



1. (10 分) Let f be the function defined by

$$f(x) = \begin{cases} \frac{\sin x}{2x} & \text{if } x < 0; \\ (x+c)^2 & \text{if } x > 0; \end{cases}$$

Find the number(s) c such that the limit of $f(x)$ as $x \rightarrow 0$ exists. What is the limit of $f(x)$ as $x \rightarrow 0$ in this case?

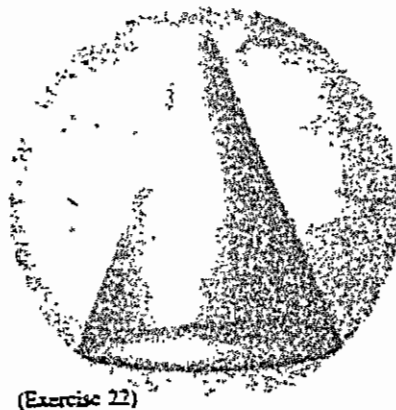
2. (10 分) Compute

$$\lim_{h \rightarrow 0} \frac{(3+h)^{100} - 3^{100}}{h}$$

(Hint : Use the Power Rule.)

3. (10 分) A right circular cone (shown at the top of the next column) is inscribed in a sphere of radius 10 cm. Find the dimensions for which the volume of the cone is a maximum.

Figure.



(Exercise 22)

4. (10 分) Specify a cubic polynomial $p(x)$ that satisfies all of the following properties :

- (1) p is increasing on the intervals $(-\infty, -1)$ and $(+1, \infty)$.
- (2) p is decreasing on the interval $(-1, +1)$;



- (3) the graph of p is concave down on $(-\infty, 0)$.
- (4) the graph of p is concave up on $(0, \infty)$; and
- (5) $p(0) = 2$.
5. (10 分) Find the area of the region bounded by the x -axis, $f(x) = x^2 + 3$, $x = 0$, $x = 3$
6. (10 分) Find the volume generated by revolving the triangle with vertices $(0, 0)$, $(0, 2)$ and $(2, 0)$ about
- the x -axis,
 - the y -axis,
 - the line $x = -1$,
 - the line $y = -1$,
7. (10 分) 解 $y' - \frac{y}{x} = x \sec\left(\frac{y}{x}\right)$ 之通解
8. (10 分) 解 $\frac{dy}{dx} + \frac{2y}{x} = y^2 \ln x$ 之通解
9. (10 分) 以 Laplace transform 解 $y'' + 2y' + 5y = 0$ $y(0) = 2$, $y'(0) = -4$
10. (共 10 分) 假設一柱塞流式反應槽(Plug-flow reactor)為一維流動形式, Q 為流量; A 為截面積; C_i 為污染物起始濃度; C 為某平均水力停留時間 θ 時之污染物濃度; 污染物以一階動力形式降解, 即 $r_A = -kC$, 擴散作用不考慮。
- (1) 請寫出該模式所構成之一階偏微分方程(不必解題)。(4 分)
- (2) 假設在穩定狀況(Steady state)下, 即 $\frac{\partial C}{\partial t} = 0$, 改寫上(1)之一階偏微分方程為常微分方程, 並求解。(6 分)



- 1.(10 分) Please derive removal equations for a CSTR (continuous stirred tank reactor) and a PFR (plug flow reactor), and define each term clearly.
- 2.(10 分) Please describe bioventing, including where it is used (groundwater? Soils?), and the contaminant classes on which it can be used.
- 3.(10 分) A surface impoundment contains the following contaminants in aqueous solution:

