A2-2007 Q1

The Oahe hydroelectric power plant in South Dakota has a total peak capacity of 826 MW from its seven generators. The water intakes are 25m below the surface level of the lake. There are seven 7.4m diameter tunnels, which are the intakes for the turbines; that is one tunnel for each turbine. Calculate the speed of the water flowing along the tunnels, assuming the generators are 50% efficient.

density of water = 10^3 kg m^{-3}

(7 marks)

A2-2005 Q2

(a) State Boyle's law.

(b) Figure 2.1 shows a length of capillary tubing in which a column of air is trapped by a mercury column of length 100 mm. The length of the air column is 400 mm. The bottom of the tubing is sealed and the top is open to the atmosphere.

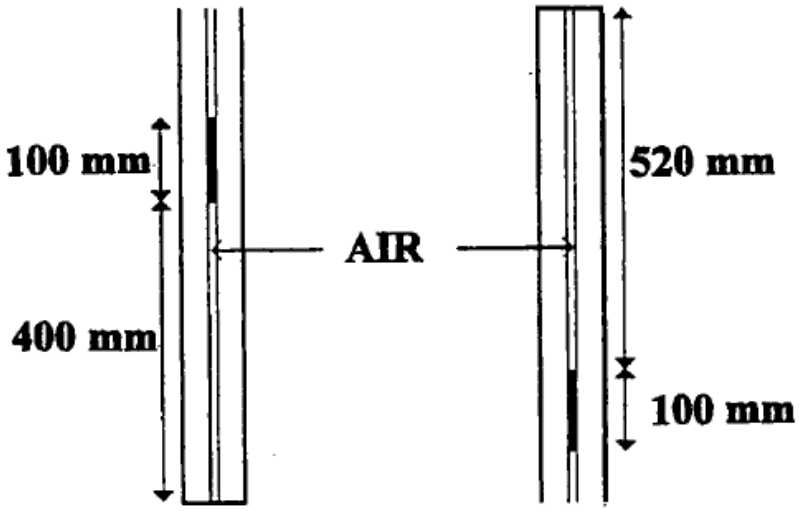

Figure 2.1

Figure 2.2

The tubing is now inverted, Figure 2.2, and the air column is seen to increase in length to 520 mm. Use this observation to calculate a value for atmospheric pressure, expressed in mm of mercury.

(c) A typical value for atmospheric pressure, expressed in SI units, is 101 kPa. The surface area A of the Earth is related to its mean radius R by the expression

$$A = 4\pi R^2,$$

where R has the value 6400 km.

Calculate

(i) the sum of the magnitudes of the forces exerted by the atmosphere on the surface of the Earth,

(ii). the mass of the Earth's atmosphere, assuming g does not vary with height above the Earth's surface.

(11 marks)

A2-2011 Q4

A typical value for the atmospheric pressure on Earth is 101 kPa. The surface area of the Earth A, is related to its mean radius R by the expression $A = 4\pi R^2$, where R has the value 6400 km.

(a) How is the weight of the atmosphere related to the pressure of the atmosphere acting on the Earth's surface?

[1]

Calculate:

(b) The weight of the atmosphere.

[2]

(c) The mass of the atmosphere, assuming that g does not vary with height between the bottom and the top of the atmosphere.

[2]

(d) The number of molecules in the atmosphere, assuming that the mass of a mole of air is 30 g.

[2]

(e) The height of the atmosphere if the density $\rho = 1.2$ kg m^{-3}.

[4]

(f) The height of the atmosphere calculated in (iii) is less than the height at which aircraft often fly. Explain why our calculation gives a low result for the height.

[2]

(g) The height of the atmosphere is typically given as 200 km. Does this mean that our calculation of the mass is completely wrong (by a significant factor)?

[1]

(14 marks)