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. 請先閱讀下段英文敘述，然後明確指出文中哪些描述（包括名詞與情形）與哪些流體力學的現象或原理有關，並盡你所知分別解釋這些流體力學的現象及原理。請以條列式回答，每條依序包括 (a)原英文中的關鍵字詞及所在的行數、(b)流體力學的現象或原理的名稱、(c)你的解釋。(20%)

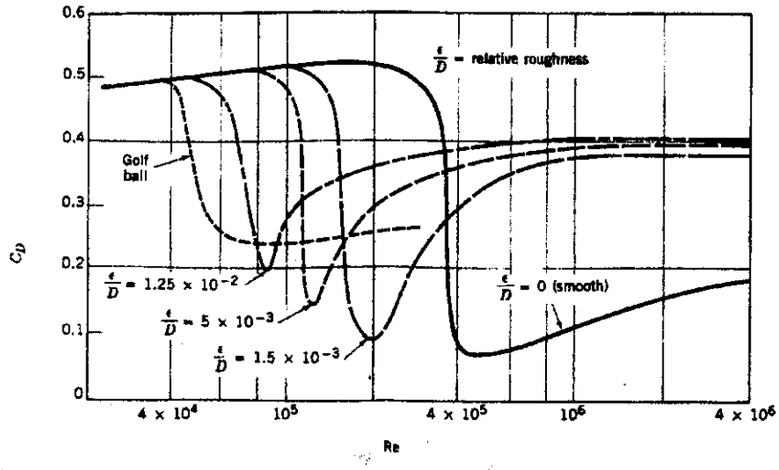
> Water supply was suddenly suspended due to high turbidity last Saturday afternoon, affecting more than 250,000 households in northern Taiwan. Water Resources Agency (WRA) officials said yesterday that an ongoing project to flush sediment accumulated at the gates of the Shihmen Reservoir (石門水庫) would continue in a bid to solve turbidity problems as soon as possible. Water experts said that rainfall exceeded 800mm during the passage of Typhoon Aere in 2004 and Typhoon Matsa last year, triggering mudflows and landslides in mountainous areas near the Shihmen Reservoir. (Adpated from *Taipei Times*)

2. For incompressible Newtonian fluids, the governing equations include three important physical mechanisms related to mass, momentum, and energy. If heat is ignored, please write down:
   (a) English names of these equations in the same order. But the names do NOT include these words: mass, momentum, energy (3%);
   (b) The complete three equations, including the physical meanings of each term in these equations (6%);
   (c) The physical meanings of these equations (6%).

3. Assuming there is a 2-D flow with velocity $u = x^2+3x-4y$ and $v = -2xy-3y$, answer the following questions:
   (a) Does this flow satisfy mass conservation equation? Prove it. (3%)
   (b) Is this flow rotational? Prove it. (4%)
   (c) Is the point (-1.5, 0) a stagnation point? Why? (3%)
   (d) Find its stream function. (5%)

4. To study a fish's swimming problem, we will consider the following variables: swimming speed U, fish length l, density of water ρ, viscosity of water μ, tail's swinging frequency f, tail's stroke distance H, and thrust force T. Use dimensional analysis method to determine PI terms. Use ρ, U and l as repeating variables. (15%)

5. Please use boundary layer theory and turbulence concept to explain why a sphere with slightly rough surface (e.g. a golf ball) might have a lower drag than a smooth sphere at some certain velocity. You may plot a figure like the following one to help your explanation. Use all related knowledge you know and explain every **detail** aspect as you can. (15%)



(背面仍有題目,請繼續作答)

6. 我們考慮棒球被擊出後的飛行問題，牽涉到的物理量符號與機制假設如下：
   - 直角座標系的原點在本壘板中心，由本壘往投手板爲+x 方向，往左外野爲+y 方向，往上爲+z 方向。空氣密度爲ρ，重力加速度爲 g。
   - 球的直徑爲 D，質量爲 M，擊出後的初速度大小爲 Vi ，仰角爲θ（水平向上爲正），偏角爲ϕ（球場中心線偏左外野爲正）。
   - 空氣阻力係數 C_D爲雷諾數 Re 的函數，$C_D=C_D(Re)$。假設球場上空無風。
   - 假設棒球旋轉所引起的環流量 $\Gamma=cVn/\rho$，其中的 c 爲係數，V爲當時球的速率，n爲球的轉速，並假設 n 在球擊出後不會改變。Magnus force 由 Kutta-Joukowski Theorem 計算。
   - 球飛出後任一瞬間的速度爲 $V(t)$(三個分量爲 Vx, Vy, Vz)，位置爲 $P(t)$(三個方向座標值爲 Px, Py, Pz)。
   - 球受所有下列力量作用：地球重力、Magnus force、空氣阻力。

請依據上述符號與假設，先畫一立體的場地與球飛行軌跡的示意圖(3%)，然後列出計算此球飛行軌跡對時間的函數關係 $P(t)$所需的所有<u>理論方法（含方程式）與演算步驟</u> (17%)。不需進行實際的數學計算，僅需<u>依序</u>詳細說明方法。