*可使用工程型計算機

Multiple Choice, choosing the one alternative that best completes the statement or answers the question (**4 points each**).

1. Perform the following mathematic operations, and express the result to **the correct number** of **significant figures**.
$\frac{2.526}{3.1}+\frac{0.470}{0.623}+\frac{80.705}{0.4326}=?$
[A] 188.1272　[B] 188.127　[C] 188.13　[D] 188.1　[E] 188

2. Which one of the following statements is **correct**?
[A] The systematic name for TeO_3^{2-} is tellurate ion.　[B] The systematic name for NO_2 is nitrogen(IV) oxide.
[C] The systematic name for $Mg_3(SbO_4)_2$ is magnesium antimonate.
[D] The systematic name for GaAs is gallium arsenate.　[E] The systematic name for Na_2O_2 is sodium oxide.

3. A 100.-L flask contains a mixture of methane (CH_4) and argon gases at 25℃. The mass of argon present is 228 g and the mole fraction of methane in the mixture is 0.650. **The total kinetic energy** for methane in the mixture is _____ J.
[A] 3.94×10^1　[B] 3.94×10^4　[C] 6.06×10^4　[D] 6.06×10^1　[E] 1.06×10

4. Given that a sample of air is made up of nitrogen, oxygen and argon in the mole fractions 78% N_2, 21% O_2 and 1.0% Ar, **the density** of air at standard temperature and pressure is _____ mg/L.
[A] 1.26×10^4　[B] 12.6×10^{-1}　[C] 1.26×10^1　[D] 1.3×10^2　[E] 1.3×10^3

5. The overall reaction in a commercial heat pack can be represented as $4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s)$, $\Delta H = -1652$ kJ. How much **heat** is released when 1.00 g Fe is reacted with excess of O_2?
[A] -7390 J　[B] -14760 J　[C] -1650 J　[D] -6600 J　[E] -2200 J

6. A hypothetical reaction, A + B +2C → 2D + 3E, has the rate law as Rate = $-(\Delta[A]/\Delta t) = k[A][B]^2$. An experiment is carried out when $[A]_0 = 0.01$ M, $[B]_0 = 3.0$ M and $[C]_0 = 2.0$ M. The reaction is started, and after 8 s, the concentration of A is 0.0038 M. Based on the information, **the concentration of A** after 13 s is _____ M.
[A] 0.0038　[B] 0.30　[C] 0.025　[D] 0.0021　[E] 0.00011

7. The rate constant for the gas-phase decomposition of N_2O_5, $N_2O_5 \rightarrow 2NO_2 + (1/2)O_2$ has the following temperature dependence: k (s^{-1}) = 4.9×10^{-3} at 338 K, 5.0×10^{-4} at 318 K, and 3.5×10^{-5} at 298 K. **The activation energy** for the reaction is ____ kJ/mol.
[A] 91.5　[B] 186　[C] 100　[D] 19　[E] 139

8. At a particular temperature, $K = 3.75$ for the reaction $SO_2(g) + NO_2(g) \rightleftharpoons SO_3(g) + NO(g)$. If all four gases had initial concentrations of 0.800 M, the calculated **equilibrium concentration** of **$SO_3(g)$** for this reaction is _____ M.
[A] 1.06　[B] 1.26　[C] 0.80　[D] 0.54　[E] 0.24

9. A 0.050 M solution of the salt NaB has a pH of 9.00. **The $[OH^-]$** of a 0.010 M solution of HB is thus _____ M.
[A] 4.6×10^{-11}　[B] 4.5×10^{-6}　[C] 3.0×10^{-9}　[D] 2.2×10^{-4}　[E] 2.2×10^{-5}

10. An excited hydrogen atom with an electron in the $n = 5$ state emits light having a frequency of 6.90×10^{14} s^{-1}. **The principal quantum level** for **the final state** in this electronic transition is calculated to be _____.
[A] 5　[B] 4　[C] 3　[D] 2　[E] 1

11. Which of the following statement **correctly** predict the molecular structure of each compound?
[A] IF_3, T-shaped [B] KrF_2, V-shaped [C] SO_2, linear [D] SeO_3, trigonal pyramid [E] CF_4, square planar

