Chemistry 123 | Spring 2009 | Oregon State University
Exam 2 | May 21, 2009 | Dr. Richard Nafshun

DO NOT OPEN THIS EXAM UNTIL INSTRUCTED. CALCULATORS ARE NOT TO BE SHARED.

Test Form 1

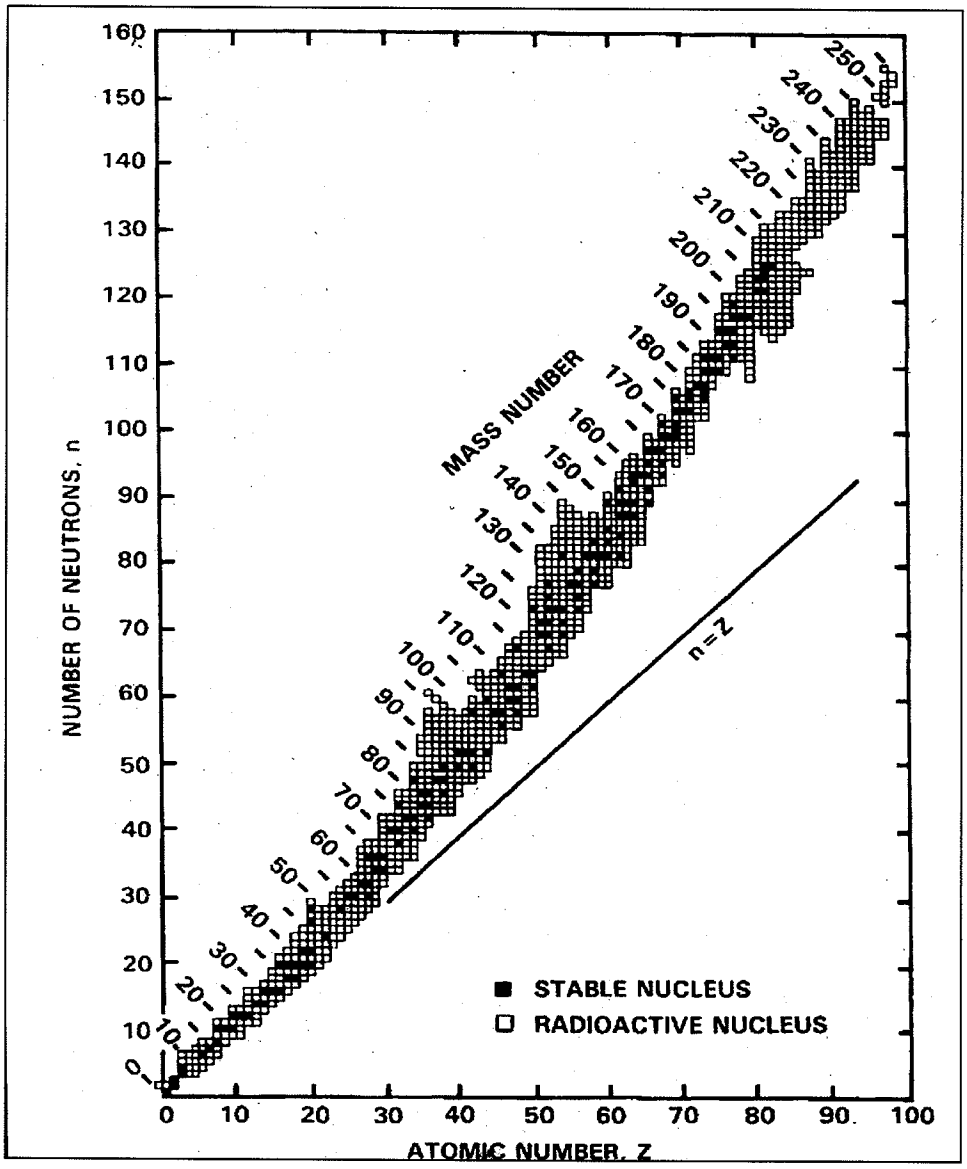
Instructions: You should have with you several number two pencils, an eraser, your 3" x 5" note card, a calculator, and your University ID Card. If you have notes with you, place them in a sealed backpack and place the backpack OUT OF SIGHT or place the notes directly on the table at the front of the room.

