19. (Electromagnetic radiation, spectroscopy) Which wave has a higher frequency?

**A**, B, both have the same frequency

21. (Electronic configuration) Mn: $[Ar]4s^2 3d^?$ How many d electrons does Mn have?
4, **5**, 6

22. (Electronic configuration, valence electrons) Which electrons are most likely to be involved in chemical reactions?
those nearest to the nucleus, **those farthest from the nucleus**, all are equally likely to be involved

23. (Ionic radius) Which is larger,
$Na^+$ or **Na**?
Cl or **$Cl^-$**?

24. (Valence electrons) How many valence electrons are in Cl, $[Ne]3s^2 3p^5$?
2, 5, **7**
For Cl to achieve a noble gas configuration, it is more likely that
**electrons would be added**, electrons would be removed

25. (Lewis dot structures, octet rule) What is a correct Lewis dot representation of carbon monoxide?

26. (Lewis dot structures, bonding) Compare O-O and O=O. Is O=O expected to be
**stronger**, weaker, or the same strength?
Is O=O expected to be
longer, **shorter**, or the same length?

37. (Isoelectronic structures, periodic properties; Ch. 7 "Companion") Ge is a semiconductor. If half of the Ge atoms of a sample of Ge are replaced with Ga atoms, with what element should the other half of the Ga atoms be replaced in order for this new compound to be isoelectronic with Ge?
Sn, **As**, Se

38. (Band gap energy, spectroscopy, semiconductors; Ch. 7 "Companion") Setup: Band gap energy has been introduced in a localized picture: it can be defined as the energy needed to remove an electron from a bond in the solid, enabling the electron to move freely through the solid to conduct electricity. When itinerant electrons return to such a one-electron bond, the band gap energy can be released as a photon. The band gap energy is to a first approximation expected to increase as the bonds become stronger and shorter and the electrons are held more tightly. The group 14 elements illustrate this effect with diamond being an electrical insulator, silicon and germanium (longer, weaker bonds in the same diamond structure) being semiconductors, and α–tin being a metal. **Demonstration 7.11** "Companion"**:** A trio of

related predictions: what will happen to interatomic spacing, band gap energy, and the color of the light emitted when an orange LED is cooled in liquid nitrogen. On cooling,

**atoms of the semiconductor will get closer together**, atoms will get farther apart
**band gap energy increases**, band gap energy decreases
color of light will become more red, **color of light will become more yellow**

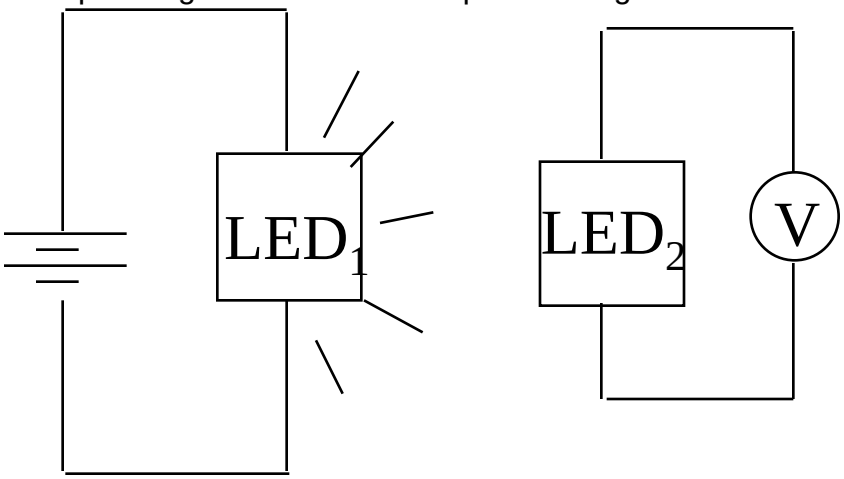
40. (Spectroscopy; Ch. 7 "Companion") Knowing diamond is transparent, which curve best represents the absorption spectrum of diamond (*see* below)?

**A**, B, C

235. (Nuclear chemistry, periodic properties) Researchers are trying to prepare element 114 (*Science* , 24 October 1997, **278**, 571-572.). If a compound could be made from only this element and hydrogen, based on its position in the periodic table, how many H atoms would you expect to bond to element 114?