Carbon tetrachloride	10 mg/L
Cyanide	220 mg/L
Lead	20 mg/L
MEK	4500 mg/L

Propose a treatment scheme for the aqueous solution.
- 4.(10 分) A 200-L drum of benzene is spilled into a 38,000-L water storage tank. What percentage of the spilled benzene is present in the aqueous phase? Where would you find the benzene that is not dissolved? (water solubility of benzene = 1770 mg/L; density of benzene = 0.877 kg/L)
- 5.(10 分) A quantity of TCE was spilled accidentally into a treated wastewater-storage basin. Estimate the time required for the concentration of PCE (dimensionless $H_c = 1.0$) drop by 90 percent from the initial concentration due to volatilization. Assume liquid-film mass transfer coefficient (k_{La}) = 10 (1/hr), the ratio of gas-film to liquid-film mass transfer coefficient (k_{Ga}/k_{La}) = 10.
- 6.(10分) 假設地面對煙流擴散有全反射作用,某一污染源質量流率為 Q ,今假設煙囪口平均風速 U ,有效煙囪高度 H ,試以 $\sigma_y = 2x^{0.5}$ 及 $\sigma_z = 4x^{0.25}$ 推導出最大地面濃度的距離 X_{max} 及濃度 C_{max} 的公式?
- 7.(10分) A 1000-MW pulverized coal-fired steam power plant of 40 percent thermal efficiency uses coal with an ash content of 12 percent and a heating value of 26700 KJ /KG, Assume that 50 percent of the ash goes up the stack as particulate matter in the flue gas. The particulate emission is controlled by an electrostatic precipitator which has the following removal efficiencies and weight distribution in the given size ranges.



Particle size, μm	0-5	5-10	10-20	20-40	>40
Efficiency, %	70	92.5	96	99	100
Wt, %	14	17	21	23	25

Determine the amount of fly ash emitted, in kilograms per second, with the flue gas?
(hint: produce 1 KW-S need 1 KJ)

8. (10 分) Estimate how long will the percolation of water take to produce a leachate through a landfill 10 m deep, with a 2 m top cover of sandy loam soil? If the hydraulic head is 5 meters, please determine the breakthrough time in years for leachate to penetrate a 1.2 meters thick bottom clay liner? Assume that this landfill is in Toulieu, and that precipitation = 1500 mm/yr, runoff coefficient = 0.10, evapotranspiration = 500 mm/yr, soil field capacity = 300 mm/m, refuse field capacity = 600 mm/m as packed, Assume further that the top cover soil has a moisture content of 250 mm/m, and that the incoming refuse has a moisture content of 450 mm/m. For bottom clay liner: the effective porosity is 0.20, and the coefficient of permeability is 10^{-7} cm/s.
9. (10 分) As a consulting engineer, you have been commissioned to develop a comprehensive solid waste system for a community interested in achieving a greater recovery and reuse of its solid wastes. Two of the possible alternatives are separation at the home or separation at a materials recovery facility. What important factors must be considered in evaluating these two alternatives?
10. (10 分) Consider a best processing operation for purity of Glass (純度最高非回收量最大) which consisting of an air classifier, a trommel screen, and a magnet, placed in various sequences? The feed is assumed to contain four materials: paper, glass, ferrous, and aluminum. The f-value (fraction of material rejected) for each of the unit operations for each of the materials and the feed rates mixed materials are shown below:

	Air classifier	Trommel screen	Magnet	Feed, lb/h
Paper	0.1	0.9	1.0	70
Glass	0.8	0.1	1.0	10
Ferrous	1.0	1.0	0	10
aluminum	0.9	0.9	0.9	10

The assumption is that the air classifier will reject 10% of the paper and accept 90% of the paper ($f = 0.1$ and $1-f = 0.9$). the trommel screen will, however, reject 90% of the paper.



一、解釋名詞（每題 3 分，共 24 分）

- | | |
|---------------------------|---------------------------------|
| 1. Newton's first law | 2. Law of universal gravitation |
| 3. Relativistic momentum | 4. Second law of thermodynamics |
| 5. Aromatic Hydrocarbons | 6. Nitrogen cycle |
| 7. Covalent chemical bond | 8. Transition metals |

二、選擇題（單選 每題 2 分，共 20 分，答錯每題倒扣 1 分，不答題不扣分）

- Express 135,000 in exponential notation.: a) 1.35000×10^5 b) 1.35×10^5 c) 1.3500×10^{-5} d) 1.35×10^{-5} e) 135×10^3
- Which of the following metric relationships is incorrect?: a) 1 microliter = 10^{-6} liters b) 1 gram = 10^3 kilograms c) 10^3 milliliters = 1 liter d) 1 gram = 10^2 centigrams e) 10 decimeters = 1 meter
- The formula for calcium bisulfate is: a) $\text{Ca}(\text{SO}_4)_2$ b) CaS_2 c) $\text{Ca}(\text{HSO}_4)_2$ d) Ca_2HSO_4 e) Ca_2S
- What is the molar mass of ethanol ($\text{C}_2\text{H}_5\text{OH}$)?: a) 45.07 b) 38. c) 46.07 d) 34.17 e) 62.07
- How many grams of NaCl are contained in 350. mL of a 0.250 M solution of sodium chloride?: a) 41.7 g b) 5.11 g c) 14.6 g d) 87.5 g e) none of above (Na:23 Cl:35.5)
- Determine the coefficient for O_2 when the following equation is balanced in standard form (smallest whole number integers)

