國立中山大學九十三學年度轉學生招生考試試題

Full marks are 100; the marks are indicated within questions.

I.

(a) [10%] Evaluate $\int_0^\infty e^{-st}\cos at\,dt$ for $a, s > 0$.

(b) [15%] Evaluate $\int_0^1 x^3\sqrt{1-x^2}\,dx$.

II.

(a) [10%] Find the Taylor series for e^x at $x = -1$.

(b) [15%] Find the interval of convergence of the power series $\sum_{n=1}^\infty \frac{(x-1)^n}{2^{n+1}}$.

III.

(a) [10%] Let $f(x,y) = x^3y$. Calculate the directional derivative of f in the direction of the vector $\mathbf{v} =< 1, -1 >$ at the point $(1,2)$.

(b) [15%] Find the mass of the ball $x^2+y^2+z^2 \le 1$ if its density at a point is the square root of the distance from the point to the origin.

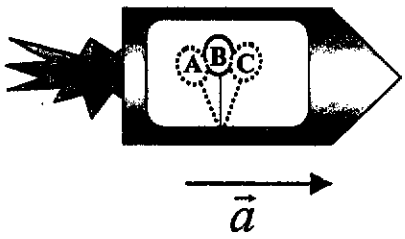
IV.

(a) [10%] Evaluate the line integral $\int_C \mathbf{f}\cdot d\mathbf{r}$ where $\mathbf{f}(x,y) = (x^2 + xy^2, x^2y + y^2)$ and C is the parabola $y = x^2 - 2x$ from $(0,0)$ to $(2,0)$.

(b) [15%] Evaluate the surface integral $\int\int_S x\,d\sigma$ where $S = \{(x,y,z) : z = x^2, 0 \le x \le 1, 0 \le y \le 2\}$.

Selections (5% for each question, total 30%)

1. A tank is filled up with pure water and is carried by a rocket acceleration horizontally to the right as shown in the figure 1. A balloon a fixed by a wire attached to the bottom of the water tank, where will the balloon stabilize at (1) A, (2) B, (3) C and (4) the bottom of the tank.



2. An ambulance running with a velocity of $\vec{v}_0$ away from an observer who stands still on the ground. If the emergency alarm is of frequency f, what frequency (f') should the observer hear? (a) $f' = f\left(1-\frac{v_0}{v}\right)$, (b) $f' = f\left(1+\frac{v_0}{v}\right)$, (c) $f' = f\left(\frac{1}{1-\frac{v_0}{v}}\right)$, (d) $f' = f\left(\frac{1}{1+\frac{v_0}{v}}\right)$.

3. What will happen when a balloon filled with He gas is warmed up? (a) He atoms moves slower, (b) He atoms moves faster, (c) He atoms moves toward the same direction, (d) the speed of He atoms does not change.

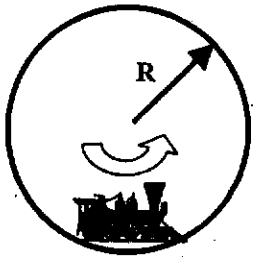
4. A conductor is charged with Q. What is the electric field (E) and the electric potential (V) inside the conductor? (a) E = constant , V = constant; (b) E = constant, V = 0; (c) E = 0, V = 0; (d) E = 0, V = constant.

5. Two parallel wires carry the same current that flow in the same direction, the two wires will (a) remain still; (b) reject each other; (c) attract with each other; (d) become twisted.

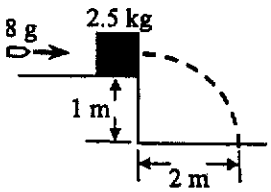
6. Total reflection will occurred at an interface when light is traveling from (a) the medium with small n to the medium with large n, (b) the medium with large n to the medium with small n, (c) mediums with the same refractive index, (d) the air into water. (n is the refractive index)

Calculations (total 70%)

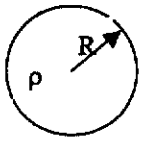
1. (15%)A train of mass *m* is running on a vertical circle rail with radius of R as shown in the right figure.
   (a) In order to run through the top of the rail without falling down, what does the minimum speed the train need?
   (b) What is the normal force at the bottom of the rail need to support the train?



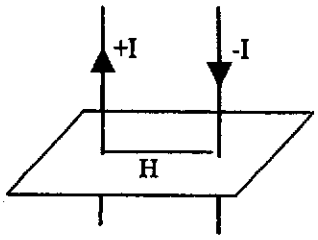
2. (10%)An 8-g bullet is fired into a 2.5-kg block initially at rest at the edge of a frictionless table of height 1 m. The bullet remains in the block, and after impact the block lands 2 m from the bottom of the table. Determine the initial speed of the bullet.