Fill in the front page of the Scantron answer sheet with your test form number (listed above), last name, first name, middle initial, and student identification number. **Leave the class section number blank.**

This exam consists of 25 multiple-choice questions. Each question has four points associated with it. Select the best multiple-choice answer by filling in the corresponding circle on the rear page of the answer sheet. If you have any questions before the exam, please ask. If you have any questions during the exam, please ask the proctor. Open and start this exam when instructed. When finished, place your Scantron form in the appropriate stack. You may keep the exam packet, so please show your work and mark the answers you selected on it.

IA		IIIB	IVB	VB	VIB	VIIB	VII			IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
1 H Hydrogen 1.0079																	2 He Helium 4.0026
3 Li Lithium 6.941	4 Be Beryllium 9.01218											5 B Boron 10.81	6 C Carbon 12.011	7 N Nitrogen 14.0067	8 O Oxygen 15.9994	9 F Fluorine 18.9984	10 Ne Neon 20.179
11 Na Sodium 22.98977	12 Mg Magnesium 24.305											13 Al Aluminum 26.9815	14 Si Silicon 28.0855	15 P Phosphorus 30.97376	16 S Sulfur 32.06	17 Cl Chlorine 35.453	18 Ar Argon 39.948
19 K Potassium 39.0983	20 Ca Calcium 40.08	21 Sc Scandium 44.9559	22 Ti Titanium 47.88	23 V Vanadium 50.9415	24 Cr Chromium 51.996	25 Mn Manganese 54.9380	26 Fe Iron 55.847	27 Co Cobalt 58.9332	28 Ni Nickel 58.70	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.72	32 Ge Germanium 72.59	33 As Arsenic 74.9216	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.80
37 Rb Rubidium 85.4678	38 Sr Strontium 87.62	39 Y Yttrium 88.9059	40 Zr Zirconium 91.22	41 Nb Niobium 92.9064	42 Mo Molybdenum 95.94	43 Tc Technetium 98.906	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.9055	46 Pd Palladium 106.4	47 Ag Silver 107.868	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.69	51 Sb Antimony 121.75	52 Te Tellurium 127.60	53 I Iodine 126.9045	54 Xe Xenon 131.30
55 Cs Cesium 132.9054	56 Ba Barium 137.33	57–71 *Rare earths	72 Hf Hafnium 178.49	73 Ta Tantalum 180.9479	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.2	77 Ir Iridium 192.22	78 Pt Platinum 195.09	79 Au Gold 196.9665	80 Hg Mercury 200.59	81 Tl Thallium 204.37	82 Pb Lead 207.2	83 Bi Bismuth 208.9804	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
87 Fr Francium (223)	88 Ra Radium 226.0254	89–103 †Actinides	104 Rf Rutherfordium (261)	105 Ha Hahnium (262)	106 Sg Seaborgium (263)	107 Ns Neilsbohrium (262)	108 Hs Hassium (265)	109 Mt Meitnerium (266)	110 ‡ (269)	111 ‡			114	→ Stable region?			

57 La Lanthanium 138.9055	58 Ce Cerium 140.12	59 Pr Praseodymium 140.9077	60 Nd Neodymium 144.24	61 Pm Promethium 145	62 Sm Samarium 150.4	63 Eu Europium 151.96	64 Gd Gadolinium 157.25	65 Tb Terbium 158.9254	66 Dy Dysprosium 162.50	67 Ho Holmium 164.9304	68 Er Erbium 167.26	69 Tm Thulium 168.9342	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967
89 Ac Actinium 227.0278	90 Th Thorium 232.0381	91 Pa Protactinium 231.0359	92 U Uranium 238.029	93 Np Neptunium 237.0482	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (254)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium 259	103 Lr Lawrencium 262