$$\text{C}_4\text{H}_{10}(\text{g}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{g})$$
a) 4 b) 8 c) 10 d) 13 e) 20
- Consider the element indium, atomic number 49, atomic mass 114.8 g. The nucleus of an atom of indium-112 contains: a) 49 protons, 63 neutrons, 49 electrons. b) 49 protons, 49 neutrons. c) 49 protons, 49 alpha particles. d) 49 protons, 63 neutrons. e) 49 protons, 112 neutrons.
- $\text{O}_3 + \text{NO} \rightarrow \text{O}_2 + \text{NO}_2$ 氧化劑為 a) O_2 b) O_3 c) NO d) O_3 及 O_2 e) NO_2



9. 汞的敘述何者為非? a)就是俗稱的水銀 b)有機汞中毒最有名的例子為水俣症(Minamata Disease) c)汙染通常是無機汞 d)無機汞進入水中，透過微生物的作用，轉化成有機汞 e)汞進入人體因排出速度非常緩慢，會累積引起中毒。
10. 有關戴奧辛何者不正確? a)其實戴奧辛是單一種有毒的化學物質 b)是統稱具有兩個氧原子聯結一對苯環類的化合物。 c)當氯原子取代苯環上的氫，即生成氯化戴奧辛，其化學結構有八個位置可供氯取代 d)化合物種類多達七十五種 e)四氯戴奧辛(2,3,7,8-tetrachlorodibenzo-p-dioxin簡稱TCDD)，是目前人類所知最毒化學劑之一。

三、計算問答題 (共 56 分)

1. 有一質量 4.0Kg 的物體，在光滑的水平面上受一水平拉力 8.0 N 的作用，結果在旁邊的觀察者清楚看到，該物體從靜止開始運動，運動時間有 5.0 秒。請問：(1)「力」(Force)在 5.0 秒內對物體做「功」的平均功率是多少?(2)「力」在 5.0 秒末對物體做「功」的瞬時功率是多少? (10 分)
2. 把電量為 20 庫倫的電荷放在電場中的 P 點，其電位能是 60 焦耳。請問：(1)把電量為 5 庫倫的電荷放在 P 點的「電位能」是多少?(2)把電量 -5 庫倫的電荷放在 P 點的「電位能」又是多少? (8 分)
3. What would be the final temperature when 150 g of 25°C water is mixed with 65 g of 40°C water? (8 分)
(Hint : Equate the heat gained by the cool water to the heat lost by the warm water.)
4. A solution is prepared by dissolving 10.8 g ammonium sulfate in enough water to make 100.0 mL of stock solution. A 10.00-mL sample of this stock solution is added to 50.00 mL of water. Calculate the concentration of ammonium ions and sulfate ions in the final solution. S:32, N:14, O:16 (6 分)



5. 鐵生鏽反應式 $4 \text{Fe}_{(s)} + 3 \text{O}_{2(g)} \rightarrow 2 \text{Fe}_2\text{O}_3_{(s)}$ 求 25°C 平衡常數 ? (6 分)

$\text{Fe}_2\text{O}_3_{(s)}, \text{Fe}_{(s)}, \text{O}_{2(g)}$ ΔH_f° (kJ/mole) -826, 0, 0

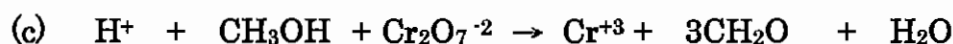
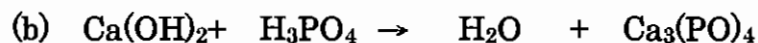
S° (J/K.mole) 90, 27, 205

(Hint: $\Delta G^\circ = \Delta H_f^\circ - T \Delta S^\circ$, $\Delta G^\circ = -RT \ln K$, $R=8.314 \text{ J/K mole}$)

6. How do you suppose the frequency of an electromagnetic wave compares with the frequency of the electrons it sets into oscillation in a receiving antenna? (8 分)

7. On a steam mirror wipe away just enough to see your full face. How tall will the wiped area be compared with the vertical dimension of your face? (4 分)

