

※注意：請於「非選擇題作答區」依序作答，並標明作答之部分及其題號。

- (1) (3 pts) According to Bohr's model of the atom, which is the largest radius? (a) the  $n=1$  state of H. (b) the  $n=2$  state of H. (c) the  $n=3$  state of  $\text{Li}^{2+}$ . (d) the  $n=3$  state of H. (e) the  $n=4$  state of  $\text{He}^+$ .
- (2) (3 pts) For the one dimensional particle in a box if you double the length of the box the ground state energy will (a) decrease by a factor of 4. (b) decrease by a factor of 2. (c) stay the same. (d) increase by a factor of 2. (e) increase by a factor of 4.
- (3) (3 pts) If the bond in carbon monoxide is modeled as a harmonic oscillator the force constant is  $1860 \text{ N m}^{-1}$ , and the reduced mass is 6.86 amu. What is the energy of the ground vibrational state of CO? (a)  $1.35 \times 10^{-21} \text{ J}$  (b)  $2.71 \times 10^{-21} \text{ J}$  (c)  $3.53 \times 10^{-21} \text{ J}$  (d)  $2.13 \times 10^{-20} \text{ J}$  (e)  $4.26 \times 10^{-20} \text{ J}$  (The Planck constant is  $h=6.63 \times 10^{-34} \text{ J s}$ )
- (4) (3 pts) What is the probability of finding a particle in a box of length  $L$  between zero and  $L/2$ ? (a) 1 (b) 0.5 (c) 0.25 (d)  $L/2$  (e) it depends on the quantum number  $n$
- (5) (3 pts) Which of the follow are possible quantum numbers for a 3d wave function in a hydrogen atom? (a)  $n=2 \ l=3 \ m=3$  (b)  $n=3 \ l=0 \ m=0$  (c)  $n=3 \ l=3 \ m=-2$  (d)  $n=3 \ l=2 \ m=-1$  (e) none of the above
- (6) (3 pts) How many radial and angular nodes does a 4p orbital for a one electron atom have? (a) 3 radial, 1 angular (b) 2 radial, 2 angular (c) 2 radial, 1 angular (d) 2 radial, 0 angular (e) 1 radial, 1 angular
- (7) (3 pts) Which of the following has the highest bond order  $\text{O}_2$ ,  $\text{O}_2^+$ ,  $\text{N}_2$ ,  $\text{N}_2^+$ ? (a)  $\text{O}_2^+$  (b)  $\text{O}_2$  (c)  $\text{N}_2$  (d)  $\text{N}_2^+$  (e)  $\text{N}_2$  and  $\text{O}_2$  are the same and the highest
- (8) (3 pts) If you remove one of the electrons from  $\text{N}_2$  what will happen to its bond length? (a) the bond length will increase (b) the bond length will decrease (c) the bond length will stay the same (d) there will no longer be a bond in the molecule
- (9) (3 pts) The lowest energy antibonding orbital in  $\text{H}_2^+$  (a) has a node along the internuclear axis (b) has an energy that is higher than  $\text{H} + \text{H}^+$  (c) is antisymmetric with respect to inversion (d) a & b (e) all of the above
- (10) (3 pts) A MO orbital for a heteronuclear diatomic is given by  $\psi_{MO}^{\text{bonding}} = C_A\phi_A + C_B\phi_B$  where  $C_A$  and  $C_B$  are both positive. If A is more electronegative than B then you would predict that (a)  $C_A > C_B$  (b)  $C_A = C_B$  (c)  $C_A < C_B$  (d)  $C_A = -C_B$  (e) you would not expect any relation between these coefficients and the electronegativity of the elements A & B
- (11) (3 pts) In  $\text{CO}_2$  the hybridization of the C atom is (a) not hybridized (b) sp (c)  $\text{sp}^2$  (d)  $\text{sp}^3$  (e)  $\text{sp}^3\text{d}^2$
- (12) (3 pts) The complete combustion of 1 mole of cyclobutanol into carbon dioxide and water will yield how many moles of water? (a) 1 (b) 3.5 (c) 4 (d) 4.5 (e) 9
- (13) (3 pts) Oxidation of an aldehyde will result in the formation of (a) a primary alcohol (b) a secondary alcohol (c) a ketone (d) a carboxylic acid (e) an ester.
- (14) (3 pts) Why is there an energetic barrier to rotation of the C=C bond in ethene? (a) The trans isomer is more stable than the cis isomer. (b) Rotation breaks the  $\sigma$  C-C bond. (c) Rotation breaks the  $\pi$  C-C bond. (d) Steric repulsion between the hydrogen atoms. (e) There is no energy barrier to rotation of this bond.