Spectrochemical series: $CN^- > NO_2^- > en > NH_3 > NCS^- > H_2O > F^- > Cl^-$

$F = 96{,}485$ C/mole e^-

$N_A = 6.02 \times 10^{23}$

Reduction Half-Reaction	E°, volt
Acidic Solution	
$F_2\ (g) + 2\ e^- \rightarrow 2F^-\ (aq)$	+2.866
$O_3(g) + 2\ H^+(aq) + 2\ e^- \rightarrow O_2\ (g) + H_2O(l)$	+2.075
$S_2O_8^{2-}\ (aq) + 2\ e^- \rightarrow 2\ SO_4^{2-}\ (aq)$	+2.01
$H_2O_2\ (aq) + 2H^+\ (aq) + 2\ e^- \rightarrow 2\ H_2O(l)$	+1.763
$MnO_4^-(aq) + 8H^+\ (aq) + 5\ e^- \rightarrow Mn^{2+}(aq) + 4\ H_2O(l)$	+1.51
$PbO_2\ (s) + 4H^+\ (aq) + 2\ e^- \rightarrow Pb^{2+}(aq) + 2\ H_2O(l)$	+1.455
$Cl_2\ (g) + 2\ e^- \rightarrow 2\ Cl^-\ (aq)$	+1.358
$Cr_2O_7^{2-}\ (aq) + 14\ H^+\ (aq) + 6\ e^- \rightarrow 2\ Cr^{3+}(aq) + 7\ H_2O(l)$	+1.33
$MnO_2(s) + 4H^+\ (aq) + 2\ e^- \rightarrow Mn^{2+}(aq) + 2\ H_2O(l)$	+1.23
$O_2(g) + 4H^+\ (aq) + 4\ e^- \rightarrow 2\ H_2O(l)$	+1.229
$2\ IO_3^-\ (aq) + 12H^+\ (aq) + 10\ e^- \rightarrow I_2(s) + 6\ H_2O(l)$	+1.20
$Br_2(l) + 2\ e^- \rightarrow 2\ Br^-\ (aq)$	+1.065
$NO_3^-\ (aq) + 4H^+\ (aq) + 3\ e^- \rightarrow NO(g) + 2\ H_2O(l)$	+0.956
$Ag^+\ (aq) + e^- \rightarrow Ag(s)$	+0.800
$Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq)$	+0.771
$O_2(g) + 2H^+\ (aq) + 2\ e^- \rightarrow H_2O_2(aq)$	+0.695
$I_2(s) + 2\ e^- \rightarrow 2\ I^-\ (aq)$	+0.535
$Cu^{2+}(aq) + 2\ e^- \rightarrow Cu(s)$	+0.340
$SO_4^{2-}\ (aq) + 4H^+\ (aq) + 2\ e^- \rightarrow 2\ H_2O(l) + SO_2(g)$	+0.17
$Sn^{4+}\ (aq) + 2\ e^- \rightarrow Sn^{2+}\ (aq)$	+0.154
$S(s) + 2H^+\ (aq) + 2\ e^- \rightarrow H_2S(g)$	+0.14
$2H^+(aq) + 2\ e^- \rightarrow H_2(g)$	0
$Pb^{2+}(aq) + 2\ e^- \rightarrow Pb(s)$	-0.125
$Sn^{2+}(aq) + 2\ e^- \rightarrow Sn(s)$	-0.137
$Co^{2+}(aq) + 2\ e^- \rightarrow Co(s)$	-0.277
$Fe^{2+}(aq) + 2\ e^- \rightarrow Fe(s)$	-0.440
$Zn^{2+}(aq) + 2\ e^- \rightarrow Zn(s)$	-0.763
$Al^{3+}(aq) + 3\ e^- \rightarrow Al(s)$	-1.676
$Mg^{2+}(aq) + 2\ e^- \rightarrow Mg(s)$	-2.356
$Na^+(aq) + e^- \rightarrow Na\ (s)$	-2.713
$Ca^{2+}(aq) + 2\ e^- \rightarrow Ca(s)$	-2.84
$K^+(aq) + e^- \rightarrow K(s)$	-2.924
$Li^+(aq) + e^- \rightarrow Li(s)$	-3.040
Basic Solution	
$O_3(g) + H_2O(l) + 2\ e^- \rightarrow O_2(g) + 2\ OH^-(aq)$	+1.246
$OCl^-(g) + H_2O(l) + 2\ e^- \rightarrow Cl^-(aq) + 2\ OH^-(aq)$	+0.890
$O_2(g) + 2\ H_2O(l) + 4\ e^- \rightarrow 4\ OH^-(aq)$	+0.401
$2\ H_2O(l) + 2\ e^- \rightarrow H_2(g) + 2\ OH^-(aq)$	-0.828

