Chemistry 1250 - Sp22
Practice Midterm 2

1. The reaction below was carried out in a bomb calorimeter.

$$4\ Al_2O_3(s) + 9\ Fe(s) \longrightarrow 3\ Fe_3O_4(s) + 8\ Al(s)$$

A thermometer in the calorimeter registered a decrease in temperature. Choose words correctly to complete the following statements for this system.

The reaction is _____. (exothermic, endothermic)
The products have _____(lower, higher) heat content than the reactants.
The quantity of heat determined is a measure of _____. (ΔH, ΔE)

A. exothermic	lower	ΔH
B. exothermic	higher	ΔE
C. exothermic	lower	ΔE
D. endothermic	lower	ΔH
E. endothermic	higher	ΔE

2. Calculate the **heat energy** (in kcal) released when 208 g of **acetylene** gas, C_2H_2, reacts with excess oxygen according to the following combustion reaction?
(Atomic weights: C = 12.01, H = 1.008, O = 16.00; Mol. Wts.: C_2H_2 = 26.04, O_2 = 32.00, CO_2 = 44.01, H_2O = 18.02)

$$2\ C_2H_2\ (g) + 5\ O_2\ (g) \longrightarrow 4\ CO_2\ (g) + 2\ H_2O\ (g) \qquad \Delta H = -302 \text{ kcal}$$

A. 603
B. 1.02×10^3
C. 1.21×10^3
D. 1.75×10^3
E. 2.41×10^3

3. Which of the following reactions corresponds to a heat of formation, ΔH_f° ?

A. $2\ N_2(g) + 4\ H_2(g) + 3\ O_2(g) \rightarrow 2\ NH_4NO_3(s)$

B. $1/2\ N_2(g) + O_2(g) \rightarrow NO_2(g)$

C. $6\ C(s) + 6\ H(g) \rightarrow C_6H_6(\ell)$

D. $P(g) + 4\ H(g) + Br(g) \rightarrow PH_4Br(\ell)$

E. $6\ C(\ell) + 11\ H_2(g) + 11\ O(g) \rightarrow C_6H_{22}O_{11}(s)$

4. A 28.2 g sample of a metal was heated to 99.7 °C. It was placed in 150.0 g of water at 23.4 °C. After the metal cools, the final temperature of the metal and water is 24.9 °C. Calculate the **specific heat** of the **metal** (in J/g°C), assuming no heat was lost to the calorimeter. Specific heat of water = 4.184 J/g°C

A. 0.446
B. 0.492
C. 0. 410
D. 0.382
E. 0.365

5. Determine ΔH° (kJ) for the following reaction using the listed heats of formation.

$$3\ H_2S(g) + 2\ HNO_3(\ell) \longrightarrow 2\ NO(g) + 4\ H_2O(\ell) + 3\ S\ (s)$$

H_2S (g)	ΔH_f° = -20.6 kJ/mol
$HNO_3(\ell)$	ΔH_f° = -174.1 kJ/mol
NO(g)	ΔH_f° = 90.25 kJ/mol
H_2O (ℓ)	ΔH_f° = -285.6 kJ/mol

A. -485.6
B. -551.9
C. +551.9
D. $+1.04 \times 10^3$
E. -1.04×10^3

6. From the enthalpies of reaction, calculate the ΔH_{rxn} (kJ) for the reaction of B_2H_6 with Cl_2.

$BCl_3(g) + 3\ H_2O\ (\ell) \rightarrow H_3BO_3(g) + 3\ HCl(g)$ $\Delta H = -112.5$ kJ

$B_2H_6(g) + 6\ H_2O\ (\ell) \rightarrow 2\ H_3BO_3(g) + 6\ H_2(g)$ $\Delta H = -493.4$ kJ

$1/2\ Cl_2(g) + 1/2\ H_2(g) \rightarrow HCl(g)$ $\Delta H = -92.3$ kJ

$$B_2H_6(g) + 6\ Cl_2(g) \longrightarrow 2\ BCl_3(g) + 6\ HCl(g)$$

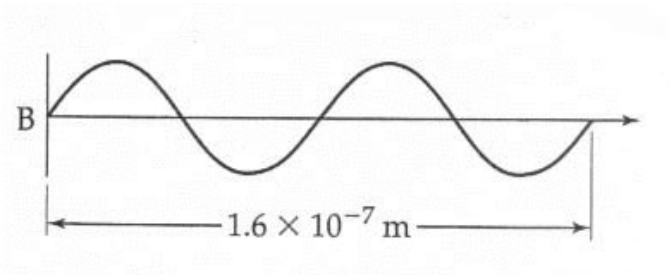
A. - 1376
B. - 543.3
C. - 360.7
D. - 698.2
E. - 473.2