8. 請平衡下列化學平衡式 (6 分)





一. 選擇題 (15%, 每題 3分)

請依題號作答並將答案寫在答案卷上，違者不予計分。

- Which of the following name(s) is (are) correct? 1. Sulfide S^{2-} 2. Ammonium chloride NH_4Cl 3. Acetic acid $C_2H_4O_2$ 4. Xylene C_7H_8
 (a) all (b) 1,2,3 (c) 1, 2 (d) 3, 4 (e) None of above answers.
- What weight of sodium formate must be added to 400ml of 1.0M formic acid. ($HCOOH$, $K_a = 1.77 \times 10^{-4}$) to prepare a buffer solution that has a pH of 4.0
 (a) 0.48 g (b) 4.82 g (c) 48.2g (d) 14.82g (e) None of above answers.
- Try to select the following compounds in order of decreasing the acid constants (pK_a values).
 (a) ethanol > water > p-nitrophenol > phenol > acetic acid. (b) water > ethanol > p-nitrophenol > phenol > acetic acid. (c) water > ethanol > phenol > p-nitrophenol > acetic acid. (d) ethanol > water > phenol > p-nitrophenol > acetic acid. (e) None of above answers.
- An unknown compound A rapidly decolorized a solution of bromine in carbon tetrachloride. When A was subjected to ozonolysis, the products were 2-butanone and 1-propanal. What might be the structure of A? (a) $CH_3-CH_2-(CH_3)C=CH-CH_2-CH_3$ (b) $CH_2=CH-(CH_3)CH-CH_2-CH_2-CH_3$ (c) $CH_3-CH_2-(CH_3)CH-CH=CH-CH_3$ (d) $CH_3-CH=C(CH_3)CH_2-CH_2-CH_3$ (e) None of above answers.
- The light sources of UV are widely used for environmental identifications and chemical treating processes. Compounds A and B have the formula C_5H_8 , and on hydrogenation all yield n-pentane. Their UV spectra show the following values of λ_{max} : A, 176nm; B, 211nm (1-pentene has λ_{max} 178nm). What are the likely structures for A and for B?
 (a) A: $CH_2=CH-CH=CH-CH_3$ (trans isomer), B: $CH_2=CH-CH=CH-CH_3$ (cis isomer)
 (b) A: $CH_2=CH-CH_2-CH=CH_2$, B: $CH_2=CH-CH=CH-CH_3$ (trans isomer)
 (c) A: $CH_2=CH-CH_2-CH=CH_2$, B: $CH_2=CH-CH=CH-CH_3$ (cis isomer),
 (d) A: $CH_2=CH-CH=CH-CH_3$ (trans isomer), B: $CH_2=CH-CH_2-CH=CH_2$, (e) None of above answers.

二. 計算題 (35%)

- (5分) 0.1M 乳酸($HC_3H_5O_3$)的水溶液，其解離百分率為 3.7%，試計算此酸 K_a 值。
- (7分) 乙炔(Acetylene) 酸解離數 ionization constants (k_a) 10^{-22} 。試計算 0.01M 乙炔在 14 M Potassium hydroxide 溶液中 乙炔離子(acetylide ion) 濃度(假設是 Ideal solution)? [hint: 反應式 $C_2H_2 + OH^- \rightleftharpoons H_2O + C_2H^-$ in Potassium hydroxide]。
- (7分) 假設 Toluene 平衡時在水中濃度為 50uM (u mol/l), 已知 Toluene 20 °C 亨利常數 2.8×10^{-1} (dimensionless), 試計算 20 °C 空氣中 Toluene 濃度值?並以 atm.m³/mol 表示亨利常數。
- (6分) 某電鍍廢水含 317 mg/L Cu^{2+} , 欲用 $Cu(OH)_2$ 使其沈降到 3 mg/L Cu^{2+} , 試問溶液中 OH^- 濃度應提升至多少 mole/L? ($K_{sp} = 2 \times 10^{-19}$)
- (10分) 25°C 下, 水體中加入 $NaHCO_3$ 之總濃度為 0.01M, 不考慮活性校正時, 測量其 pH 為 8.3, 試求各物種濃度? $pK_{a1} = 6.4$ $pK_{a2} = 10.3$