3. (25%)A sphere with a radius R contains charges distributed as $\rho = br$ where ρ and r are the charge density and the distance to the center of the sphere. Please calculate the electric field ($\vec{E}$) and the electric potential (V) at r < R, r = R and r < R.



4. (20%)Two parallel conduction wires carry the same current I in oppersite directions and separate each other with a distance H. Please determine the magnetic force on each other?



國立中山大學九十三學年度轉學生招生考試試題

科目：普通化學【海工系二年級】

MULTIPLE CHOICE (單選，每題4分)

1. Wherever it is found, water is always found to contain oxygen and hydrogen in the mass ratio of 8 to 1. Taken by itself, this fact demonstrates what natural law?

   a) Conservation of Mass
   b) Constant Composition
   c) Multiple proportions
   d) The Atomic Theory
   e) Periodicity

2. How many iron ions (Fe^{3+}) are present in 43.6 g $FeCl_3$?

   a) 1.62×10^{23}
   b) 6.50×10^{23}
   c) 4.23×10^{23}
   d) 3.72
   e) 0.807

3. Calculate the mass percent of nitrogen in HNO_3.

   a) 22.2
   b) 20.0
   c) 25.0
   d) 76.2
   e) none of these

4. What is the oxidation number of chromium in $Cr_2O_7^{-2}$?

   a) +2
   b) +3
   c) +4
   d) +6
   e) -3

5. Which of the following laws concerning gases is misstated?

   a) in a mixture of gases, the total pressure of the gases equals the sum of the individual pressures of each gas.
   b) at fixed temperature and pressure, the volume of a gas is inversely proportional to the number of moles of that gas.
   c) at fixed pressure, the volume of a gas is directly proportional to its temperature in Kelvin.
   d) at fixed temperature, the volume of a gas is inversely proportional to its pressure.
   e) the average translational kinetic energy of the molecules of a gas is directly proportional to the temperature in Kelvin.

6. A helium balloon is filled on the ground where the atmospheric pressure is 768 torr. The volume of the balloon is 8.00 m^3. When the balloon reaches an altitude of 4200 m, its volume is found to be 16.8 m^3. Assuming that the temperature remains constant, what is the air pressure at 4200 m in torr?

   a) 1.61×10^3
   b) 366
   c) 543
   d) 111
   e) 89

7. Which is not true for an endothermic reaction?

   a) The temperature of the surroundings decreases.
   b) The enthalpy change for the reaction is positive.
   c) Heat flows from the surroundings into the system.
   d) The products have a lower enthalpy than the reactants.
   e) All of the above are true.

8. What is the frequency, in Hz, of blue light with a wavelength of 465 nm?

a) 6.45×10^{14}
b) 465
c) 1.55×10^{14}
d) 4.65
e) 4.65×10^{14}

9. What is the total number of orbitals in the principal shell n = 3?

a) 1
b) 4
c) 8
d) 9
e) 18

10. Which of the following subshell notations reflects an atom in the ground state?

a) $1s^2 2s^2 2p^2 3s^1$
b) $1s^2 2s^2 2p^6 3s^3$
c) $1s^2 2s^2 3s^2$
d) $1s^2 2s^2 2p^6 3s^2 3d^5$
e) $1s^2 2s^2 2p^6$

11. What is the ground state electron configuration of sulfur?

a) $[Ne]\, 2s^2 2p^4$
b) $[Ar]\, 2s^2 2p^4$
c) $[Ne]\, 3s^2 3p^4$
d) $[Ne]\, 3s^2 3d^4$
e) $[Ar]\, 2p^6$

12. What is the appropriate VSEPR notation for the central atom BF_3?

a) AX_2
b) AX_2E
c) AX_3
d) AX_3E
e) AX_2E_2

13. The fact that the BF_3 molecule is planar means that the B atom is:

a) unhybridized
b) sp^3 hybridized
c) sp^2 hybridized
d) sp hybridized
e) involved in resonance

14. Which of the following quantities would be largest (most positive)?

a) ΔH_{vap}
b) ΔH_{fusion}
c) $\Delta H_{sublimation}$
d) $\Delta H_{condensation}$
e) $\Delta H_{melting}$

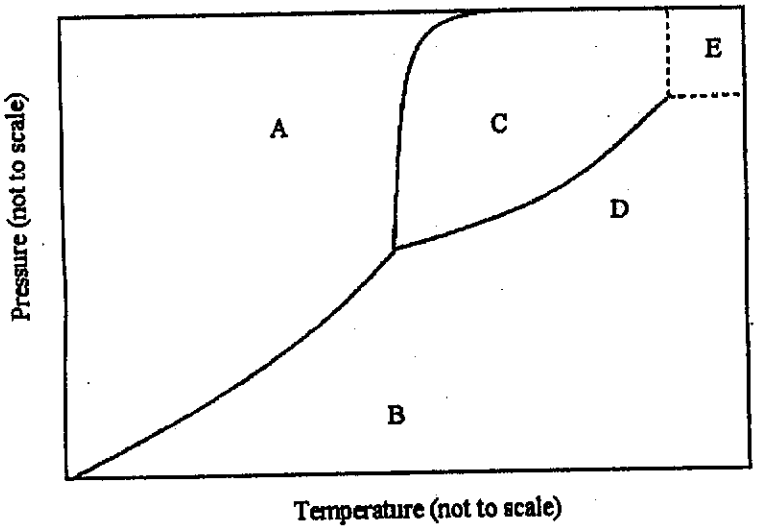
15. Which statement is incorrect?

