Do all the problems in detail.

1. (a) Find the limit $\lim_{x\to 0^+} x\sin(1/x^2)$ if it exists. (10%)

   (b) Find the relative extreme values of $f(x)=\frac{x^2+1}{x}$. (10%)

2. (a) Evaluate $\int_1^2 x^2\ln x\,dx$. (10%)

   (b) Evaluate the integral $\int_0^2 \sqrt{x(2-x)}\,dx$. (10%)

3. (a) Evaluate the integral $\int_0^{\pi/2}\sin^3 x\,dx$. (10%)

   (b) Evaluate the integral $\int_2^3 \frac{x}{x^2-1}\,dx$. (10%)

4. (a) Let $f(x,y)=e^{xy^2}+x^2\ln y$. Find all first-order and second-order partial derivatives of f. (10%)

   (b) Find all critical points for $f(x,y)=x^2+y^2-2x-4y+5$ and determine whether each corresponds to a relative maximum, a relative minimum, or a saddle point. (10%)

5. (a) Let $R=\{(x,y)|1\le x\le 2, 0\le y\le 3\}$. Evaluate the double integral $\int\int_R(4x+xy^2)\,dA$. (10%)

   (b) Let $R=\{(x,y)|-1\le x\le 1, y\ge 0, 1\le x^2+y^2\le 4\}$. Evaluate the double integral $\int\int_R x^2y\,dA$. (10%)

End of Paper

國立中山大學100學年度學士班轉學生招生考試試題

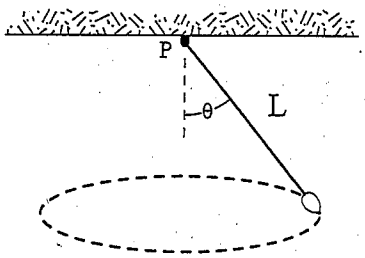
科目：普通物理【海洋環境及工程學系二年級】

一.單選題，共二十題，每題四分

1. A block of mass m is initially moving to the right on a horizontal frictionless surface at a speed v. It then compresses a spring of spring constant k. At the instant when the kinetic energy of the block is equal to the potential energy of the spring, the spring is compressed a distance of:

(A) $v\sqrt{m/2k}$ (B) $(1/2)mv^2$ (C) $(1/4)mv^2$ (D) $mv^2/4k$ (E) $(1/4)\sqrt{mv/k}$

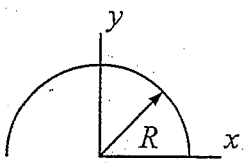
2. A hanged ball moves in a horizontal circle, as shown in the figure below. The length of the string is L, and the gravitational acceleration is g. What is the period of this circular motion?



(A) $2\pi\sqrt{\frac{L\cos\theta}{g}}$ (B) $\sqrt{\frac{L\cos\theta}{g}}$ (C) $\frac{1}{2\pi}\sqrt{\frac{L\cos\theta}{g}}$

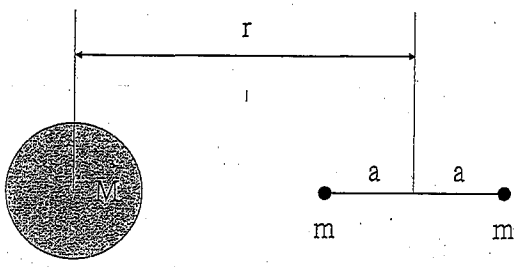
(D) $2\pi\sqrt{\frac{L}{g}}\cos\theta$ (E) $\frac{1}{2\pi}\sqrt{\frac{L}{g}}\cos\theta$

3. Where is the center of mass for the thin semicircular ring (mass M)?



(A) (0, $\frac{R}{M}$) (B) (0, $\frac{3R}{M}$) (C) (0, $\frac{4R}{M}$) (D) (0, $\frac{R}{2M}$) (E) (0, $\frac{2R}{M}$)

4. A dumbbell has a massless rod and a rod length of 2a. It is placed next to a solid sphere. If r>>a, what is the force difference (the tidal force) between the two particles?



