1																	18
1 H 1.008	2											13	14	15	16	17	2 He 4.003
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
11 Na 22.99	12 Mg 24.31	3	4	5	6	7	8	9	10	11	12	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	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 65.38	31 Ga 69.72	32 Ge 72.64	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
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)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57 La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.20	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (267)	105 Db (268)	106 Sg (269)	107 Bh (270)	108 Hs (270)	109 Mt (278)	110 Ds (281)	111 Rg (282)	112 Cn (285)	113 Nh (286)	114 Fl (289)	115 Mc (290)	116 Lv (293)	117 Ts (294)	118 Og (294)

58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (266)

constants

$R = 0.08206$ L atm/mol K

$R = 8.314$ J/mol K

$N_A = 6.022 \times 10^{23}$ /mol

$h = 6.626 \times 10^{-34}$ J·s

$c = 3.00 \times 10^8$ m/s

$g = 9.81$ m/s^2

conversions

1 atm = 760 torr

1 atm = 101325 Pa

1 atm = 1.01325 bar

1 bar = 10^5 Pa

°F = °C(1.8) + 32

K = °C + 273.15

conversions

1 in = 2.54 cm

1 ft = 12 in

1 yd = 3 ft

1 mi = 5280 ft

1 lb = 453.6 g

1 ton = 2000 lbs

1 tonne = 1000 kg

1 gal = 3.785 L

1 gal = 231 in^3

1 gal = 128 fl oz

1 fl oz = 29.57 mL

water data

$C_{s,ice} = 2.09$ J/g °C

$C_{s,water} = 4.184$ J/g °C

$C_{s,steam} = 2.03$ J/g °C

$\rho_{water} = 1.00$ g/mL

$\rho_{ice} = 0.9167$ g/mL

$\rho_{seawater} = 1.024$ g/mL

$\Delta H_{fus} = 334$ J/g

$\Delta H_{vap} = 2260$ J/g

$K_w = 1.0 \times 10^{-14}$

This exam should have exactly 20 questions. Each question is equally weighted at 5 points each. Bubble in your answer choices on the bubblehseet provided. Your score is based on what you bubble on the bubblesheet and not what is circled on the exam.

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1. Which of the following types of radiation is capable of ionizing organic molecules like DNA?

●a. UV-C radiation

b. infrared radiation

c. orange light

d. radio waves

e. blue light

Explanation: The higher energy forms of radiation are capable of ionizing matter: UV, x-ray, and gamma.

---

2. Compared to yellow light, ultraviolet light will have a...

I. shorter wavelength

II. lower frequency

III. higher energy

IV. greater velocity

a. I, II, III, and IV

b. I and IV

c. I, III, and IV

●d. I and III

Explanation: Ultraviolet light will have a higher energy, higher frequency, and shorter wavelength than yellow light. The speed of light will be constant.

---

3. Your chemist friend suggests that you tune the radio to 3.0333 m, but you know that radio stations are listed as frequencies in MHz. What radio station is this?

a. 93.7 KLBJ

b. 101.5 KROX

c. 93.3 KGSR

●d. 98.9 KUT

e. 103.5 BOB

Explanation: $\nu = \frac{c}{\lambda}$

$9.89 \times 10^7 \text{ Hz} = \frac{3.00 \times 10^8 \text{ m/s}}{3.03 \text{ m}}$

$= 98.9 \text{ MHz}$

---

4. What is the wavelength of a 2.45×10^9 Hz wave?

a. 0.753 m

●b. 0.122 m

c. 8.17×10^{-18} m

d. 1.62×10^{-24} m

e. 7.53 m

Explanation: $\lambda = \frac{c}{\nu} = \frac{3.00 \times 10^8}{2.45 \times 10^9} = 0.122 \text{ m}$