1. The oxidation number of each titanium in $Na_2Ti_3O_7$ is:

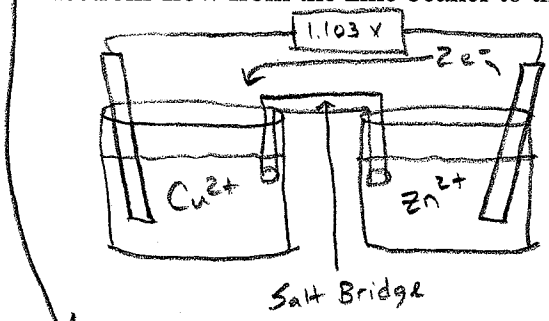
(A) +4
(B) +5
(C) +6
(D) +7
(E) +10

2+ 14-
12+
3 times 4+

2. Consider a "General Chemistry Battery" in which one beaker contains aqueous copper sulfate ($CuSO_4$) and a copper metal electrode and the other beaker contains aqueous zinc sulfate ($ZnSO_4$) and a zinc metal electrode.

Which of the following statements is **false**?

(A) The theoretical cell voltage is 1.103 V ✓
(B) A salt bridge is used to allow the flow of ions but restrict the flow of electrons ✓
(C) The mass of the zinc electrode will decrease as the process proceeds ✓
(D) The concentration of Cu^{2+} (aq) increases as the process proceeds ✗
(E) Electrons flow from the zinc beaker to the copper beaker ✓



$Cu^{2+} + 2e^- \rightarrow Cu^0$ decreases
$Zn^0 \rightarrow Zn^{2+} + 2e^-$

3. Consider the reaction $3\ Ag^+(aq) + Al(s) \rightarrow Al^{3+}(aq) + 3\ Ag(s)$. The oxidizing agent is:

(A) Ag^+ (aq)
(B) Al (s)
(C) Al^{3+} (aq)
(D) Ag (s)

Al^{3+}
↑
Al^0 Al^0 is oxidized; Al^0 is the reducing agent

Ag^+
↓
Ag^0 Ag^+ is reduced; Ag^+ is the oxidizing agent

4. Consider fuel cells. Which of the following is **false**?

(A) A hydrogen fuel cell produces energy ✓
(B) The hydrogen fuel cell demonstrated in class produced water ✓
(C) The hydrogen fuel cell demonstrated in class contains platinum to facilitate the process ✓
(D) The fuel cell consists of tiny chambers that allow hydrogen gas to explode ✗
(E) The hydrogen fuel cell demonstrated in class input hydrogen and oxygen gases ✓

