Hydrodynamics

U85-P4b A high building has a large water tank. The water level in the tank is 30 m above the ground. Water is supplied through a water pipe of effective cross-sectional area of 1.0 cm^2 to each room in the building.

(i) Calculate the velocity of the water coming out from a tap, which is 20 m above the ground level.

(ii) Calculate the minimum time needed to fill up a container of capacity 20 liters. [Take g = 9.8 m s^{-2}] [14 m s^{-1}, 14.29 s]

U86-10 Five small tubes A, B, C, D and E of equal diameter are screwed onto a large horizontal pipe PQ as shown in Fig.U86-10. Which tube would have the highest water level when water flows steadily from P to Q?

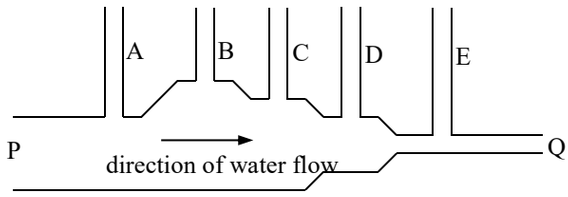

Fig.U86-10

U89-P3 A stream of water traveling horizontally with speed 20 m s^{-1} is ejected from a hose of cross sectional area 30 cm^2 and is directed against a vertical wall.

(a) Calculate the force exerted on the wall, assuming the water does not rebound after striking the wall. [1200 N]

(b) What is the power of the pump needed to give the ejected water the above-mentioned kinetic energy? [12000 W]

(c) How the kinetic energy of the ejected water is converted after striking the vertical wall?

(d) Regarding part (a) above, there is in fact some degree of rebound when the stream of water strikes the wall. If we take this into consideration, what would likely be the result for part (a), a larger or a smaller force? Explain.

U92-P5a What is an **ideal fluid**?

With regard to fluid flow, define **streamline**.

(b) Explain briefly what you understand by **Bernoulli's equation**?

(c) Water is flowing smoothly through a closed-pipe system. At one point P in the pipe the speed of the water is 2.0 m s^{-1}, while at another point Q 1.5 m higher the speed is 3.2 m s^{-1}. If the pressure is 1.0×10^5 Pa at the point Q, what is the pressure at the point P? [1.18×10^5 Pa]

(d) In part (c) above, what would be the pressure at the point P if the water were to stop flowing and the pressure at the point Q remains the same? [1.15×10^5 Pa]

U94-6 An inclined plane is usually fitted to the roof of the vehicle towing a caravan, as shown in Fig.U94-6. The use of the inclined plane is to _____.

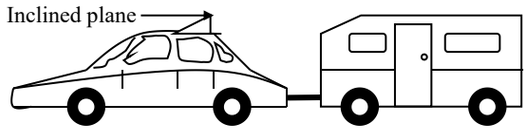

Fig.U94-6

A. serves as a decoration for the towing vehicle
B. protect the people traveling in the towing vehicle as well as those in the caravan
C. protect the caravan from direct sunlight
D. direct the oncoming air flows in an upward direction such that it would not hit the caravan normally and reduce the speed of the caravan and the towing vehicle

U94-P3a (i) What is **Bernoulli's equation**?

(ii) With the aid of a labeled sketch, give one device, which applies Bernoulli's principle.

(b) Oil of density 800 kg m^{-3} flows along a pipe from a lower horizontal section X to another section Y, which is 10 m higher than X, as shown in Fig.U94-P3b. The internal radii of sections X and Y are 60 cm and 30 cm respectively. The pressure and speed of the oil flow in section X are 100 kPa and 0.20 m s^{-1} respectively. Calculate

(i) the speed;

(ii) the pressure; and

(iii) the dynamic pressure of the oil flow in section Y. [0.8 m s^{-1}, 21360 Pa, 256 Pa]

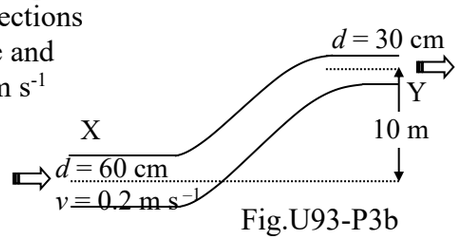

Fig.U93-P3b

U95-13 Two containers A and B are connected through a narrow tube with a valve K as shown in Fig.U95-13. When the valve is closed, water is poured into the two containers until the water-level in A is higher than that in B. Then the open-end of A is sealed up and the valve K is opened. Which of the following statements is **correct**?