7. Which of the following sets of quantum numbers are allowed for an electron in an atom?

	n	ℓ	m_ℓ	m_s
1)	3	0	-1	+ ½
2)	4	2	+2	- ½
3)	6	4	0	- ½
4)	2	2	0	- ½
5)	2	1	-1	0

A. 2, 3
B. 1, 4
C. 2, 3, 4
D. 1, 5
E. 3, 5

8. Consider the wave shown representing electromagnetic radiation. What is the energy associated with this wave?



A. 2.5×10^{16} J

B. 3.5×10^{15} J

C. 5.0×10^{-17} J

D. 1.3×10^{-18} J

E. 2.5×10^{-18} J

9. The yellow light given off by a sodium vapor lamp of a street light has a wavelength of 589 nm. What is the frequency of this radiation (in Hz)?

A. 5.09×10^{14}
B. 5.89×10^{-7}
C. 5.89×10^{-9}
D. 1.70×10^{14}
E. 1.70×10^{-3}

10. Which of the following statements, **a-d**, about quantum theory is **incorrect** for multi-electron systems?

A. The exact momentum and exact position of an electron can not be calculated from wave functions.

B. Lower energy orbitals are filled with electrons before higher energy orbitals.

C. When filling degenerate orbitals, two electrons will occupy an orbital with the same m_ℓ value before filling an orbital with a different m_ℓ value

D. The energy levels of the subshells within a shell are degenerate like they are in the hydrogen atom.

E. Choose this answer if more than one of the statements, **a-d**, above are incorrect.

11. For the hydrogen atom, what is the change in energy, ΔE, associated with the decay of an excited state with an electron in the 4s orbital to form the ground state?

A. $-1/16\ hcR_H$
B. $+1/16\ hcR_H$
C. $+15/16\ hcR_H$
D. $-15/16\ hcR_H$
E. $-3/4\ hcR_H$

12. The electron configuration of Pt is $[Xe]4f^{14}5d^{9}6s^{1}$. How many **unpaired** electrons are in this atom? (Be careful!)

A. 1
B. 2
C. 7
D. 8
E. 9

13. Which of the following electron configurations for the species in their ground state are **CORRECT**?

1) Ti: $[Ar]\ 4s^2\ 4d^2$
2) Sn: $[Kr]\ 5s^2\ 4d^{10}\ 5p^2$
3) Fe^{2+}: $[Ar]\ 3d^6$
4) In: $[Kr]\ 5s^2\ 4d^{10}\ 5p^3$
5) Au: $[Xe]\ 6s^1\ 4f^{14}\ 5d^{10}$

A. 1, 2
B. 2
C. 1, 2, 4
D. 2, 3, 5
E. 1, 2, 5

14. Which of the following statements is **INCORRECT**?

A. $_{37}$Rb is **more metallic** than $_{19}$K .

B. The ionic **radius** of S^{2-} is **greater** than that of Ca^{2+}.

C. The **radius** of $_{33}$As is **greater** than that of $_{31}$Ga.

D. It is **easier** to pull off the most loosely held electron from $_{52}$Te than from $_{16}$S.

E. $_{56}$Ba forms a **cation more easily** than $_{38}$Sr does.

15. Which of the following has the **intermediate** (middle) value when the five elements listed are arranged in order of **increasing nonmetallic** character?

A. Pb(82)
B. As(33)
C. Br(35)
D. Sb(51)
E. Se(34)

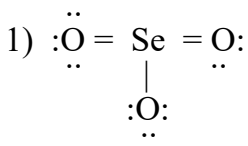
16. Based on the relationship between lattice energy, ionic charge and interionic distance, which of the following is expected to have the **smallest** lattice energy?

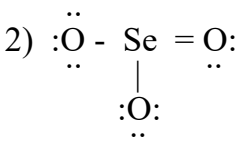
A. LiF
B. KBr
C. CaO
D. CaS
E. AlN

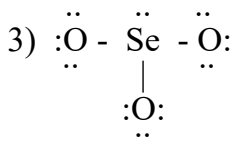
17. Which of the following substances is most likely to have the least polar bond(s)?

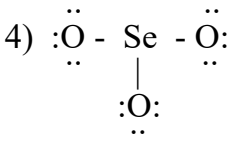
A. HF
B. H_2O
C. HCl
D. PH_3
E. H_2S

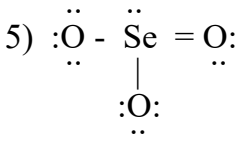
18. Which of the following is the best Lewis structure, conforming to Octet rule, for SeO_3^{2-}?