5. The calculated cell potential for the $Mg\ (s) + 2\ Ag^+\ (aq) \rightarrow Mg^{2+}\ (aq) + 2\ Ag\ (s)$ cell is:

(A) + 1.556 V
(B) + 3.956 V
(C) - 1.556 V
(D) + 0.756 V
(E) + 3.156 V

$Ag^+ + 1e^- \rightarrow Ag^0$ $\quad +0.800V$

difference $\quad \updownarrow \quad 3.156V$

$Mg^{2+} + 2e^- \rightarrow Mg^0$ $\quad -2.356V$

6. A student provides a current of 8.0 amps through a solution of $Co^{2+}\ (aq)$ for 6.00 hours. The voltage is such that cobalt metal is deposited at the cathode. The mass of cobalt deposited is:

(A) 12.2 g
(B) 24.4 g
(C) 62.1 g
(D) 52.8 g
(E) 78.4 g

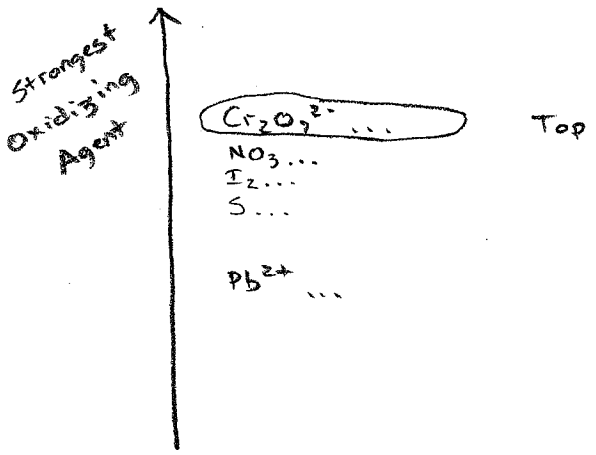
$Co^{2+} + 2e^- \rightarrow Co^0$

$$6.00\ h\left(\frac{3600\ s}{1\ h}\right)\left(\frac{8.00\ C}{1\ s}\right)\left(\frac{1\ mol\ e^-}{96{,}485\ C}\right)\left(\frac{1\ mol\ Co^0}{2\ mol\ e^-}\right)\left(\frac{58.93\ g}{1\ mol\ Co^0}\right) = 52.8\ g\ Co^0$$

↑ Amps ↑ F

7. Consider $Cr_2O_7^{2-}$ (aq), Pb^{2+} (aq), S (s), NO_3^- (aq), and I_2 (s). The strongest oxidizing agent is:

(A) $Cr_2O_7^{2-}$ (aq)
(B) Pb^{2+} (aq)
(C) S (s)
(D) NO_3^- (aq)
(E) I_2 (s)



8. When the reaction Sn^{2+} (aq) + $Mo_2O_8^{4-}$ (aq) → Mo^{2+} (aq) + Sn^{4+} (aq) is correctly balanced in acid,

(A) 3 protons (H^+) are consumed
(B) 4 protons (H^+) are consumed
(C) 8 protons (H^+) are consumed
(D) 16 protons (H^+) are consumed
(E) 42 protons (H^+) are consumed

$4 \times [Sn^{2+} \rightarrow Sn^{4+} + 2e^-]$

$[8e^- + \underbrace{16H^+ + Mo_2O_8^{4-}}_{12+} \rightarrow \underbrace{2\,Mo^{2+} + 8\,H_2O}_{4+}]$

$8e^- + 16H^+ + Mo_2O_8^{4-} + 4\,Sn^{2+} \rightarrow 4\,Sn^{4+} + 8e^- + 2\,Mo^{2+} + 8H_2O$

9. $^{238}U^{2+}$ has:

(A) 238 protons and 92 neutrons and 236 electrons
(B) 92 protons and 238 neutrons and 90 electrons
(C) 92 protons and 146 neutrons and 90 electrons
(D) 146 protons and 92 neutrons and 144 electrons
(E) 238 protons and 238 neutrons and 236 electrons