(A) $\frac{4GMa}{5r^3}$ (B) $\frac{4GMa}{r^3}$ (C) $\frac{GMa}{r^3}$ (D) $\frac{GMm}{r^2}$ (E) $\frac{4GMm}{r^3}$

5. A spring (k = 600 N/m) is placed in a vertical position with its lower end supported by a horizontal surface. A 2.0-kg block that is initially 0.40 m above the upper end of the spring is dropped from rest onto the spring. What is the kinetic energy of the block at the instant it has fallen 0.50 m (compressing the spring 0.10 m)?

(A) 5.3 J (B) 6.8 J (C) 6.3 J (D) 5.8 J (E) 6.5 J

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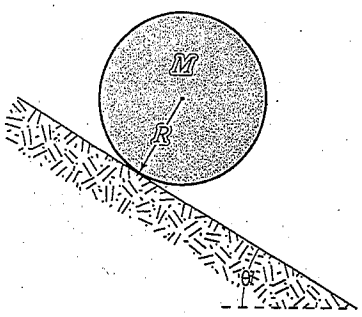
6. A 2.0-kg object moving 5.0 m/s collides with and sticks to an 8.0-kg object initially at rest. Determine the kinetic energy lost by the system as a result of this collision.

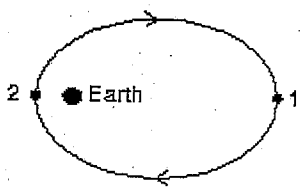
(A) 20 J (B) 15 J (C) 30 J (D) 25 J (E) 5.0 J

7. A solid cylinder rolls without slipping down an incline as shown in the figure. The linear acceleration of its center of mass is



(A) $(5/7)g\sin\theta$ (B) $(1/2)g\sin\theta$ (C) $(2/3)g\sin\theta$ (D) $(3/5)g\sin\theta$ (E) $(4/5)g\sin\theta$

8. A small satellite is in elliptical orbit around Earth as shown. If L denotes the magnitude of its angular momentum and K denotes kinetic energy:



(A) $L_2 > L_1$ and $K_2 > K_1$ (B) $L_2 > L_1$ and $K_2 = K_1$
(C) $L_2 = L_1$ and $K_2 = K_1$ (D) $L_2 < L_1$ and $K_2 = K_1$
(E) $L_2 = L_1$ and $K_2 > K_1$

9. If $y = 0.02 \sin(30x - 400t)$ (SI units) and if the mass density of the string on which the wave propagates is 0.005 kg/m, then the transmitted power is:

(A) 1.03 W. (B) 2.13 W. (C) 4.84 W. (D) 5.54 W. (E) 106 W.

10. The temperature of n moles of an ideal monatomic gas is increased by T at constant pressure. The energy Q absorbed as heat, change E_{int} in internal energy, and work W done by the environment are given by:

(A) $Q = (5/2)nRT$, $E_{int} = 0$, $W = -nRT$
(B) $Q = (3/2)nRT$, $E_{int} = (5/2)nRT$, $W = -(3/2)nRT$
(C) $Q = (5/2)nRT$, $E_{int} = (5/2)nRT$, $W = 0$
(D) $Q = (3/2)nRT$, $E_{int} = 0$, $W = -nRT$
(E) $Q = (5/2)nRT$, $E_{int} = (3/2)nRT$, $W = -nRT$

11. During a reversible adiabatic expansion of an ideal gas, which of the following is NOT true?

(A) $pV^{\gamma} = \text{constant}$ (B) $pV = nRT$ (C) $TV^{\gamma-1} = \text{constant}$
(D) $W = -pdV$ (E) $pV = \text{constant}$