三、說明題（15分）

1. Prokaryotes
2. 活性污泥之原生動物（5種）
3. 滅菌
4. 選擇培養基
5. 微生物與氮的循環的關係

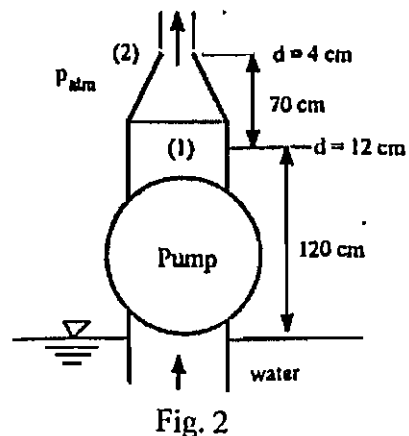
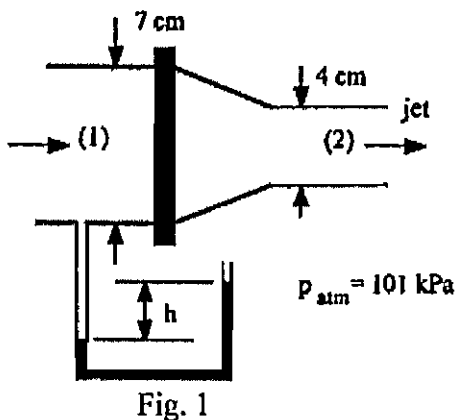
四、問答題（35分）

1. 大腸菌類（*Coliform*）基本上包括糞便內全部兼性需氧的革蘭氏陰性桿菌，主要分為哪四種菌屬？
2. 請說明影響消毒劑的因素。
3. 堆肥過程中，溫度和酸鹼度會有什麼變化？為什麼？
4. 到廢水處理場參觀，首觀察其曝氣槽，你該如何判定此槽的活性污泥是否正常？
5. 請說明活性污泥產生膨化的原因和可能參與的微生物。



(一) 選擇題(每題 5 分)

- If a uniform solid body weighs 50 N in air and 30 N in water, its specific gravity is
(a) 1.5 (b) 1.67 (c) 2.5 (d) 3.0 (e) 5.0
- A tank of water (SG = 1.0) has a gate in its vertical wall 5 m high and 3 m wide. The top edge of the gate is 2 m below the surface. What is the hydrostatic force on the gate?
(a) 147 kN (b) 367 kN (c) 490 kN (d) 661 kN (e) 1028 kN
- In Fig.1 water exits from a nozzle into atmospheric pressure of 101 kPa. If the flow rate is 160 gal/min, what is the average velocity at section 1?
(a) 2.6 m/s (b) 0.81 m/s (c) 93 m/s (d) 23 m/s (e) 1.62 m/s
- A fireboat pump delivers water to a vertical nozzle with a 3:1 diameter ratio, as shown in Fig. 2. If friction is neglected and the flow rate is 500 gal/min, how high will the outlet water jet rise?
(a) 2.0 m (b) 9.8 m (c) 32 m (d) 64 m (e) 98 m
- Given the steady velocity distribution $V = 3xi + 0j + Cyk$, where C is a constant, if the flow is irrotational, the value of C should be
(a) 3 (b) 3/2 (c) 0 (d) -3/2 (e) -3
- Given the parameters (U, L, g, ρ , μ) which affect a certain liquid flow problem. The ratio $V^2/(Lg)$ is usually known as the
(a) velocity head (b) Bernoulli head (c) Froude No. (d) kinetic energy (e) impact energy
- The Reynolds number for a 1-ft-diameter sphere moving at 2.3 mi/hr through seawater (specific gravity 1.027, viscosity $1.07E-3 \text{ N} \cdot \text{s/m}^2$) is approximately
(a) 300 (b) 3000 (c) 30,000 (d) 300,000 (e) 3,000,000
- In flow through a straight, smooth pipe, the diameter Reynolds number for transition to turbulence is generally taken to be
(a) 1500 (b) 2300 (c) 4000 (d) 250,000 (e) 500,000
- For flow of oil ($\mu = 0.1 \text{ kg}/(\text{m} \cdot \text{s})$, SG = 0.9) through a long, straight, smooth 5-cm diameter pipe at 14 m³/h, the pressure drop per meter is approximately
(a) 2200 Pa (b) 2500 Pa (c) 10,000 Pa (d) 160 Pa (e) 2800 Pa
- Consider a rectangular channel 3 m wide laid on a 1° slope. If the water depth is 2 m, the hydraulic radius is
(a) 0.43 m (b) 0.6 m (c) 0.86 m (d) 1.0 m (e) 1.2 m