^{92}U → 92 p

238 − 92 = 146 n

92 − 2 = 90 e⁻

10. Al-28 decays to produce a beta particle and _____.

(A) Si-28
(B) Na-26
(C) Na-24
(D) U-238
(E) P-32

$^{28}_{13}Al \rightarrow {}^{0}_{-1}\beta + {}^{28}_{14}Si$

11. Pm-150 decays to produce an alpha particle and _____.

(A) Pm-146
(B) Pr-146
(C) Pm-151
(D) Pr-150
(E) Sm-150

$^{150}_{61}Pm \rightarrow {}^{4}_{2}\alpha + {}^{146}_{59}Pr$

12. Consider the generation of an x-ray. Which of the following is **false**?

(A) An electron escapes the nucleus ✗ Actually, an e⁻ is captured by the nucleus
(B) A high energy electron falls into a hole ✓
(C) An x-ray is generated from an electron transition ✓
(D) A proton is converted to a neutron ✓
(E) The x-ray released is electromagnetic radiation ✓

13. A student obtains a sample of C-11 ($t_{1/2}$ = 20.39 minutes) containing 1.000 g. How long will it take for the sample to decay to 0.723 g of C-11?

(A) 8.54 minutes
(B) 9.04 minutes
(C) 9.54 minutes
(D) 10.04 minutes
(E) 10.54 minutes

① Calc k $\ln \frac{1}{2} = -k(20.39\ \text{min})$

$k = 0.0340\ \frac{1}{\text{min}}$

② Calc t $\ln\left[\frac{0.723\ \text{g}}{1.000\ \text{g}}\right] = -(0.0340\ \frac{1}{\text{min}})(t)$

$t = 9.54\ \text{min}$

14. Considering the carbon cycle and radiocarbon dating, which of the following statements is **false**?

(A) The carbon-14 concentration in fossils is less than the carbon-14 concentration in you. ✓
(B) Carbon-14 in living organisms does not undergo decay. ^{14}C decays!
(C) Carbon-14 can be used to date specimens previously in the carbon cycle. ✓
(D) Carbon-14 is generated in the upper atmosphere. ✓

15. Considering nuclear chemistry, which of the following statements is **false**?

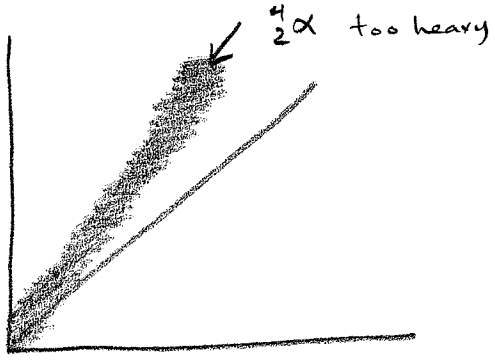
(A) An example of nuclear fusion is $^{1}_{1}H + {}^{2}_{1}H \rightarrow {}^{3}_{2}He$ ✓
(B) An example of nuclear fission is $^{1}_{0}n + {}^{235}_{92}U \rightarrow {}^{137}_{52}Te + {}^{97}_{40}Zr + 2\ {}^{1}_{0}n$ ✓
(C) The half-life is the time required for a sample to decay to one-half its original amount ✓
(D) Gamma radiation has a mass of –1
(E) A Geiger Counter can be used to show that the orange pigment in certain ceramic glazes is radioactive ✓

$^{0}_{0}\gamma$

EM

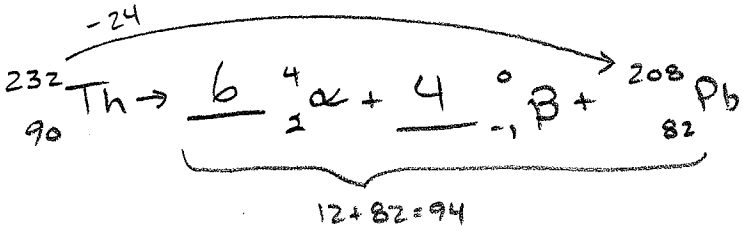
γ X-Ray UV vis IR

16. Consider the band of stability (AKA "Belt of Stability"). What decay is expected for a species located to the top-right of stable isotopes in the belt?