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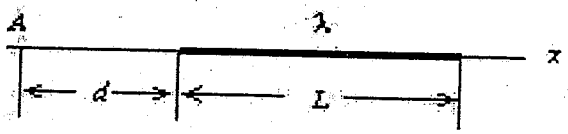
12. The pressure of the gas depends on
(A) average speed squared (B) average squared speed (C) square of the average speed
(D) root-mean-square speed (E) square root of the average speed

13. Positive charge Q is placed on a conducting spherical shell with inner radius R_1 and outer radius R_2. A point charge q is placed at the center of the cavity. The magnitude of the electric field at a point outside the shell, a distance r from the center, is:
(A) $Q/4\pi\varepsilon_0 R_1^2$ (B) $Q/4\pi\varepsilon_0\left(R_1^2-r^2\right)$ (C) $q/4\pi\varepsilon_0 r^2$ (D) $(q+Q)/4\pi\varepsilon_0 r^2$ (E) $(q+Q)/4\pi\varepsilon_0\left(R_1^2-r^2\right)$

14. A charge of +3.0 μC is distributed uniformly along the circumference of a circle with a radius of 20 cm. How much external energy is required to bring a charge of 25μC from infinity to the center of the circle?
(A) 5.4 J (B) 3.4 J (C) 4.3 J (D) 2.7 J (E) 6.8 J

15. A wire of uniform charge density λ and length L lies along the x axis as shown in Figure. What is the electric potential at point A? [$k=1/(4\pi\varepsilon)$]
(A) $k\lambda\ln[1+d/L]$ (B) $k\lambda\ln[1+L/d]$
(C) $k\lambda L/d$ (D) $k\lambda d/L$ (E) $k\lambda d/(L+d)$.



16. A dipole of dipole moment p is placed in a uniform electric field E. The maximum potential energy difference that can occur as the dipole is rotated is
(A) 0 (B) pE (C) 2 pE (D) πpE (E) pE/π

17. The semicircular wire of radius R connects two straight wire segments. If a current I follows along the wire, the magnetic field at the center of the semicircular wire due to the current in the semicircular wire is
(A) μ_0 I/(2R) (B) μ_0 I/(4R) (C) μ_0 I/(8R) (D) μ_0 I/(2πR) (E) μ_0 I/(4πR)

18. Two conducting spheres have radii R_1 and R_2, with R_1 greater than R_2. If they are far apart the capacitance is proportional to:
(A) $R_1 R_2/(R_1-R_2)$ (B) $R_1^2-R_2^2$ (C) $(R_1-R_2)/R_1 R_2$ (D) $R_1^2+R_2^2$
(E) none of these.

19. An inductance L, resistance R, and ideal battery of emfeare wired in series. A switch in the circuit is closed at time 0, at which time the current is zero. At any later time t, the emf of the inductor is given by:
(A) $\varepsilon(1-e^{-Lt/R})$ (B) $\varepsilon e^{-Lt/R}$ (C) $\varepsilon(1+e^{-Rt/L})$ (D) $\varepsilon e^{-Rt/L}$ (E) $\varepsilon(1-e^{-Rt/L})$

20. A 2-μF capacitor in series with a 2-k resistor is connected to a 60-Hz ac source. Calculate the impedance of the circuit.
(A) 1500 ohms (B) 1800 ohms (C) 2100 ohms (D) 2400 ohms (E) 8600 ohms

二計算題，共二十分

1. A block of mass M is connected to a spring of mass m and oscillates in simple harmonic motion on a horizontal, frictionless track. The force constant of the spring is k, and the equilibrium length is L. Find

(a) the kinetic energy of the system when the block has a speed v. (10%)

(b) the period of oscillation. (10%)

(Hint: Assume that all portion of the spring oscillate in phase and that the velocity of a segment dx is proportional to the distance x from the fixed end.)