1, 3, **4**, 5

239. Consider two LEDs, one red and one green, both emitting at their band gap energy. Which operating LED can cause a photovoltage in the other LED?




The red LED causes photovoltage in the green LED
**The green LED causes photovoltage in the red LED**

41. (Superconductors, periodic properties; Ch. 9 "Companion") A major research breakthrough was the discovery that an oxide of La, Cu, and Ba was superconducting. When this material was "squeezed," the high pressure raised the critical temperature at which it became superconducting. Given this effect, which element should be tried as a +3 ion replacement for La to raise the critical temperature without having to apply pressure?

Hf, **Y**, Ac

51. (Solid solutions, periodic properties; Ch. 7 "Companion") Which of the following is a reasonable solid solution?
**$Ga_xAl_{1-x}As$**, **$GaP_xAs_{1-x}$**, $GaAl_xAs_{1-x}$

55. (Energy diagrams) According to the energy diagram below for the Bohr model of the hydrogen atom, if an electron jumps from $E_1$ to $E_2$, energy is
**absorbed**, emitted, not involved

56. (Magnetism, unpaired electrons; Ch. 2 "Companion") Two gel capsules, A and B, are filled with $KMnO_4$ and $MnO_2$, respectively. Based on Mn formal oxidation state and numbers of unpaired electrons, which will have a stronger attraction to a magnet?
A, **B**

**Demonstration 2.2** "Companion": Fill one gel capsule with $KMnO_4$ ($Mn^{+7}$, $d^0$), another with $MnO_2$ ($Mn^{+4}$, $d^3$) and a third with Fe (or Co, Ni) powder. Bring a strong magnet near and even touching the $KMnO_4$ capsule. Note the lack of any attraction. Repeat with the $MnO_2$ capsule, which will be weakly attracted to the magnet due to the unpaired electrons. The Fe capsule will jump to the magnet illustrating the much stronger magnetic attraction for the ferromagnetic material with its cooperative electronic interactions. For large audiences, this demonstration can be done on an overhead projector.

57. (Transition metal complexes) $Ti(H_2O)_6^{3+}$ has how many d-electrons?
$d^0$, **$d^1$**, $d^2$

With regard to magnetic properties, $Ti(H_2O)_6^{3+}$ is
**paramagnetic**, diamagnetic?

$Ti(H_2O)_6^{3+}$ absorbs yellow light. Based on complementary color relationships (color wheel), what color does it appear?
red, green, **violet**

58. (d-orbitals) $Co^{2+}$ has seven electrons in its d-orbitals, which are split as shown below in octahedral coordination geometry. In a high spin configuration, how many electrons are unpaired?
1, 2, **3**

In a low spin configuration, how many electrons are unpaired?
**1**, 2, 3

67. (Spectroscopy, probability; Ch. 8 "Companion") If a blue cupric solution cuts the amount of red laser light reaching a solar cell, which counts photons as photocurrent, in half...

...what will happen if a second solution is added?

79. (Magnetism, polarity, surfactants; Ch. 2 “Companion,” **Demonstrations 2.6, 2.7**) In a ferrofluid preparation, the intent is to keep magnetic particles suspended in an oily medium. How do the surfactant molecules interact with this medium?
**A**, B

83. (Doping, semiconductors, periodic properties; Ch. 8 “Companion”) Which dopant will act as an acceptor for Si?
**B**, Ge, As
As a donor?
B, Ge, **As**

95. (Spectroscopy) **Demonstration:** The current measured in the set-up below is 2 mA. If the sealed sample cell containing a light-absorbing solution is turned lengthwise, what current will be measured?
>2 mA, =2 mA, **<2 mA**

96. (Transition metal complexes) For octahedral complexes, which metal ion fills the 3d subshell with electrons?
$Ni^{2+}$, $Cu^{2+}$, **$Zn^{2+}$**

What color is predicted based on the possible d–d transitions of this complex?
**white**, red, black

103. (Band gap energy; Ch. 7 & 8 "Companion") For promoting electrons to the conduction band and forming $e^-$-$h^+$ pairs, which photons are the most energy efficent?
$h\nu > E_g$, **$h\nu = E_g$**, $h\nu < E_g$

109. (Semiconductors; Ch. 7 "Companion") A CdS photocell measures light intensity by its change in resistance. If the intensity of light increases, the CdS resistance
increases, **decreases**, stays constant