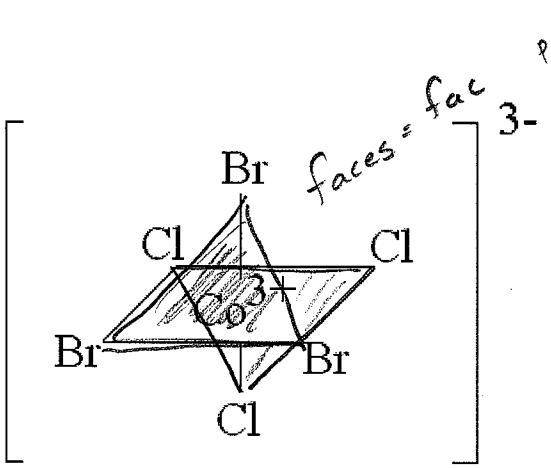
(A) Alpha decay
(B) Beta decay
(C) Gamma decay
(D) Tooth decay
(D) Brain decay due to the overuse of Twitter

17. A radioactive decay series that begins with ^{232}Th ends with formation of the stable nuclide ^{208}Pb. How many alpha particle emissions and how many beta particle emissions are involved in the sequence of radioactive decays?



(A) 7 alpha and 6 beta decays
(B) 7 alpha and 4 beta decays
(C) 7 alpha and 2 beta decays
(D) 6 alpha and 2 beta decays
(E) 6 alpha and 4 beta decays

18. The complex:



(A) is the cis- isomer and it is polar
(B) is the trans- isomer and it is polar
(C) is the mer- isomer and it is polar
(D) is the fac- isomer and it is polar
(E) is the trans- isomer and it is non-polar

19. Consider $[CoF_2Br_4]^{3-}$. Which of the following is **false**?

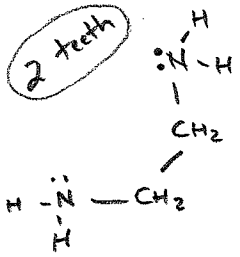
(A) F^- is a Lewis base ✓ donates a pair of e^- to form a new bond
(B) The cobalt ion (Co^{3+}) is the Lewis acid ✓ accepts a pair of e^- to form a new bond
(C) cis-$[CoF_2Br_4]^{3-}$ is polar ✓
(D) trans-$[CoF_2Br_4]^{3-}$ is nonpolar ✓
(E) $[CoF_2Br_4]^{3-}$ is a square planar complex