選擇題(單選)，每題2.5分，共100分

1) The correct name for MgF_2 is _____.
A) magnesium fluoride
B) manganese difluoride
C) monomagnesium difluoride
D) manganese bifluoride
E) magnesium difluoride

2) A sample of CH_4O with a mass of 32.0 g contains _____ molecules of CH_4O.
A) 32.0
B) 5.32 × 10-23
C) 1.88 × 1022
D) 1.00
E) 6.02 × 1023

3) The balanced reaction between aqueous potassium hydroxide and aqueous acetic acid is _____.
A) $KOH\ (aq) + HC_2H_3O_2\ (aq) \rightarrow H_2KC_2H_3O\ (aq) + O_2\ (g)$
B) $KOH\ (aq) + HC_2H_3O_2\ (aq) \rightarrow H_2O\ (l) + KC_2H_3O_2\ (aq)$
C) $KOH\ (aq) + HC_2H_3O_2\ (aq) \rightarrow OH^-\ (l) + HC_2H_3O_2^+\ (aq) + K\ (s)$
D) $KOH\ (aq) + HC_2H_3O_2\ (aq) \rightarrow KC_2H_3O_3\ (aq) + H_2\ (g)$
E) $KOH\ (aq) + HC_2H_3O_2\ (aq) \rightarrow H_2C_2H_3O_3\ (aq) + K\ (s)$

4) When a system _____, ΔE is always negative.
A) absorbs heat and does work
B) absorbs heat and has work done on it
C) gives off heat and has work done on it
D) gives off heat and does work
E) none of the above is always negative.

5) At maximum, an f-subshell can hold _____ electrons, a d-subshell can hold _____electrons, and a p-subshell can hold _____ electrons.
A) 2, 8, 18 B) 2, 12, 21 C) 14, 8, 2 D) 14, 10, 6
E) 2, 6, 10

6) This element is more reactive than lithium and magnesium but less reactive than potassium. This element is _____.
A) Be B) Ca C) Rb D) Na
E) Fr

7) Bond enthalpy is _____.
A) always zero
B) always negative
C) always positive
D) sometimes positive, sometimes negative
E) unpredictable

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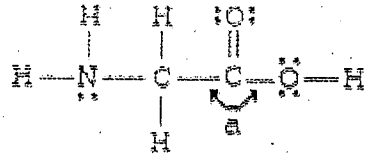
8) The bond angle marked "a" in the following molecule is about _____.



A) 109.5° B) 60° C) 120° D) 90° E) 180°

9) Pressure has an appreciable effect on the solubility of _____ in liquids.
A) solids and liquids
B) solids
C) gases
D) liquids
E) salts

10) At equilibrium, _____.
A) the rate constants of the forward and reverse reactions are equal
B) all chemical reactions have ceased
C) the rates of the forward and reverse reactions are equal
D) the value of the equilibrium constant is 1
E) the limiting reagent has been consumed

11) Which one of the following is a BrØnsted-Lowry acid?
A) HF
B) HNO_2
C) CH_3COOH
D) $(CH_3)_3NH^+$
E) all of the above

12) The standard Gibbs free energy of formation of _____ is zero.

(a) H_2O (l)
(b) O (g)
(c) H_2 (g)

A) (a) only
B) (b) only
C) (c) only
D) (b) and (c)
E) (a), (b), and (c)

13) A reversible process is one that _____.
A) must be carried out at high temperature
B) is spontaneous in both directions
C) must be carried out at low temperature
D) happens spontaneously
E) can be reversed with no net change in either system or surroundings

14) Of the following, the entropy of _____ is the largest.
A) HCl (l) B) HCl (g) C) HCl (s) D) HBr (g) E) HI (g)

15) The molar concentration of hydroxide ion in pure water at 25°C is _____.
A) 0.00 B) 1.0×10^{-14} C) 7.00 D) 1.0×10^{-7} E) 1.00

16) Nitric acid is a strong acid. This means that _____.
A) HNO_3 cannot be neutralized by a weak base
B) aqueous solutions of HNO_3 contain equal concentrations of $H^+(aq)$ and $OH^-(aq)$
C) HNO_3 dissociates completely to $H^+(aq)$ and $NO_3^-(aq)$ when it dissolves in water
D) HNO_3 produces a gaseous product when it is neutralized
E) HNO_3 does not dissociate at all when it is dissolved in water

17) The K_{eq} for the equilibrium below is 0.112 at 700.0°C.

$$SO_2(g) + \frac{1}{2}O_2(g) \rightleftharpoons SO_3(g)$$

What is the value of K_{eq} at this temperature for the following reaction?