(二) 計算題

- Write the conservation-of-mass relation for steady flow through a streamtube (flow everywhere parallel to the walls) with a single one-dimension exit 1 and inlet 2(Fig. 3). (10 分)
- The tank in Fig. 4 is being filled with water by two one-dimensional inlets. Air is trapped at the top of the tank. The water height is h . (a) Find an expression for the change in water height dh/dt . (b) Compute dh/dt if $D_1 = 1$ in, $D_2 = 3$ in, $V_1 = 3$ ft/s, $V_2 = 2$ ft/s, and $A_t = 2$ ft², assuming water at 20°C. (10 分)
- As shown in Fig. 5, a pipe bend is supported at point A and connected to a flow system by flexible couplings at sections 1 and 2. The fluid is incompressible, and ambient pressure p_a is zero. (a) Find an expression for the torque T which must be resisted by the support at A, in terms of the flow properties at sections 1 and 2 and the distances h_1 and h_2 . (b) Compute this torque if $D_1 = D_2 = 3$ in , $p_1 = 100$ lbf/in² gage, $p_2 = 80$ lbf/in² gage, $V_1 = 40$ ft/s, $h_1 = 2$ in, $h_2 = 10$ in, and $\rho = 1.94$ slugs/ft³. (20 分)
- Under what conditions does the velocity field

$$V = (a_1x + b_1y + c_1z)i + (a_2x + b_2y + c_2z)j + (a_3 + b_3y + c_3z)k$$
 where a_1, b_1 , etc. = const, represent an incompressible flow which conserves mass?(10 分)

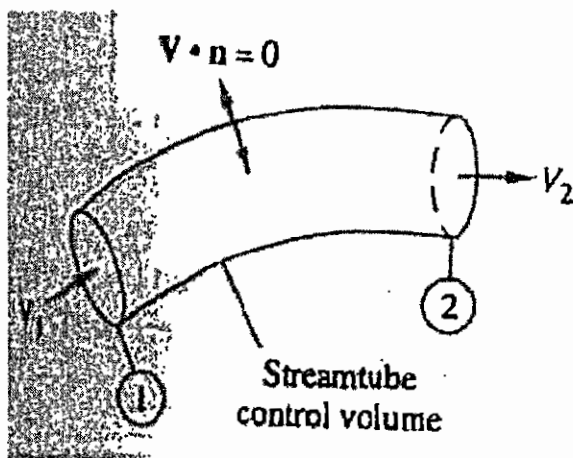


Fig. 3

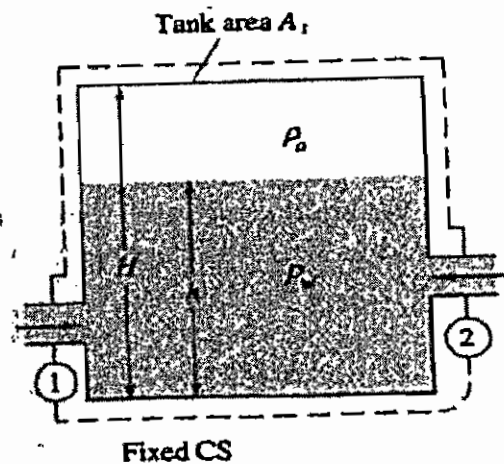


Fig. 4

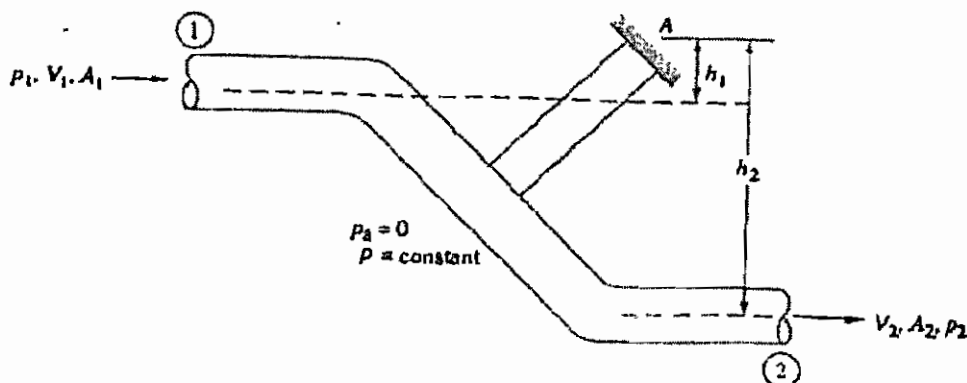


Fig. 5



請依題號作答並將答案寫在答案卷上，違者不予計分。

一、問答題：(80%)