---

5. What is the energy of a single 680 nm red light photon?

●a. 2.92×10^{-19} J

b. 2.92×10^{-17} J

c. 3.88×10^{-21} J

d. 2.66×10^{38} J

e. 4.51×10^{-40} J

Explanation: Use $E = \frac{hc}{\lambda}$

$2.92 \times 10^{-19} \text{ J} = \frac{(6.626 \times 10^{-34})(3.00 \times 10^8)}{6.80 \times 10^{-7}}$

---

6. It takes light with a frequency of approximately 2.687×10^{15} Hz to break the triple bond between carbon and oxygen in carbon monoxide. Calculate the energy (in kJ/mol) necessary to break one mole of carbon-oxygen triple bonds.

a. 945.2 kJ/mol

b. 4.455×10^{-17} kJ/mol

c. 1.780×10^{-18} kJ/mol

● d. 1072 kJ/mol

e. 687.2 kJ/mol

Explanation: $E = h\nu = (6.626 \times 10^{-34})(2.687 \times 10^{15})$

Next scale up by multiplying energy by N_A and divide by 1000 to convert from J/mol to kJ/mol:

1072 kJ/mol $= E \times (6.022 \times 10^{23}) \times \frac{1\,\text{kJ}}{1000\,\text{J}}$

---

7. Complete the sentence regarding the energy levels of an electron in the hydrogen atom. As the principal quantum number increases,

a. the spacing between successive energy levels increases

● b. the spacing between successive energy levels decreases

c. the energy levels remain degenerate

d. the spacing between successive energy levels remains constant

Explanation: As n increases, the energy change between each energy level in the atom decreases.

---

8. Which of the following quantum number sets is not possible?

a. $n = 4, \quad \ell = 3, \quad m_\ell = 0, \quad m_s = \frac{1}{2}$

● b. $n = 4, \quad \ell = 2, \quad m_\ell = 3, \quad m_s = \frac{1}{2}$

c. $n = 1, \quad \ell = 0, \quad m_\ell = 0, \quad m_s = -\frac{1}{2}$

d. $n = 3, \quad \ell = 1, \quad m_\ell = -1, \quad m_s = \frac{1}{2}$

e. $n = 5, \quad \ell = 2, \quad m_\ell = -2, \quad m_s = \frac{1}{2}$

Explanation: The one that violates the rules is: $n = 4, \quad \ell = 2, \quad m_\ell = 3, \quad m_s = \frac{1}{2}$. In this example, the m_ℓ value is greater than ℓ.

---

9. Which subshell contains an electron with the following quantum number set?

$n = 4, \quad \ell = 0, \quad m_\ell = 0, \quad m_s = \frac{1}{2}$

● a. 4s

b. 4p

c. 4d

d. 4f

e. 3s

f. 3p

g. 3d

Explanation: The subshell is determined by the n and ℓ values. $n = 4$ and ℓ provides the shape, which is s when $\ell = 0$.

---

10. How many unpaired electrons will you find in the electronic configuration of nitrogen?

● a. 3

b. 2

c. 1

d. 0

e. 5

Explanation: Nitrogen has 5 valence electrons. You will fill the 2s first, then place three electrons in the three 2p orbitals. Following Hund's rule, you will see that all three 2p electrons are unpaired.

---

11. What is the electron configuration for the oxide anion?

a. $1s^2 2s^2 2p^4$

● b. $1s^2 2s^2 2p^6$

c. $1s^2 2s^2 3p^4$

d. $1s^2 2s^2 2p^2$

e. $1s^2 2s^2 3p^2$

Explanation: Write the electron configuration for oxygen and then add two electrons for the two negative charges: $1s^2 2s^2 2p^6$

---

12. What is the electron configuration for selenium, Se?

a. $[Kr]4s^2 4d^{10} 4p^4$

b. $[Ar]4s^2 4d^{10} 4p^6$

● c. $[Ar]4s^2 3d^{10} 4p^4$

d. $[Ar]4s^2 3d^{10} 4p^6$

e. $[Ar]4s^2 4p^4$

Explanation: Begin at [Ar] and include only the electrons that fill after. This will include the 3d electrons: $[Ar]4s^2 3d^{10} 4p^4$

---

13. The following species are isoelectronic. Select the atom or ion that will have the largest radius.

● a. S^{2-}

b. Ca^{2+}

c. Cl^-

d. Ar

e. K^+

Explanation: Anions becomes larger with the addition of each electron due to electron repulsions in the valence shell. In this isoelectronic series, the sulfur ion has two extra electrons.

