系所組別：生物醫學工程學系甲組

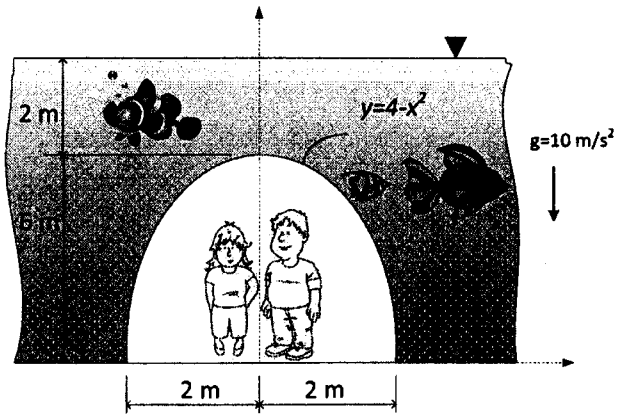
考試科目：流體力學 考試日期：0223，節次：2

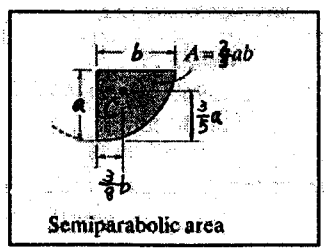
※ 考生請注意：本試題不可使用計算機

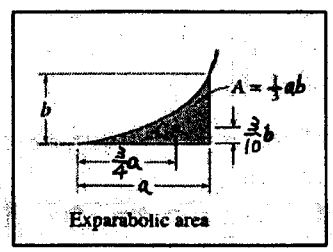
1. Give physical interpretations for the following terms: a). boundary layer, b). head loss, c). Reynolds number. (12%)

2. Write down the mathematical expression of the Bernoulli equation in a steady flow and give the basic assumptions for which the equation can be used. (12%) Give an example relevant to the Bernoulli equation. (6%)

3. The underwater tunnel in the San Diego Sea World is fabricated from reinforced glass formed in the shape of a parabola ($y=4-x^2$). The length of the tunnel is 10 m. Determine the total magnitude of the hydrostatic force that acts over the surface of the tunnel. The density of the water is ρ_w=1000 kg/m^3. The table of geometric properties is attached below. (20%)







（背面仍有題目，請繼續作答）

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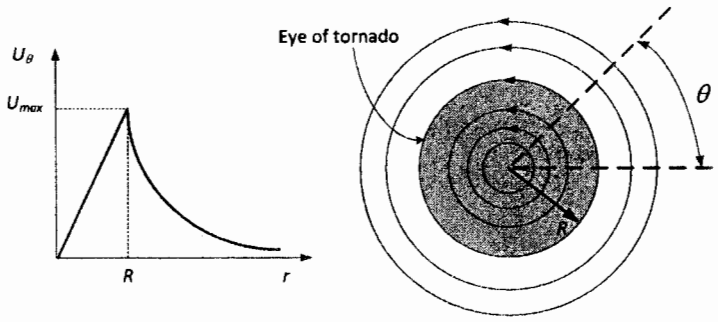
4. The eye of a tornado has a radius *R*. In the eye, the tornado flow field is approximated as solid body rotation while outside the eye the flow is a free vortex. The velocity field for the flow is :

$$u_\theta = \begin{cases} U_{max}\dfrac{r}{R} & r \le R \\ U_{max}\dfrac{R}{r} & r > R \end{cases}$$

Determine the pressure variation, *P(r)*, resulting from the tornado. Note that the pressure far from the tornado is atmospheric pressure, P_{atm}. (25%) (*Hint: the derivation can start from the Navier-Stokes equation in the polar coordinate.*)

$$\rho\left(\frac{\partial u_r}{\partial t}+u_r\frac{\partial u_r}{\partial r}+\frac{u_\theta}{r}\frac{\partial u_r}{\partial \theta}-\frac{u_\theta^2}{r}+u_z\frac{\partial u_z}{\partial z}\right)=-\frac{\partial P}{\partial r}+\mu\left[\frac{\partial}{\partial r}\left(\frac{1}{r}\frac{\partial}{\partial r}(ru_r)\right)+\frac{1}{r^2}\frac{\partial^2 u_r}{\partial \theta^2}+\frac{\partial^2 u_r}{\partial z^2}-\frac{2}{r^2}\frac{\partial u_\theta}{\partial \theta}\right]+\rho f_r$$



5. A cart hangs from a wire as shown in the figure below. Attached to the cart is a scoop of width *W* (into the page) which is submerged into the water a depth, *h*, from the free surface. The scoop is used to fill the cart tank with water of density, ρ.

a). Show that any instant $V=V_0M_0/M$ where *M* is the mass of the cart and the fluid within the cart. (12%)

b). Determine the velocity, *V*, as a function of time. (13%)