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

A) 0.0125 B) 0.0560 C) 0.335 D) 0.112 E) 0.224

18) The equilibrium-constant expression for the reaction

$$Ti(s) + 2Cl_2(g) \rightleftharpoons TiCl_4(l)$$

is given by
A) $\dfrac{[TiCl_4(l)]}{[Ti(s)][Cl_2(g)]}$
B) $[Cl_2(g)]^{-2}$
C) $\dfrac{[Ti(s)][Cl_2(g)]^2}{[TiCl4(l)]}$
D) $\dfrac{[TiCl_4(l)]}{[Cl_2(g)]^2}$
E) $\dfrac{[TiCl_4(l)]}{[Ti(s)][Cl_2(g)]^2}$

19) Which of the following liquids will have the lowest freezing point?
A) pure H_2O
B) aqueous glucose (0.60 m)
C) aqueous sucrose (0.60 m)
D) aqueous KF (0.50 m)
E) aqueous FeI_3 (0.24 m)

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20) Of the concentration units below, only _____ is temperature dependent.
A) ppm B) mass % C) ppb D) molality E) molarity

21) Using the VSEPR model, the molecular geometry of the central atom in BCl_3 is _____.
A) linear
B) trigonal planar
C) trigonal pyramidal
D) bent
E) tetrahedral

22) _____ hybrid orbitals are used for bonding by Xe in the XeF_4 molecule.
A) sp^3d B) sp^3d^2 C) sp^3 D) sp E) sp^2

23) Lattice energy is _____.
A) the energy given off when gaseous ions combine to form one mole of an ionic solid
B) the sum of electron affinities of the components in an ionic solid
C) the energy required to produce one mole of an ionic compound from its constituent elements in their standard states
D) the sum of ionization energies of the components in an ionic solid
E) the energy required to convert a mole of ionic solid into its constituent ions in the gas phase

24) Of the following, _____ cannot accommodate more than an octet of electrons.
A) As B) O C) P D) I E) S

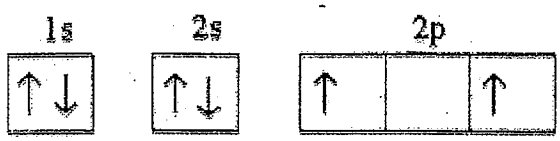
25) _____ have the lowest first ionization energies of the groups listed.
A) Transition elements
B) Noble gases
C) Alkaline earth metals
D) Alkali metals
E) Halogens

26) Consider the general valence electron configuration of ns^2np^5 and the following statements:
(i) Elements with this electron configuration are expected to form −1 anions.
(ii) Elements with this electron configuration are expected to have large positive electron affinities.
(iii) Elements with this electron configuration are nonmetals.
(iv) Elements with this electron configuration form acidic oxides.
Which statements are true?
A) (i) and (ii)
B) (i), (ii), and (iii)
C) (i), (iii,) and (iv)
D) (ii) and (iii)
E) All statements are true.

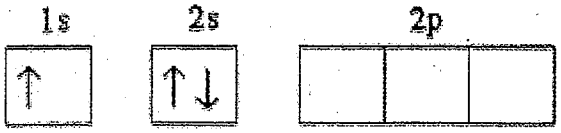
27) Which one of the quantum numbers does not result from the solution of the Schrodinger equation?
A) magnetic
B) spin
C) azimuthal
D) angular momentum
E) principal

28) Which electron configuration denotes an atom in its ground state?