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- (15) (3 pts) Benzene has a  $\pi$  electron system composed of the 6  $p_z$  orbitals on the carbon atoms? How many bonding and antibonding can be formed from these six atomic orbitals? (a) 6 bonding, 0 antibonding (b) 4 bonding, 2 antibonding (c) 3 bonding, 3 antibonding (d) 2 bonding, 4 antibonding (e) 6 bonding, 6 antibonding
- (16) (3 pts) What is the chemical formula of pentaamminechloroplatinum(IV) bromide? (a)  $[\text{Pt}(\text{NH}_3)_5\text{Cl}]\text{Br}$  (b)  $[\text{Pt}(\text{NH}_3)_5]\text{ClBr}$  (c)  $[\text{Pt}_5(\text{NH}_3)\text{Cl}]\text{Br}$  (d)  $[\text{Pt}(\text{NH}_3)_5\text{Cl}]\text{Br}_3$  (e)  $[\text{Pt}_2(\text{NH}_3)_5\text{Cl}]\text{Br}$
- (17) (3 pts) For a  $\text{Mn}^{2+}$  ion the number of unpaired electrons in an octahedral compound will be (a) greater in a weak field. (b) greater in a strong field. (c) the same in weak and strong fields. (d) will never have unpaired electrons.
- (18) (3 pts) Why are  $\text{Zn}^{2+}$  ions colorless in water? (a) they don't form coordination complexes with water. (b) the  $\text{Zn}^{2+}/\text{H}_2\text{O}$  coordination complexes have filled d orbitals. (c) the  $\text{Zn}^{2+}/\text{H}_2\text{O}$  coordination complexes are all paramagnetic. (d) the  $\text{Zn}^{2+}/\text{H}_2\text{O}$  coordination complexes are all tetrahedral. (e) none of the above
- (19) (3 pts) If air has a concentration of  $\text{CO}_2$  of 380 ppm, what is the partial pressure of  $\text{CO}_2$  if the total pressure of 0.99 atm? (a)  $3.76 \times 10^{-4}$  atm (b)  $3.84 \times 10^{-4}$  atm (c)  $3.84 \times 10^{-3}$  atm (d)  $3.76 \times 10^{-1}$  atm (e)  $3.84 \times 10^{-1}$  atm
- (20) (3 pts) From the kinetic theory of gases which do you predict is the fastest? (a) the most probable velocity of the gas. (b) the root mean square velocity of the gas. (c) the average velocity of the gas. (d) they will all be the same. (e) it depends on the molecular mass of the gas.
- (21) (3 pts) What types of intermolecular forces would you expect to find in  $\text{CHCl}_3$ ? (a) dispersion (b) dipole-dipole (c) hydrogen bonding (d) a & b (e) all of the above
- (22) (3 pts) For a given substance, the vapor pressure of a liquid can never be (a) equal to the pressure at the triple point. (b) equal to the critical temperature. (c) lower than the vapor pressure of the solid. (d) higher than the vapor pressure of the solid. (e) greater than 1 atm.
- (23) (3 pts) According to the Arrhenius theory, which of the following is a base? (a)  $\text{BH}_3$  (b)  $\text{C}_2\text{H}_5\text{OH}$  (c)  $\text{Ca}(\text{OH})_2$  (d) b and c (e) None of the above
- (24) (3 pts) On a per-mole basis, which of the following, when dissolved in water, will lower the freezing point most? (a)  $\text{NaCl}$  (b)  $\text{FeCl}_3$  (c)  $\text{MgCl}_2$  (d)  $\text{NH}_4\text{NO}_3$
- (25) (3 pts) For an adiabatic process involving ideal gases (a)  $q=w$  (b)  $w=0$  (c)  $\Delta U=0$  (d)  $\Delta U=w$  (e) a and d (f) none of the above
- (26) (3 pts) Which of the following is not a state function (a) U (b) P (c) V (d) H (e) PV (f) All of the above (g) None of the above
- (27) (3 pts) A process can be spontaneous at low temperature but non-spontaneous at high temperature if (a) both  $\Delta H$  and  $\Delta S$  are positive (b) both  $\Delta H$  and  $\Delta S$  are negative (c)  $\Delta H$  is positive and  $\Delta S$  is negative (d)  $\Delta H$  is negative and  $\Delta S$  is positive (e) this can never happen (f) More information is needed to answer the question
- (28) (3 pts) Which of the following is a Lewis acid? (a)  $\text{Fe}^{2+}$  (b)  $\text{BH}_3$  (c)  $\text{NH}_3$  (d) a and b (e) a and c (f) b and c (g) none of the above

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- (29) (3 pts) In a galvanic cell, oxidation always takes place in the: (a) cathode cell (b) anode cell (c) unable to answer without knowing sign of external potential (d) cell with the more positive reduction potential
- (30) (3 pts) For the half-reaction,  $\text{Br}_{2(l)} + 2 e^- \rightarrow 2 \text{Br}_{(aq)}$ , the standard reduction potential is 1.065 V. Thus for the half-reaction  $2 \text{Br}_{2(l)} + 4 e^- \rightarrow 4 \text{Br}_{(aq)}$ , (a)  $E^0=1.065\text{V}$  (b)  $E^0=0.532\text{V}$  (c)  $E^0=2.130\text{V}$  (d) Not enough information is given to answer the question. (e) None of the above
- (31) (3 pts) A certain first order reaction has a half life of 20.5 minutes. What is the value of the rate constant in  $\text{s}^{-1}$ . (a)  $3.38 \times 10^{-2}$  (b)  $5.64 \times 10^{-4}$  (c)  $1.47 \times 10^{-2}$  (d)  $3.38 \times 10^{-4}$
- (32) (3 pts) The rate constant for a second order reaction has the value of  $2.5 \times 10^{-3} \text{ L mol}^{-1} \text{ s}^{-1}$ . If the initial concentration of reactant is  $3.5 \text{ mol L}^{-1}$ , what will be the molar concentration of the reactant after 2.5 minutes? (a) 0.97 (b) 1.5 (c) 3.35 (d) 2.33 (e) none of the above
- (33) (4 pts) A simple VB wavefunction for NaH would be
- (a)  $\psi_g = C_1[1s^{Na}(1)1s^H(2) + 1s^{Na}(2)1s^H(1)]$
- (b)  $\psi_u = C_1[3s^{Na}(1)3s^H(2) - 3s^{Na}(2)3s^H(1)]$
- (c)  $\psi_g = C_1[3s^{Na}(1)1s^H(2) + 3s^{Na}(2)1s^H(1)]$
- (d)  $\psi_u = C_1[3s^{Na}(1)1s^H(2) - 3s^{Na}(2)1s^H(1)]$
- (e)  $\psi_u = C_1[1s^{Na}(1)1s^H(2) - 1s^{Na}(2)1s^H(1)]$

試題必須隨卷繳回