a) Decreasing the external pressure decreases the boiling point of a liquid.
b) The normal boiling point is the temperature at which the vapor pressure equals 1 atm.
c) The density of a liquid decreases with increasing temperature, while that of the vapor increases.
d) Even above the critical temperature, increasing the pressure on a gas should make it liquefy.
e) A supercritical fluid exists at temperatures above T_C and pressures above P_C.

16. Consider the phase diagram for CO_2. In going from point A to point B:

a) liquid CO_2 becomes solid.
b) gaseous CO_2 becomes solid.
c) solid CO_2 becomes liquid.
d) solid CO_2 becomes gaseous.
e) liquid CO_2 becomes gaseous.

Phase Diagram for Carbon Dioxide, CO_2



17. How many grams of water should be added to 25.0 g NaCl to produce a 0.450 m solution?

a) 5.19
b) 26.3
c) 105
d) 951
e) 55.6

18. Which of the following is not an example of a dynamic equilibrium? (assume that the situation doesn't change with time)

a) a supersaturated solution
b) solid solute in saturated solution
c) liquid and vapor in a closed container
d) liquid and vapor at the normal boiling point
e) solute gas and liquid solvent in a closed container

19. Which statement is not correct regarding the function of a catalyst.

a) it lowers the activation energy
b) it changes the mechanism of a reaction
c) it affects the rate of a chemical reaction
d) it lowers the energy of the product causing the reaction to be more exothermic
e) none of the above is incorrect

20. Which of the following statements would be correct regarding the following reaction?

$$2\ H_2(g) + O_2(g) \text{ -----> } 2\ H_2O(g)$$

a) The rate of O_2 disappearance is twice the rate of H_2 disappearance.
b) The rate of H_2 disappearance is twice the rate of O_2 disappearance.
c) The rate of H_2O disappearance is twice the rate of O_2 disappearance.
d) The rate of H_2O appearance is equal to the rate of O_2 disappearance.
e) The rate of H_2 disappearance is equal to the rate of O_2 disappearance.

21. Which statement is incorrect?

a) The half-life of a zero order reaction is directly proportional to the initial concentration (i.e., the greater the concentration the longer the half-life).
b) The half-life of a first order reaction is directly proportional to the initial concentration.
c) The half-life of a second order reaction is inversely proportional to the initial concentration.
d) The half-life of a first order reaction is independent of the initial concentration.
e) The shorter the half-life, the faster is the reaction.

22. A chemical system is at equilibrium

a) when the concentration of reactants and products are equal.
b) when all of the reactants have been used up.
c) when the rate of the forward reaction becomes zero.
d) when the rates of the forward reaction and the reverse reaction are both zero.
e) when the rates of the forward reaction and the reverse reaction are equal.

23. Which is not correct concerning equilibrium?

a) The concentration of reactants and products are no longer changing.
b) The rates of the forward and reverse reactions are the same.
c) Either the reactants or the products of a reaction could be used to attain equilibrium for a reversible reaction.
d) At equilibrium, the rates of the forward and reverse reaction become zero.
e) The ratio of the concentrations of products and reactants, raised to appropriate powers, is a constant.

24. Given the thermochemical equation:

$$2NO(g) + O_2(g) \text{ -----> } 2NO_2(g) \quad \Delta H^\circ = -114.0\ kJ$$

calculate ΔH° for the following reaction:

$$NO_2(g) \text{ -----> } NO(g) + 1/2\ O_2(g)$$

a) +114.0 kJ
b) +57.0 kJ
c) -114 kJ
d) -57.0 kJ
e) +128 kJ

25. Which process is accompanied by a decrease in entropy for the system?

a) water evaporates
b) dry ice sublimes
c) ethanol condenses
d) sodium chloride dissolves
e) wax melts

PERIODIC TABLE OF THE ELEMENTS

1 IA	2 IIA	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8	9 VIIIB	10	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1 H 1.008																	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 23.00	12 Mg 24.30											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	71 Lu 175.0	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.0	103 Lr (260)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)									

Key: 1 H 1.008 — Atomic Number, Symbol, Atomic Mass

Approved by the I.U.P.A.C. Council in Geneva, August 30, 1997

Lanthanide series	57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.2	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0
Actinide series	89 Ac 227.0	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np 237.0	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)