1) 

2) 

3) 

4) 

5) 

A. structure 1
B. structure 2
C. structure 3
D. structure 4
E. structure 5

19. Draw the resonance structures for the nitrite ion, NO_2^-. These indicate,

A. An electron pair in the molecule alternates back and forth between the two nitrogen-oxygen bonds so that the two different bonds seem to exchange positions.

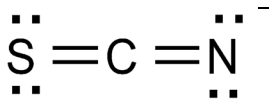
B. The two bonds in the nitrite ion are of equal length and the electron distribution in the two nitrogen-oxygen bonds is identical with an electron pair being shared by all three atoms to give a bond order of 1.5.

C. The electron distribution in the two nitrogen-oxygen bonds differs, as do their bond lengths.

D. The molecule revolves around an axis through the nitrogen atom between the two oxygen atoms so the two different nitrogen-oxygen bonds seem to exchange positions.

E. The nitrite ion exists as two different molecules which simultaneously exist.

20. One of the possible resonance structures for the thiocyanate ion (SCN^-) is given. The formal charges on S, C, and N are _____ respectively?



A. -2, +1, 0
B. -1, 0, 0
C. 0, -1, 0
D. -2, 0, +1
E. 0, 0, -1

21. Draw the Lewis formula for BrF_4^+. How many lone pair(s) of electrons are there in the valence shell of the central atom?

A. one
B. two
C. three
D. four
E. zero

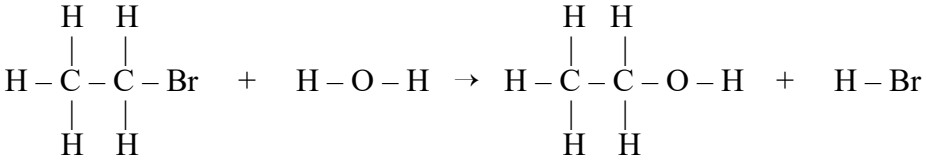
22. Which of the following does **NOT** conform to the Lewis "octet" (noble gas) rule?

1) NO_2^- 2) PF_5 3) H_2S 4) BCl_3 5) CO

A. 3
B. 1
C. 4, 5
D. 2, 4
E. 2, 3, 4

23. Use the given bond enthalpy data to estimate the ΔH° (kJ) for the following gas phase reaction

C - H = 414 kJ, H - Br = 366 kJ, C - C = 348 kJ
C - Br = 276 kJ, C - O = 358 kJ, O - H = 463 kJ



A. +35
B. -15
C. -35
D. +15
E. +50

24. The shape of AsO_3^{3-} is ___ and the bond angles are ___.

A. trigonal planar, exactly 120°
B. tetrahedral, exactly 109.5°
C. tetrahedral, approximately 109.5°
D. trigonal pyramidal, exactly 109.5°
E. trigonal pyramidal, approximately 109.5°

25. Which of the following species is **<u>trigonal</u> <u>planar</u>**?

1) BF_3 2) NF_3 3) SO_3 4) BrF_4^+ 5) SO_2

A. 1, 2
B. 1, 3
C. 1, 3, 5
D. 1, 2, 3
E. 3, 4, 5

26. Which of the following molecules is (are) **<u>non</u>**polar?

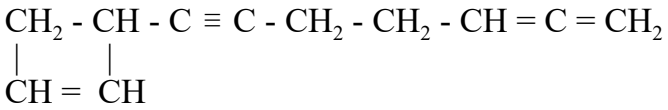
1) $AsCl_3$ 2) BF_3 3) SCl_2 4) CH_2Cl_2 5) CO_2

A. 1, 2
B. 1, 3
C. 2, 5
D. 1, 3, 4
E. 2, 4, 5

27. For the CH_3OCH_3 molecule what is the molecular shape around the C and O atoms, in the order given in the molecule?

A. tetrahedral, tetrahedral, tetrahedral
B. tetrahedral, tetrahedral, trigonal pyramidal
C. tetrahedral, bent, trigonal pyramidal
D. tetrahedral, linear, tetrahedral
E. tetrahedral, bent, tetrahedral

