本試題是否可以使用計算機： □可使用 ， ☑不可使用 （請命題老師勾選）

1. Consider a high-speed rail train, of maximum sectional area $A_1$, moving steadily in a semi-circular tunnel of inner sectional area A. At what speed U of the train do the effects of compressibility become important in air flow? You may neglect the effects of viscosity and use the speed of sound denoted by c. (10%)

2. Three water tanks of constant head elevations, as shown in Fig 1, are connected to three pipes of $L_1, L$ and $L_2$ in length, d in ~~radius~~ diameter, $V_1, V_2$ and $V_3$ in velocity, and one valve at C. Assume the elevations of tank bottoms to be $h_2, h_3$ and $h_4$, respectively. Assume that you are given the frictional factor $f$ in pipe flow no matter of the valve to be opened or closed. Neglect all entrance, exit and junction losses, and the developing length in pipes. Use this information to write down (a) the energy equations for the pipe ADB if the valve is fully closed; (b) the energy equations for the pipe AD, DB and DC if the valve is open with a loss coefficient $K$. (c) What are the relationships among $V_1, V_2$ and $V_3$ when in above cases (a) and (b). (20%)

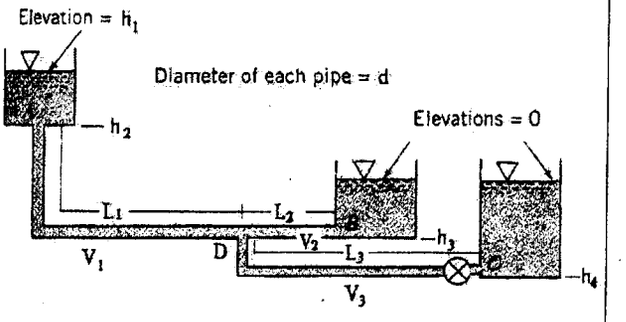

Fig. 1 three head tanks connected by two pipes

3. As referred to Fig 2, a floating ball of specific gravity $S$ and radius $R$ is submerged in the flowing water (of density $\rho$) with a constant speed $U$. (a) What are the buoyancy force and the Drag force on this ball? (gravitational constant $g$); (b) Assume the drag coefficient to be $C_D$. Please find out the speed of velocity as a function of **S, R,** $\rho$, **g** and $C_D$. (20%)

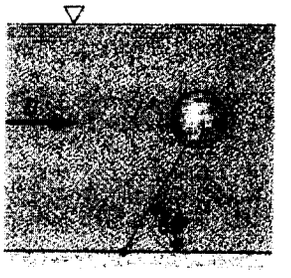
Fig. 2 a floating ball in flowing water

4. Given the angular velocity $\omega$ of a rotating cylinder filled with water (of density $\rho$ and gravitational constant $g$), and the initial depth $H$, as illustrated in Fig. 3. (a) For a fluid particle on the water surface with a distance $r$ from the rotational axis, how large is the centrifugal acceleration of this particle? (b) Please find out the minimum water depth $h$ at the center of tank. (c) What is the water depth of this particle $z(r)$. (20%)

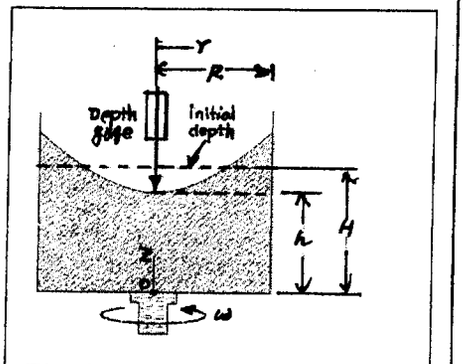

Fig. 3 a rotating open cylinder

5. Please explain the following terms. (15%)
   (a) flow separation, (b) cavitation, (c) water hammer, (d) turbulence, (e) D'Alembert paradox

（背面仍有題目，請繼續作答）

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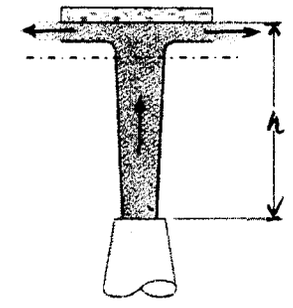
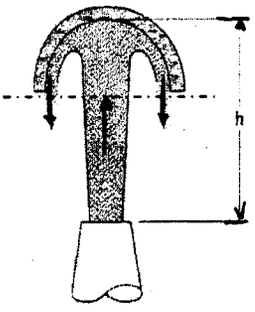



(a)




(b)

Fig. 4 water jet impact a plate

6. Consider a vertical water jet leaving from a nozzle (with exit diameter d) at a velocity U. It impacts a flat plate (case a) and a semi-spherical plate (case b) which are all located at a distance $h$ above the nozzle, as shown in fig. 4. Let the water density $\rho$ and gravitational constant $g$. Neglect the weight of water jet and friction forces on the surface and by the air. What are the forces exerted on the plates? (Hint: the dotted lines shown are taken as the control surface and the Bernoulli equation will be applied in your analysis.) (15%)