1. 試求解函數 $f(x) = \dfrac{2x^2}{x^2-1}$ 的下列問題？ (25%)

   (A) 定義域及值域
   (B) 截距及對稱性
   (C) 漸近線
   (D) 極值及反曲點
   (E) 繪出圖形

2. 試繪出下列方程式所圍成之區域，並求出其面積？ (10%)

   $$y = \sqrt{x} \ , \ y = -x+6 \ , \ y = 1$$

3. 試求解下列積分式？ (15%)

   (A) $\displaystyle\int (x^2 - 3x - 1)\cos x \, dx$

   (B) $\displaystyle\int \cos^7 x \, dx$

   (C) $\displaystyle\int \frac{2^{\ln x}}{x} \, dx$

4. You have been asked to design a one-liter can shaped like a right circular cylinder (Figure 1). What dimensions will use the least material? (15%)
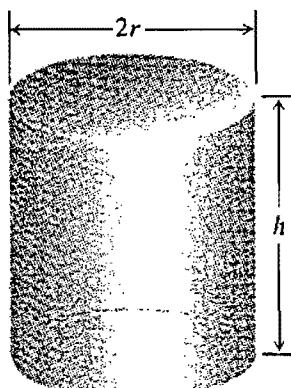

Figure 1

5. The triangular plate shown in Figure 2 has a constant density of $\delta = 3$ g/cm^2. Find (a) the plate's moment M_y about the y-axis. (b) the plate's mass M. (c) the x-coordinate of the plate's center of mass.　(15%)
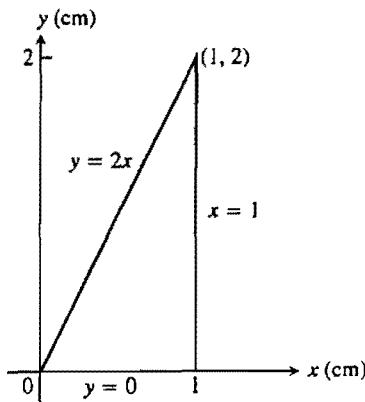
Figure 2

6. Water is flowing at the rate of $2m^3$/min into a tank in the form of an inverted cone (Figure 3) having an altitude of 16 m and a radius of 4 m. How fast is the water level rising when the water is 5 m deep? ($V = (1/3)\pi r^2 h$)　　(20%)
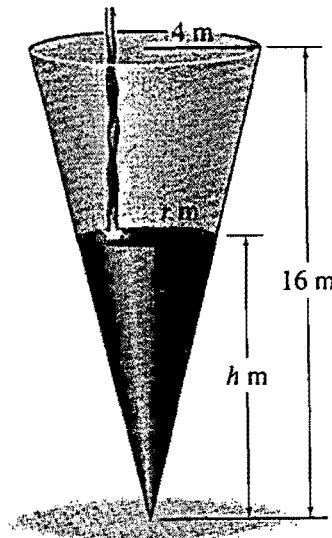

Figure 3

一、 選擇題(本試題共二小題，每小題 2.5 分，共計 5 分)

1. 在好氧生物處理中，營養物之比例(BOD5：N：P：Fe)為何？(1)100：5：1：0.5。(2)100：15：1：0.5。(3)100：10：1：0.1。(4)100：5：2：1。(5)100：5：2：0.3。

2. 下列何者敘述為非？(1)水在細胞中以結合水及游離水二種形式存在。(2)能被微生物用來構成細胞或代謝產物的碳素來源稱為碳源。(3) 被微生物用來構成細胞或代謝產物中氮素來源的物質稱為氮源。(4)培養微生物常用的有機氮源若以蛋白質降解後產物的形式存在，較容易為微生物吸收和利用稱為速效氮源。(5)微生物所需生長濃度在 10^{-8}~10^{-6}M 範圍內的元素稱為巨量元素。

二、名詞解釋(本試題共七小題，每小題 5 分，共計 35 分)

1. Standard Hydrogen Electrode
2. Photochemical smog
3. Buffer capacity or Buffer index
4. 列續反應(Consecutive reaction)
5. Chemoheterotrophic microorganism
6. Glycolysis
7. Generation time

三、問答題(本試題共六小題，每小題 10 分，共計 60 分)

1. 試以有機污染物對河川溶氧之影響，說明「氧垂曲線(dissolved oxygen sag curve)」？

2. 在酸鹼平衡計算中，主要是要確認欲解之物種濃度的數目，並尋找可使用之方程式，亦即有 n 個欲解之物種濃度，則需有 n 個方程式，以利聯立解 n 個未知參數。請問除了可利用「平衡關係式」而尋找可用之方程式外，可從哪三個方向著手？
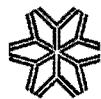
3. 試說明電鍍廢水中氰化物之化學處理法步驟？

4. 試述細胞膜的組成與結構，以及其在細菌生理上扮演的功能？

5. 在酶的合成誘導上，乳糖操縱子學說藉由葡萄糖與乳糖的存在與否瞭解參與乳糖之降解酵素的誘導合成，能加以解釋酵素誘導合成的現象，試問當有乳糖但無葡萄糖存在時，抑制蛋白(lacl repressor)與 cAMP 活化蛋白(cAMP activator protein)的表現如何？此時的乳糖降解酵素是否有表現？