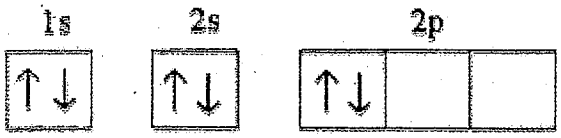
A)



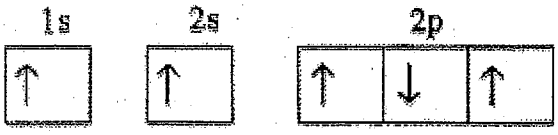
B)



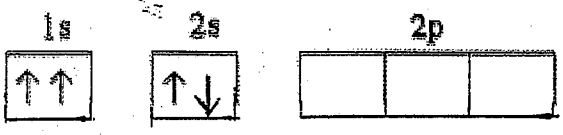
C)



D)



E)



29) ΔH for an endothermic process is _____ while ΔH for an exothermic process is _____.

A) zero, positive
B) positive, negative
C) zero, negative
D) positive, zero
E) negative, positive

30) The reaction

$$4Al\,(s) + 3O_2\,(g) \rightarrow 2Al_2O_3\,(s) \qquad \Delta H^\circ = -3351\ kJ$$

is _____, and therefore heat is _____ by the reaction.

A) exothermic, released
B) exothermic, absorbed
C) endothermic, absorbed
D) endothermic, released
E) thermoneutral, neither released nor absorbed

31) For which one of the following reactions is the value of ΔH°_{rxn} equal to ΔH°_f for the product?

A) $2H_2\,(g) + O_2\,(g) \rightarrow 2H_2O\,(g)$
B) $N_2\,(g) + O_2\,(g) \rightarrow 2NO\,(g)$
C) $2C\,(s, graphite) + 2H_2\,(g) \rightarrow C_2H_4\,(g)$
D) $H_2O\,(l) + 1/2\,O_2\,(g) \rightarrow H_2O_2\,(l)$
E) $2H_2\,(g) + O_2\,(g) \rightarrow 2H_2O\,(l)$

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32) With which of the following will the ammonium ion form an insoluble salt?
A) sulfate
B) carbonate
C) sulfate and carbonate
D) chloride
E) none of the above

33) Oxidation is the _____ and reduction is the _____.
A) gain of oxygen, loss of electrons
B) loss of oxygen, gain of electrons
C) gain of electrons, loss of electrons
D) loss of electrons, gain of electrons
E) gain of oxygen, loss of mass

34) Which one of the following is a diprotic acid?
A) phosphoric acid
B) nitric acid
C) sulfuric acid
D) hydrofluoric acid
E) chloric acid

35) The formula weight of ammonium sulfate ($(NH_4)_2SO_4$), rounded to the nearest integer, is _____ amu.
A) 116 B) 100 C) 132 D) 264 E) 118

36) The formula weight of aluminum sulfate ($Al_2(SO_4)_3$) is _____ amu.
A) 273.06 B) 150.14 C) 123.04 D) 59.04 E) 342.15

37) Automotive air bags inflate when sodium azide decomposes explosively to its constituent elements:

$$2NaN_3\,(s) \rightarrow 2Na\,(s) + 3N_2\,(g)$$

How many moles of N_2 are produced by the decomposition of 2.88 mol of sodium azide?
A) 0.960 B) 1.92 C) 8.64 D) 4.32 E) 1.44

38) Which metal is not required to have its charge specified in the names of ionic compounds it forms?
A) Fe B) Mn C) Ca D) Cu E) Pb

39) The element X has two naturally occurring isotopes. The masses (amu) and % abundances of the isotopes are given in the table below. The average atomic mass of the element is _____ amu.

Isotope	Abundance (%)	Mass (amu)
^{31}X	35.16	31.16
^{34}X	64.84	34.30

A) 35.22 B) 33.20 C) 30.20 D) 34.02 E) 32.73

40) Predict the charge of the most stable ion of bromine.
A) 2- B) 2+ C) 1- D) 1+ E) 3+