12. The standard enthalpies of formation for S(g), F(g), SF_4(g), and SF_6(g) are +278.8, +79.0, -775, and -1209 kJ/mol, respectively. Please use these data to estimate **the energy** of an **S-F bond** which could be _____.
[A] 342.5 kJ/mol [B] 357.8 kJ/mol [C] 434 kJ/mol [D] 419 kJ/mol [E] 201 kJ/mol

13. Which of the following statements is **correct**?
[A] The removal of one electron in O_2 decreases its bond order to 1.5.
[B] The bond strength of OF is expected to weaken as an electron is removed to form the positive charged ion.
[C] The bond strength of B_2 is expected to increase as an electron is removed to form the positive charged ion.
[D] CO^+ is diamagnetic. [E] The bond order of N_2^+ is 2.5.

14. Titanium metal has a body-centered cubic unit cell. The density of titanium is 4.50 g/cm^3. Please calculate **edge length** of the unit cell to be_____ pm.
[A] 328 [B] 32.8 [C] 1420 [D] 142 [E] 14.2

15. Carbon tetrachloride, CCl_4, has a vapor pressure of 213 torr at 40℃ and 836 torr at 80℃. What is **the normal boiling point** of CCl_4?
[A] 50℃ [B] 63℃ [C] 88℃ [D] 81℃ [E] 77℃

16. Consider the following solutions: 0.010 *m* Na_3PO_4 in water; 0.020 *m* $CaBr_2$ in water; 0.020 *m* KCl; 0.020 *m* HF in water (HF is a weak acid). Assuming complete dissociation of the soluble salts, which salt dissolved in water would have **the highest vapor pressure** at 28℃?
[A] 0.010 *m* Na_3PO_4 [B] 0.020 *m* $CaBr_2$ [C] 0.020 *m* KCl [D] 0.020 *m* HF
[E] They all have the same vapor pressure

17. Which of the following mixtures would result in **a buffered solution** when 1.0 L of each of the two solutions are mixed?
[A] 0.1 M KOH and 0.2 M CH_3NH_3Cl [B] 0.2 M KOH and 0.1 M CH_3NH_3Cl
[C] 0.1 M KOH and 0.2 M CH_3NH_2 [D] 0.1 M KOH and 0.1 M CH_3NH_3Cl
[E] 0.2 M KOH and 0.2 M CH_3NH_2

18. What is **the pH** at the equivalence point when 100.0 mL of 0.1 M $HC_7H_5O_2$ ($K_a = 6.4 \times 10^{-5}$) titrated by 0.10 M NaOH?
[A] 4.19 [B] 10.74 [C] 5.96 [D] 7.89 [E] 8.45

19. What is **the final concentrations** of $C_2O_4^{2-}(aq)$ in a solution prepared by adding 0.100 L of 0.200 M $K_2C_2O_4$ to 0.150 L of 0.250 M $BaBr_2$? (For BaC_2O_4, $K_{sp} = 2.3 \times 10^{-8}$)
[A] 3.3×10^{-7} M [B] 1.5×10^{-19} M [C] 0.07000 M [D] 0.300 M [E] 0.160 M

20. What is **the ΔG^o** for $H_2O(g) + (1/2)O_2 \longleftrightarrow H_2O_2(g)$ at 600. K using the following data:
$H_2(g) + O_2(g) \longleftrightarrow H_2O_2(g)$ $K = 2.3 \times 10^6$ at 600. K
$2H_2(g) + O_2(g) \longleftrightarrow 2H_2O(g)$ $K = 1.8 \times 10^{37}$ at 600. K?
[A] -7.1×10^4 J/mol [B] 1.4×10^5 J/mol [C] 1.1×10^5 J/mol [D] 7.9×10^3 J/mol [E] 1.0×10^3 J/mol

21. Consider the following reaction at 25℃: $2NO_2(g) \rightarrow N_2O_4(g)$. The values of ΔH^o and ΔS^o are -58.03 kJ/mol and -176.6 (J/K)(mol), respectively. Assuming ΔH^o and ΔS^o are temperature independent, the calculated value of ***K*** at 100℃ is _____.
[A] 2.54 [B] 0.0789 [C] 0.789 [D] 7.89 [E] 0.254