6. 溫度對湖泊的生態環境非常重要，根據該因子可將湖泊分成三區：上層區、底層區與溫躍區，請試述該些分層在夏季與冬季會產生的現象，而該改變對於微生物所需的溶氧與營養物質有何種濃度上的變化？
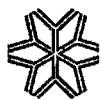
1. A shaft 6.00 cm in diameter is being pushed axially through a bearing sleeve 6.02 cm in diameter and 40 cm long. The clearance, assumed uniform, is filled with oil whose properties are $v = 0.003\,\text{m}^2/\text{s}$ and $SG = 0.88$. Estimate the force required to pull the shaft at a steady velocity of 0.4 m/s.   (20 points)

2. The cylindrical container in Fig.1 is 20 cm in diameter and has a conical contraction at the bottom with an exit hole 3 cm in diameter. The tank contains fresh water at standard sea-level conditions. If the water surface is falling at the nearly steady rate $dh/dt \approx -0.072\,\text{m/s}$, estimate the average velocity V out of the bottom exit.   (30 points)
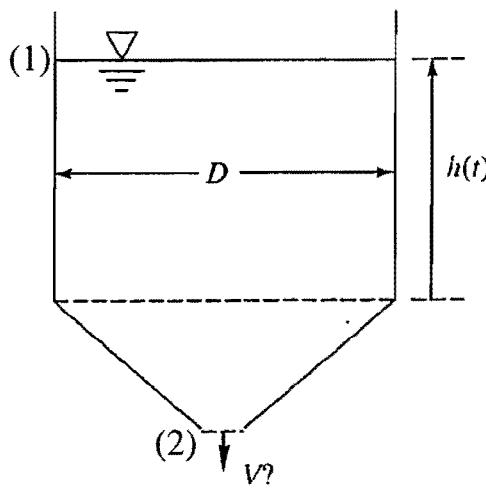

Fig. 1

3. A two-dimensional steady flow, the stream function can be expressed as
$$\psi = xy$$
Find the fluid acceleration at the point (x=1, y=1).   (15 points)

4. A sharp flat plate with 1 m of length and 3 m of width is immersed parallel to a stream of velocity 2 m/s.   Find the drag force on one side of the plate for (a) air, $\rho = 1.23\,\text{kg/m}^3$ and $v = 1.46\times10^{-5}\,\text{m}^2/\text{s}$; and (b) water, $\rho = 1000\,\text{kg/m}^3$ and $v = 1.02\times10^{-6}\,\text{m}^2/\text{s}$. Assuming
$$C_D = \frac{1.328}{\text{Re}_L^{1/2}}.$$ (15 points)

5. At low velocities (laminar flow), the volume flux Q through a small-bore tube is a function only of the pipe radius r, the fluid viscosity μ, and the pressure drop per unit pipe length dp/dx.   Using the power-product method, rewrite the suggested relationship $Q = f(r, \mu, dp/dx)$ in dimensionless form.   (20 points)

1. Nickel has a face-centered cubic unit cell (4 atoms inside). The density of nickel is 6.84 g/cm^3. Calculate a value for the atomic radius of nickel. (Ni=58.69 g/mol) ....(15%)

2. An excited hydrogen atom emits light with a frequency of 1.141×10^{-4} Hz to reach the energy level for which n =4. If you want to calculate what principal quantum level did the electron begin, please write down the calculating processes. (You should not show the final answer)

   Hint: $\Delta E = h\nu$

   $$\Delta E = -2.178 \times 10^{-18} (\frac{1}{n_f^2} - \frac{1}{n_i^2})$$
   ....(15%)

3. For each of the following molecules, write the Lewis structure, predict the molecular structure (including bond angels), and give the excepted hybrid orbitals on the central atoms. (a). SF_2 ; (b). $S_2O_3^{2-}$ ....(10%)

4. An iron ore sample contains Fe_2O_3 plus other impurities. A 652-g sample of impure iron ore is heated with excess carbon, producing 343 g of pure iron by the following reaction:(Fe=55.85)

   $Fe_2O_3(s) + 3\ C(s) \rightarrow 2\ Fe(s) + 3\ CO(g)$
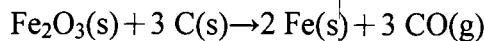
   What is the mass percent of Fe_2O_3 in the impure iron ore sample? Assume that Fe_2O_3 is the only source of iron and that the reactions is 100% efficient.
   ....(10%)

5. The logarithmic values of a pure substance's vapor pressure are inversely proportional to their corresponding temperatures. **(a)** List the equation that can describe this relationship. **(b)** Calculate the vapor pressure of water at 50°C if the vapor pressure of water at 25°C is 23.8 torr and the heat of vaporization of water at 25°C is 43.9 kJ/mol. ....（15%）

（where: $e^{-1.37} = 0.254$）

6. A certain first-order reaction has a half-life of 20.0 minutes. **(a)** Calculate the rate constant for this reaction. **(b)** How much time is required for this reaction to be 75% complete? (where: ln(2)=0.693) ....（10%）

7. **(a)** Calculate the percent dissociation of acetic acid ($Ka = 1.8 \times 10^{-5}$) in 1.00 M $HC_2H_3O_2$ solutions.　**(b)** Which solution has a higher value of percent dissociation, a 1.00 M or a 0.10 M $HC_2H_3O_2$ solutions?　..（15%）

8. Calculate the solubility of solid CaF_2 ($K_{sp} = 4.0 \times 10^{-11}$) in a 0.025 M NaF solution. ....（10%）