- (1) 試述有靜電危害存在情況時之控制方法？(10%)
- (2) 試述火災四要素及滅火原理？(10%)
- (3) 試述靜電成爲石油類火災點火源之構成條件？(10%)
- (4) 請說明勞工健康檢查計畫應該包括哪些內容？(10%)
- (5) 請說明存在於空氣中的有害物的補集方法？(10%)
- (6) 行政院勞工委員會於九十一年十二月十八日修訂了「勞工安全衛生組織管理與自動檢查辦法」，其中第八十條對於定期檢查、重點檢查紀錄做了哪些變更？(10%)
- (7) 請說明阿司曼通風乾濕計構造與作用原理？(10%)
- (8) 請說明噪音對於人體的影響與危害？(10%)

二、計算題：(20%)

- (1) 設一 3,000 人之工廠，其工作日數爲每月工作 30 天，工作時數爲每日工作 8 小時。若某月份發生失能傷害事故 3 件，輕傷害 2 件，疾病 4 人，事故死亡 1 人，求其傷害率？傷害嚴重性？事故率 (I.R.)？(10%)
- (2) 丙酮之爆炸範圍爲 2.55~12.8%，試求使一加侖丙酮蒸發而不致造成燃燒或爆炸之最低空氣容積爲多少立方呎（設安全因子爲 4）？已知丙酮液體比重爲 0.792、丙酮蒸氣比重爲 2、水的密度爲 8.33 磅/加侖、空氣密度爲 0.075 磅/立方呎。(10%)



請依題號作答並將答案寫在答案卷上，違者不予計分。

一、是非題：(10%) (每題 2%)

1. () 兩物呈熱平衡時，兩物間及達到相同的溫度。
2. () 冷氣室門打開時，門楣上的紙條往內飄。
3. () 物質常保持恆溫時，就沒有吸收熱量。
4. () 多原子理想氣體在自由膨脹中，溫度升高。
5. () 當 100°C 水蒸氣凝結為水時，分子的質心動能不變。

二、選擇題：(30%) (每題 2%)

1. () 「熱平衡狀態」無論對開放系統或獨立系統，均成立的系統為 (A) 兩物之間熱交互作用 (B) 總能量維持不變 (C) 無法再與其他系統作熱的交互作用 (D) 溫度不在變化 (E) 兩物間無溫差。
2. () A、B 兩種不同的金屬製成複棒，如 A 的膨脹係數比 B 小，當溫度降低時 (A) 向 A 棒一方彎曲 (B) 向 B 棒一方彎曲 (C) 維持原狀 (D) A 棒彎曲，B 棒伸直 (E) A 棒伸直，B 棒彎曲。
3. () 鐵軌之長度為 50 m，於冬天氣溫 22°F 時鋪設。若再夏天氣溫 112°F 時，鄰接兩軌恰密接，問鋪軌時應留的空隙為若干厘米？ ($\alpha = 1.2 \times 10^{-5}/^{\circ}\text{C}$) (A) 1 mm (B) 2 mm (C) 3 mm (D) 4 mm (E) 5 mm。
4. () 水銀在 0°C 時的密度為 13.595 g/cm^3 ；設水銀的體膨脹係數為 $0.00018/^{\circ}\text{C}$ ，求 50°C 時水銀的密度 (g/cm^3) (A) 13.717 (B) 13.351 (C) 13.229 (D) 13.107 (E) 13.473。
5. () 將同質量之 100°C 的水蒸氣與 0°C 的冰置於一絕熱容器內，當達到熱平衡時，則下列敘述何者正確？ (A) 全部是液態 (B) 全部是氣態 (C) 氣態之質量為總質量的 $25/54$ ，液態之質量為總質量的 $29/54$ (D) 氣態之質量為總質量的 $1/4$ ，液態之質量為總質量的 $3/4$ (E) 氣態之質量為總質量的 $1/3$ ，液態之質量為總質量的 $2/3$ 。
6. () 已知 0°C 的冰， 47°C 的水及 100°C 的水蒸氣，其重量比為 8 : 7 : 1，若將三者混合之，求其最後溫度為 (A) 16°C (B) 18.7°C (C) 31.5°C (D) 54°C (E) 68.1°C 。
7. () 一運動員每天消耗 8000 仟卡的熱量，這熱能大約 100 瓦特的燈泡在一天內放出能量的 (A) 1 倍 (B) 2 倍 (C) 4 倍 (D) 10 倍 (E) 20 倍。
8. () 一雨滴自空中自由落下，若無能量損失，當落下 220 m 時，開始以等速落下，若此時雨點溫度升高 0.5°C ，則雨滴的末速(m/s)為 (A) 10 (B) 15 (C) 20 (D) 25 (E) 30。
9. () 曾在法國使用一段時間的溫度標定水的冰點為 0°R ，沸點為 80°R ，則正常人的體溫 37°C ，用此溫度標表示為 (A) 46.3°R (B) 37°R (C) 29.6°R (D) 22.2°R (E) 53.7°R 。