22. Please calculate the value of **the solubility product (K_{sp})** for iron(II) sulfide given the following standard reduction potentials:

$FeS(s) + 2e^- \rightarrow Fe(s) + S^{2-}(aq)$ $E^o = -1.01$ V

$Fe^{2+}(aq) + 2e^- \rightarrow Fe(s)$ $E^o = -0.44$ V

[A] 2.28×10^{-10} [B] 2.28×10^{-15} [C] 5.1×10^{-20} [D] 1.7×10^{-25} [E] 1.7×10^{-30}

23. The atomic mass of ^1H is 1.00782 amu and the mass of a neutron is 1.00866 amu. **The binding energy** for carbon-12 (atomic mass 12.0000) is calculated to be _____ J/nucleon.

[A] 1.23×10^{-11} [B] 1.23×10^{-12} [C] 1.23×10^{-13} [D] 1.47×10^{-12} [E] 1.47×10^{-11}

24. Please rank the following complex ions in order of **high to low** frequency of light absorbed.

[A] $Co(CN)_6^{3-} > Co(en)_3^{3+} > CoI_6^{3-} > Co(H_2O)_6^{3+}$ [B] $Co(en)_3^{3+} > Co(CN)_6^{3-} > Co(H_2O)_6^{3+} > CoI_6^{3-}$

[C] $Co(en)_3^{3+} > Co(H_2O)_6^{3+} > Co(CN)_6^{3-} > CoI_6^{3-}$ [D] $Co(CN)_6^{3-} > Co(en)_3^{3+} > Co(H_2O)_6^{3+} > CoI_6^{3-}$

[E] $Co(en)_3^{3+} > Co(CN)_6^{3-} > CoI_6^{3-} > Co(H_2O)_6^{3+}$

25. When heat is added to proteins, the hydrogen bonding in secondary structures in the proteins is disrupted. What are **the algebraic signs** of ΔH and ΔS for the protein denaturation process?

[A] ΔH = - and ΔS = - [B] ΔH = - and ΔS = + [C] ΔH = + and ΔS = + [D] ΔH = + and ΔS = -

[E] $\Delta H = \Delta S = 0$

Physical Constants

Constant	Symbol	Value
Atomic mass unit	amu	1.66054×10^{-27} kg
Avogadro's number	N	6.02214×10^{23} mol^{-1}
Bohr radius	a_0	5.292×10^{-11} m
Boltzmann constant	k	1.38066×10^{-23} J/K
Charge of an electron	e	1.60218×10^{-19} C
Faraday constant	F	96,485 C/mol
Gas constant	R	8.31451 J/K · mol
		0.08206 L · atm/K · mol
Mass of an electron	m_e	9.10939×10^{-31} kg
		5.48580×10^{-4} amu
Mass of a neutron	m_n	1.67493×10^{-27} kg
		1.00866 amu
Mass of a proton	m_p	1.67262×10^{-27} kg
		1.00728 amu
Planck's constant	h	6.62608×10^{-34} J · s
Speed of light	c	2.99792458×10^{8} m/s

The Periodic Table

Period	1	2	3	4	5	6	7	8	9	10	11	12	13/III	14/IV	15/V	16/VI	17/VII	18/VIII
	1 H 1.008																	2 He 4.003
2	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
3	11 Na 22.99	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
4	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 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
5	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 98.91	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
6	55 Cs 132.9	56 Ba 137.3	La-Lu	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 210.0	85 At 210.0	86 Rn 222.0
7	87 Fr 223.0	88 Ra 226.0	Ac-Lr	104 Unq	105 Unp	106 Unh	107 Uns	108 Uno	109 Une	.....								

s block | d block | p block

Lanthanides	57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm 144.9	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	71 Lu 175.0
Actinides	89 Ac 227.0	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np 237.0	94 Pu 239.1	95 Am 243.1	96 Cm 247.1	97 Bk 247.1	98 Cf 252.1	99 Es 252.1	100 Fm 257.1	101 Md 256.1	102 No 259.1	103 Lr 260.1

f block

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