---

14. Name the following compounds: $AlPO_4$ and SO_2?

a. aluminum phosphoxide and sulfur dioxide

● b. aluminum phosphate and sulfur dioxide

c. aluminum phosphate and sulfur oxide

d. aluminum phosphite and sulfur oxide

e. aluminum phosphoxide and sulfur oxide

f. aluminum phosphite and sulfur dioxide

Explanation: The correct names are: aluminum phosphate and sulfur dioxide.

---

15. Name the salt with the strongest ionic bond strength:

$MgBr_2$ $CaCl_2$ $MgCl_2$ $CaBr_2$

a. calcium bromide

b. calcium dibromide

● c. magnesium chloride

d. magnesium dichloride

e. magnesium dibromide

f. calcium dichloride

Explanation: Choose the ionic compound with the greatest charge density: $MgCl_2$. Then name it properly: magnesium chloride.

---

16. Chromium(III) and sulfide (S^{2-}) form an ionic bond. What is the formula for the ionic compound?

● a. Cr_2S_3

b. CrS

c. CrS_3

d. Cr_3S_2

e. Cr_2S

Explanation: The least common multiple between the +3 and -2 charges is 6. Therefore, you will have 2 Cr and 3 S, resulting in Cr_2S_3.

---

17. What is the ionic compound formed between Na and O?

● a. Na_2O

b. NaO_2

c. NaO

d. Na_2O_3

e. Na_3O_2

Explanation: Na is in group 1A and will ionize to form a +1 cation. Oxygen will ionize to form a -2 anion. After balancing the charges, you get: Na_2O

---

18. Identify the set that contains ONLY ionic compounds.

a. $CaCl_2$, HI, H_2O

b. CH_3CH_2OH, Al_2O_3, CH_4

c. $CuCl_2$, NaCl, $HClO_3$

d. HCl, AgCl, Al_2O_3

● e. NaBr, Fe_2O_3, $CaCl_2$

Explanation: Look for a metal bonded to a nonmetal. Remember that hydrogen is not a metal, even though it is positioned in the top left of the periodic table. The correct set is: NaBr, Fe_2O_3, $CaCl_2$.

---

19. Carbon and oxygen form a polar covalent bond. Which of the following statements accurately uses the periodic table trends to explain why this type of bond forms?

● a. Oxygen has a greater electronegativity than carbon, which pulls the shared electrons closer to oxygen.

b. Oxygen has a greater ionization energy than carbon, which transfers electrons from carbon to oxygen.

c. Carbon has a greater electronegativity than oxygen, which pushes the shared electrons closer to oxygen.

d. Carbon has a smaller radius than oxygen, which causes the electrons to be shared between the two atoms.

e. Oxygen and carbon have similar electronegativities, causing the electrons to be shared equally between the two atoms.

Explanation: The polar bond forms based on the fact that oxygen has a greater electronegativity (electron withdrawing power) than carbon. This pulls the electrons closer to oxygen, creating a polar covalent bond.

---

20. Select the ionic compound with the highest lattice energy.

● a. MgO

b. Na_2O

c. NaF

d. $MgCl_2$

e. MgS

Explanation: Lattice energy depends on charge and radius. Look for the largest charges first. This reduces your choices to MgO and MgS. Now use the radius, knowing that the stronger lattice energy will be the smaller radius. The answer is MgO.

Remember to bubble in ALL your answers BEFORE time is called. Double check your name, uteid, and version number before you turn in your bubblesheet. You must keep your exam for future reference. Please do not lose it. We will not replace it.