

## Hydraulics

### Tutorial Sheet 7 – Conservation of energy and Bernoulli's theorem

- Water flowing in a pipeline 4 m above datum level has a mean velocity of  $12 \text{ m s}^{-1}$  and is at a gauge pressure of 36 kPa. If the density of water is  $1000 \text{ kg m}^{-3}$ , and  $\alpha$  is 1.0, what is
  - the mean total energy per unit mass of the water, relative to the datum and to atmospheric pressure, and the mean total head? (Ans:  $147 \text{ J kg}^{-1}$ , 15 m)
  - How are these results affected if the Coriolis coefficient  $\alpha$  is 1.3? (Ans:  $169 \text{ J kg}^{-1}$ , 17.2 m)
- A pipe 300 m long tapers from 1.2 m diameter to 0.6 m diameter at its lower end and slopes downwards at a slope of 1 in 100. The pressure at the upper end is 69 kPa. Neglecting friction losses and assuming  $\alpha = 1$ , find the pressure at the lower end when the rate of flow is  $5.5 \text{ m}^3/\text{min}$ . (Ans: 98.4 kPa)
- A siphon is in the form of a hose, one end of which is immersed in a swimming pool, it passes over a fence 1.2 m higher than the pool surface and its other end (2.4 m below the pool surface) is allowed to discharge the water down the stormwater drain. What is the velocity of water in the hose, and what is the pressure in the pipe at the point where it passes over the fence? Use  $\alpha = 1.1$ . (Ans:  $6.54 \text{ m s}^{-1}$ ,  $-35.3 \text{ kPa}$ )
- The highest residential area in a town is at an elevation of 250 m. It is local regulations that the minimum static supply pressure anywhere in town be 100 kPa. What must the surface level in the local reservoir be to ensure this without installing a pump? Also, with what velocity would the water issue from a garden hose in that residential area if the water was at that minimum level and  $\alpha = 1.1$ ? (Ans: 260.2 m,  $13.5 \text{ m s}^{-1}$ )
- A jet of water is initially 12 cm in diameter and when directed vertically upwards reaches a maximum height of 20 m. Assuming that the jet remains circular in cross-section and  $\alpha = 1$ , determine the volume rate of water flowing and the diameter of the jet at a height of 10 m. (Ans:  $0.224 \text{ m}^3 \text{ s}^{-1}$ , 0.143 m)
- A horizontal venturi meter, consisting of a converging portion followed by a throat section of constant diameter and then a diverging portion is used to measure the rate of flow in a pipe. The diameter of the pipe is 15 cm, and at the throat section it is 10 cm. The pressure difference between the two sections is 20 kPa, when oil of density  $900 \text{ kg m}^{-3}$  flows in the pipe. Use the integral energy equation to determine the discharge in the pipe, with  $\alpha = 1.06$ . (Ans:  $56.8 \text{ L s}^{-1}$ ).
- A Pitot tube is used to measure air velocity. If a manometer connected to the instrument indicates a difference in pressure head of 4 mm of water between the entry to the tube and a point on the same streamline upstream, calculate the air velocity. (Density of air is  $1.2 \text{ kg m}^{-3}$ ) (Ans:  $8.08 \text{ m s}^{-1}$ )