↓

$[CoF_2Br_4]^{3-}$ is octahedral

20. An example of a bidentate is:

(A) edta
(B) F^-
(C) Cu^{2+}
(D) $NH_2CH_2CH_2NH_2$
(E) H_2O

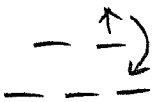


21. How many d-electrons does Cu^{2+} have? 11-2=9 d^9

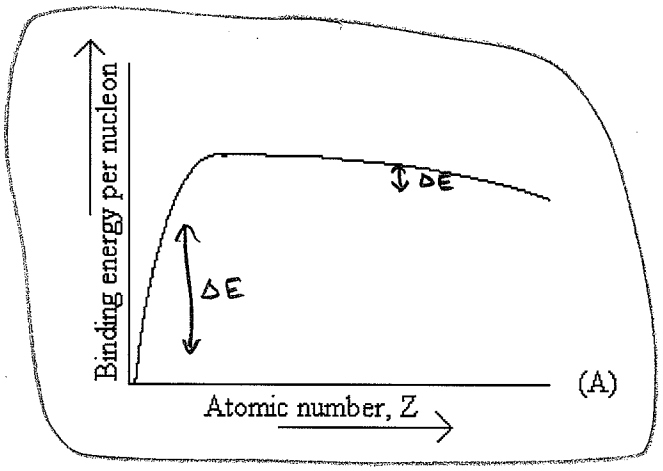
(A) 7
(B) 8
(C) 9
(D) 10
(E) 11

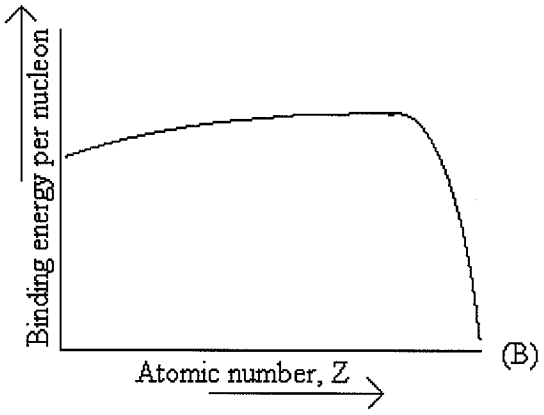
22. The colors in transition metal complexes are due to:

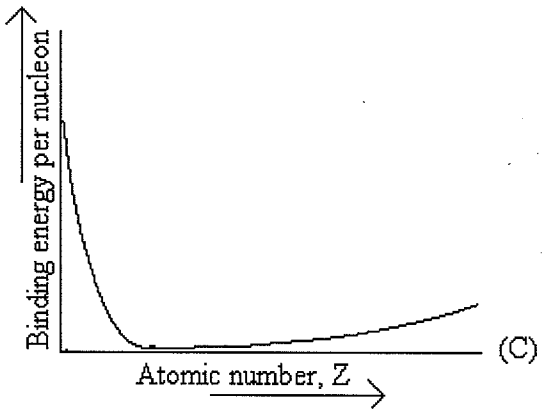
(A) Electrons falling from high energy levels to low energy levels in split d-orbitals
(B) X-rays
(C) Gamma rays
(D) Electrons flowing through a filament
(E) Protons being converted to neutrons

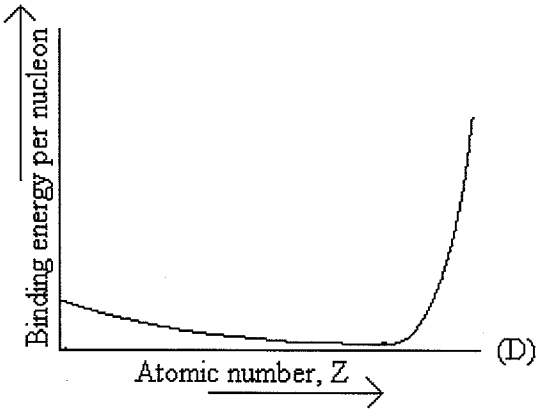


23. Which of the following correctly depicts the curve of nuclear binding energy?







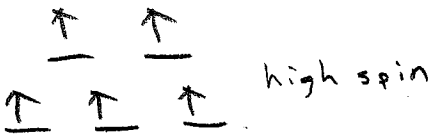


[Turn over for last page of the exam]

24. How many **unpaired** electrons are present in $[Fe(NO_2)_6]^{2-}$?
[Fe is the Fe^{3+} ion; (NO_2) is the NO_2^- ion; and the Fe^{3+} is **high spin**].

(A) 1
(B) 2
(C) 3
(D) 4
(E) 5

Fe^{3+} $8-3=5$ d^5



25. The CH 123 Final Exam is scheduled for Monday, June 8, 2009, 4:00-5:50pm. Which one of the following statements is **FALSE**?

(A) The CH 123 Final Exam is scheduled for Monday, June 8, 2009, 4:00-5:50pm
(B) The CH 123 Final Exam is scheduled for Monday, June 8, 2009, 4:00-5:50pm
(C) The CH 123 Final Exam is scheduled for Monday, June 8, 2009, 4:00-5:50pm
(D) The CH 123 Final Exam is scheduled for Monday, June 8, 2009, 4:00-5:50pm
(E) The oxidation number of Mn in MnO_2 is -4

+4

[Any response will receive full credit; even no response.]