A. Water in A does not flow into B and the levels in A and B remain unchanged.
B. Water in A flows into B but the level in A is still higher than that in B.
C. Water in A flows into B until the level in B is slightly higher than that in A.
D. Water in A flows into B until the levels in A and B are the same.

Fig.U95-13

U97-7 A water pipe with cross-section A shoots out a water-truck horizontally on a vertical wall as shown in Fig.5. If the water-trunk is shot out with a speed of u and rebounds with a speed of $\frac{u}{2}$, what is the average pressure exerted on the wall? [Note: ρ is the density of water]

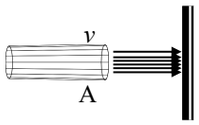

Fig.U97-7

A. ρu^2 B. $\frac{1}{2}\rho u^2$ C. $\frac{3}{2}\rho u^2$ D. $\frac{3}{2}\frac{\rho u^2}{A}$

U2k1-P5 (a) On the wall of a big container as shown in Fig.U2k1-P5a, there is a hole positioned at the place where depth of water is h. Prove that the speed of water flows out from the hole is $v = \sqrt{2gh}$.

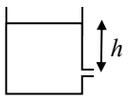

Fig.U2k1-P5a

U2k05-P4 (b) As shown in Fig.U2k05-P4b, water flows steadily from a holding tank. The cross-sections of the pipes at point A and at point B are 0.06 m^2 and 0.02 m^2 respectively. Neglecting viscosity, determine

(i) the water speed at B; [3%]
(ii) the flow rate at B; [1%]
(iii) the kinetic pressure at point A. [3%]

[9.9 m s^{-1}, 0.20 $m^3 s^{-1}$, 5.4×10^3 Pa]

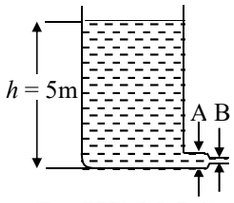

Fig.U2k05-P4b

U2k06-P5 (b) What do you understand by Bernoulli's Equation? [2%]

(c) As shown in Fig.U2k06-P5c, water of density 1000 kg m^{-3} flows from one end A of a pipe to another end B. Given that A and B have a difference of height of 2.0 m, and that their internal radii are 0.30 m and 0.15 m respectively. If the pressure at A is 120 kPa and the speed of flow at A is 0.32 m s^{-1}, find the pressure and the speed of flow at B. [6%]

[1.28 m s^{-1}, 99632 Pa]

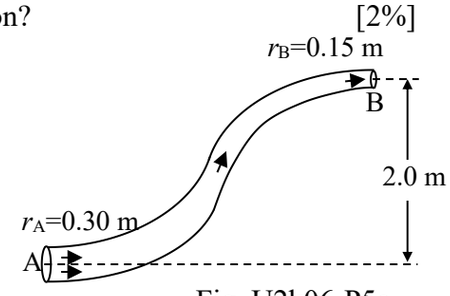

Fig. U2k06-P5c

U2k8-13 The cross-sectional area of a normal human's aorta (the main blood vessel in the heart) is 3 cm^2, and the blood velocity through this area is 30 cm s^{-1} while he is at rest. If compared with a typical blood capillary, the cross-sectional area of which is 3×10^{-7} cm^2, and the blood velocity is 0.05 cm s^{-1}, how many blood capillaries does he have?

A. 6 million B. 60 million C. 600 million D. 6 billion

U2k08-14 Fig.U2k08-14 shows an aeroplane flying horizontally at a constant altitude with constant velocity. P, Q, R, and S are four forces acting on the plane. Which force is caused by the Bernoulli's effect?

A. P
B. Q
C. R
D. S

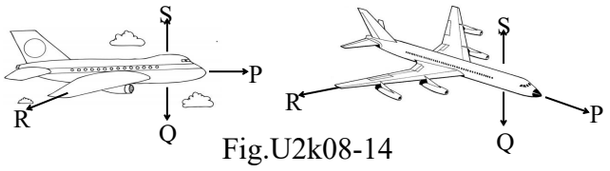

Fig.U2k08-14

U2k11-9 As shown in Fig.U2k11-9, the area of the cross section at P is half of that of the tube AB. When the speed of water at the two ends of the tube A and B maintains at 2.0 m s^{-1}, what is the difference h between the water levels in the tubes?

A. 45 cm B. 61 cm
C. 82 cm D. 96 cm

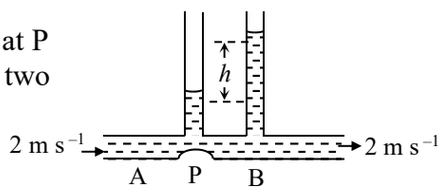

Fig.U2k11-9