28. How many **sp** hybridized carbon atoms are contained in the following compound?



A. 1
B. 2
C. 3
D. 4
E. 5

29. If a molecule has bond angles of 107° around an atom what is the hybridization of the atom?

A. sp
B. sp^2
C. sp^3
D. sp^3d
E. sp^3d^2

30. Which of the following bonds is most likely to be the **shortest**?

A. C = C
B. C = N
C. O = O
D. C - C
E. C ≡ C

USEFUL INFORMATION

1 amu = 1.66×10^{-24} g

Avogadro's number, N_A, = 6.02×10^{23} particles/mole

$1 \text{ Å} = 1 \times 10^{-10} \text{ m} = 1 \times 10^{-8} \text{ cm}$

$q = C \times \Delta T \quad q = m \times C_s \times \Delta T$

$h = 6.626 \times 10^{-34}$ J•s $c = 3.00 \times 10^{8}$ m/s $R_H = 1.097 \times 10^{7}$ m^{-1} 1 J = 1 kg•m^2/s^2

electron charge, $e = 1.602 \times 10^{-19}$ C 1D = 3.34×10^{-30} C•m $\mu = Q \bullet r$

$E = h\nu \quad c = \lambda\nu \quad E_{Hydrogen} = (-hcR_H)(1/n^2) \quad \Delta E_{Hydrogen} = -(2.18 \times 10^{-18} \text{ J})(1/n_f^2 - 1/n_i^2)$

$1/\lambda = R_H (1/n_f^2 - 1/n_i^2) \quad \lambda = h/(mv) \quad p = mv \quad \Delta x \bullet \Delta p \geq h/4\pi,$

	IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIIIB			IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
1	1.008 **H** 1																	4.003 **He** 2
2	6.941 **Li** 3	9.012 **Be** 4											10.811 **B** 5	12.011 **C** 6	14.007 **N** 7	15.999 **O** 8	18.998 **F** 9	20.179 **Ne** 10
3	22.990 **Na** 11	24.305 **Mg** 12											26.98 **Al** 13	28.09 **Si** 14	30.974 **P** 15	32.06 **S** 16	35.453 **Cl** 17	39.948 **Ar** 18
4	39.098 **K** 19	40.08 **Ca** 20	44.96 **Sc** 21	47.88 **Ti** 22	50.94 **V** 23	52.00 **Cr** 24	54.94 **Mn** 25	55.85 **Fe** 26	58.93 **Co** 27	58.69 **Ni** 28	63.546 **Cu** 29	65.38 **Zn** 30	69.72 **Ga** 31	72.59 **Ge** 32	74.92 **As** 33	78.96 **Se** 34	79.904 **Br** 35	83.80 **Kr** 36
5	85.47 **Rb** 37	87.62 **Sr** 38	88.91 **Y** 39	91.22 **Zr** 40	92.91 **Nb** 41	95.94 **Mo** 42	98 **Tc** 43	101.07 **Ru** 44	102.91 **Rh** 45	106.42 **Pd** 46	107.87 **Ag** 47	112.41 **Cd** 48	114.82 **In** 49	118.69 **Sn** 50	121.75 **Sb** 51	127.60 **Te** 52	126.90 **I** 53	131.39 **Xe** 54
6	132.91 **Cs** 55	137.33 **Ba** 56	138.91 **La** 57	178.39 **Hf** 72	180.95 **Ta** 73	183.85 **W** 74	186.21 **Re** 75	190.23 **Os** 76	192.22 **Ir** 77	195.08 **Pt** 78	196.97 **Au** 79	200.59 **Hg** 80	204.38 **Tl** 81	207.2 **Pb** 82	208.98 **Bi** 83	209 **Po** 84	210 **At** 85	222 **Rn** 86
7	223 **Fr** 87	226.03 **Ra** 88	227.03 **Ac** 89	261 **Rf** 104	262 **Ha** 105	263 **Sg** 106	262 **Ns** 107	265 **Hs** 108	266 **Mt** 109	269 110	272 111	277 112						

Lanthanide Series	140.12 **Ce** 58	140.91 **Pr** 59	144.24 **Nd** 60	145 **Pm** 61	150.36 **Sm** 62	151.96 **Eu** 63	157.25 **Gd** 64	158.93 **Tb** 65	162.50 **Dy** 66	164.93 **Ho** 67	167.26 **Er** 68	168.93 **Tm** 69	173.04 **Yb** 70	173.04 **Lu** 71
Actinide Series	232.04 **Th** 90	231.04 **Pa** 91	238.03 **U** 92	237.05 **Np** 93	**Pu** 94	**Am** 95	**Cm** 96	**Bk** 97	**Cf** 98	**Es** 99	**Fm** 100	**Md** 101	**No** 102	**Lr** 103

A PERIODIC CHART OF THE ELEMENTS
(Based on ^{12}C)

Chemistry 1250

Answers to Practice Midterm 2

1) E	11) D	21) A
2) C	12) B	22) D
3) B	13) D	23) D
4) A	14) C	24) E
5) B	15) B	25) B
6) A	16) B	26) C
7) A	17) D	27) E
8) E	18) C	28) C
9) A	19) B	29) C
10) E	20) E	30) E