- 10.() 若 6 m^3 的氫在 STP 被壓縮入一容器後壓力 136 atm ， 27°C ，求此容器的體積為若干升？ (A) 16.2 (B) 32.4 (C) 48.5 (D) 64.8 (E) 81。
- 11.() 一氣體分子的平均動能可由下列何者決定？ (A) 僅由氣體分子數 (B) 僅由氣體壓力 (C) 僅由氣體的溫度 (D) 僅由氣體的分子數 (E) 以上無一者可單獨決定。
- 12.() 一高空研究汽球，其容積 500 m^3 。若用每桶 40 l ， 150 atm 的氮氣筒充氣，需多少桶才能使汽球內的氣壓為 1 atm ？ (A) 62 (B) 84 (C) 102 (D) 124 (E) 144。
- 13.() 一容器內含 0.1 莫耳的氫及 0.1 莫耳的氧。若氣體成熟平衡狀態，則 (A) 一個氧分子及一個氫分子有相同的平均動能 (B) 氧及氫分子的速率都相同 (C) 兩種氣體的速率都相同 (D) 兩種氣體的莫耳比熱以氧較大 (E) 氧分子的方均根速率較大。
- 14.() 將 1 莫耳的單原子氣體在定容下從 40°C 加熱至 100°C ，須吸熱若干卡？ (A) 748 (B) 640 (C) 482 (D) 365 (E) 179。
- 15.() 已知鋁的原子量為 27.0 g/mole ，求鋁的比熱為若干 $\text{Cal/g}\cdot^\circ\text{C}$ ？ (A) 0.11 (B) 0.13 (C) 0.15 (D) 0.18 (E) 0.22。

三、簡答：(30%)

1. 熱的傳播方式。(5%)

2. 請解釋查理-給呂薩克定律。(5%)

3. 試以物態變化來解釋手指會被剛從冰箱取出的金屬製冰盒黏住。(5%)

4. 請解釋若器壁和氣體的溫度不同時，和器壁碰撞是否可視為彈性碰撞？(5%)

5. 亞佛加厥學說「同溫同壓下，同體積的氣體含有相同數的分子」試由分子運動論與平均質心動能倒出此定律。(10%)



四、計算：(30%) (每題 10%)

1. 一學生在晚餐吃進 2000 千卡的熱量，他希望以舉重方式消耗掉等量的能量，若它所舉之能量為 50 Kg，且每次上舉時位移 2 m，下放時不作功，求 (1) 此學生應舉多少次？ (2) 每次消耗時 5 秒，舉多久才能消耗此熱量？

2. 一合金重為 300 克。如將此合金加熱，至 99.4°C 後，投入 400 克的水中，而裝水的銅製量熱器之質量為 90 克，其溫度自 20°C 升高 25.1°C ，(已知銅的比熱為 $0.093 \text{ cal}/^{\circ}\text{C}$)，求
 - (1) 合金的熱容量為若干 ($\text{cal}/^{\circ}\text{C}$)？
 - (2) 此合金的比熱為若干 ($\text{cal}/\text{g} \cdot ^{\circ}\text{C}$)？

3. 一容器體積 0.3 m^3 含 2 莫耳的氮氣在 20°C ，假設氮氣猶如理想氣體，且分子量為 4 g/mole ，求
 - (1) 系統總內能；
 - (2) 每一分子的平均動能；