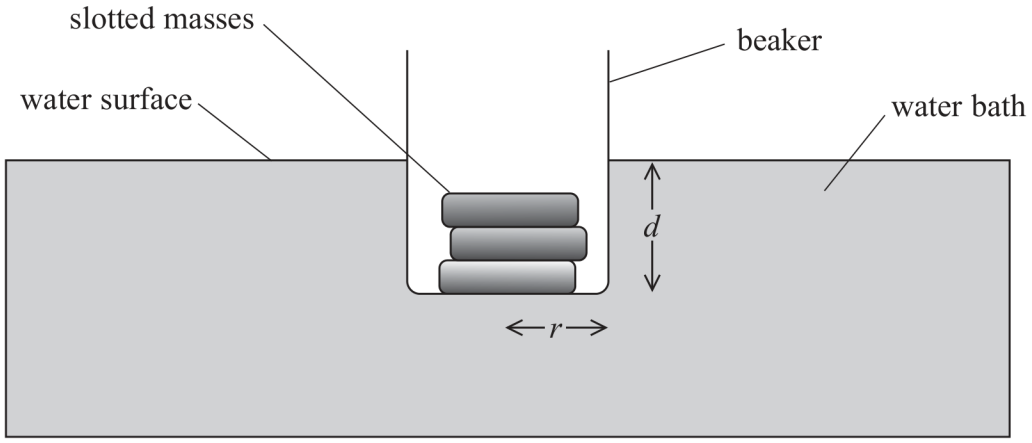
2 A student investigated the relationship between the mass m a boat can carry and the depth d below the water surface of the lowest point of the boat.

He modelled the boat using a glass beaker.

He added 10 gram slotted masses and marked the position of the water surface on the beaker, as shown.



The student assumed the beaker was a cylinder with radius r cm and the water had a density of $1\,g\,cm^{-3}$.

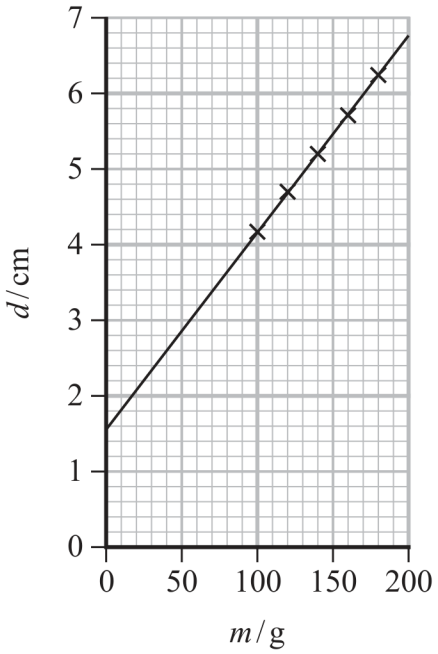
(a) Show that the upthrust U on the beaker could be calculated using the equation

$$U = \frac{\pi r^2 dg}{1000}$$

where d is in cm and U is in N.

(4)

(b) The student marked the position of the water surface on the beaker for different values of m. He plotted a graph of d in cm against m in g.



When the beaker is in equilibrium upthrust = weight, leading him to the following equation

$$m = \rho\pi r^2 d$$

where $\rho = 1\,\text{g cm}^{-3}$.

Determine the diameter of the beaker, using information from the graph.

(3)

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Diameter of beaker = ...

(c) The graph shows that the beaker would have a depth under the water surface with no mass added.

Identify the source of the systematic error and how it could be corrected.

(2)

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(Total for Question 2 = 9 marks)