115. (Electronegativity, bonding, band gap energy; Ch. 7 "Companion") The atoms below have the following electronegativities:

| Zn | Ga | Ge | As | Se |
|---|---|---|---|---|
| 1.6 | 1.7 | 1.9 | 2.1 | 2.4 |

The three isoelectronic semiconductors Ge, GaAs, and ZnSe all have roughly the same size unit cell and internuclear separation (exclusively Ge-Ge, Ga-As, and Zn-Se bonds, respectively). If under these conditions, band gap energy increases with ionic character, which isoelectronic solid should have the largest band gap energy?
Ge, GaAs, **ZnSe**

119. (Coordination chemistry) Consider the complex $CrF_6^{3-}$ with anionic $F^-$ ligands. What is the formal oxidation state of the chromium?
**3**, 0, -3

120. (Coordination chemistry) Which of the following are isoelectronic with the $H_2O$ molecule, which commonly serves as a ligand?
**methane $CH_4$, ammonia $NH_3$, fluoride $F^-$**

Which of the above could serve as a ligand if lone pairs are required for binding to the metal center?
methane $CH_4$, **ammonia $NH_3$, fluoride $F^-$**

137. (Solar cells, band gap energy; Ch. 8 "Companion") Two solar cells are to be used by stacking one atop the other. Solar cell A has a band gap energy of 2 eV; solar cell B's band gap energy is 1 eV. Either alone will absorb all the light above its band gap energy. But which one must be on top (nearest the sun) for both to function simultaneously?
**A**, B

138. (Band gap energy, Ch. 7 "Companion") Given the fact that table salt, NaCl, is a poor conductor of electricity and transparent, where does its band gap energy approximately fall?
**in the UV region at > 3 eV**, in the visible between 1.7 and 3 eV, in the IR at < 3 eV

141. (Spectroscopy) Given the three energy levels below, how many emissive transitions are there?
1, 2, **3**
A plot of these three emission bands is shown below. Which of the three peaks corresponds to the transition from $E_3$ to $E_1$?
1, 2, **3**

144. (Concentration, moles) **Demonstration:** A mass of 0.02 moles of copper sulfate is to be dissolved in 200 mL of water to make solution A. A mass of 0.04 moles of copper sulfate is to be dissolved in 400 mL of water to make solution B. Will the two solutions have the same concentration?

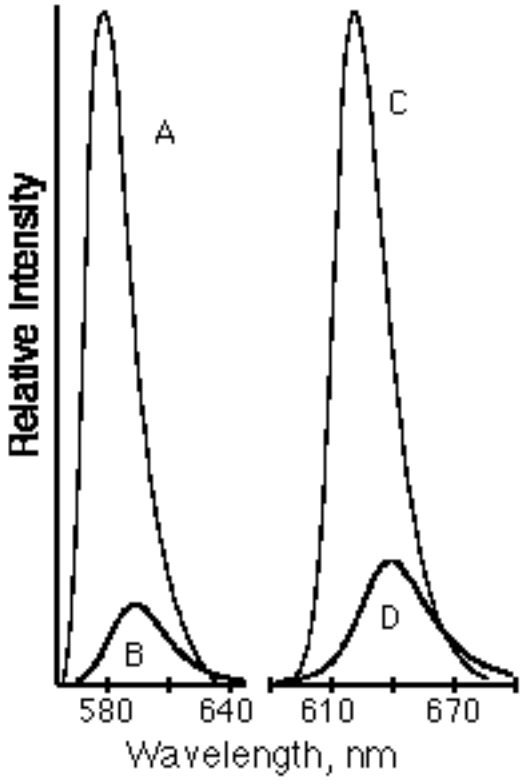
**yes** no

Will they have the same intensity of color in a given pathlength?

**yes** no

152. (Polarization) **Demonstration:** Shine several light sources including a flashlight, LED and pocket laser through a polarizer and observe the transmitted intensity as the polarizer is rotated. Identify whether each source is or is not polarized.

192. Shown below are the emission spectra for two LED's, GaP0.65As0.35 and GaP0.40As0.60. For each LED the spectrum was taken at room temperature and at liquid nitrogen temperature. These four spectra are labeled A through D. Which spectrum corresponds to GaP0.65As0.35 at liquid nitrogen temperature?




**A**, B, C, D

213. Which of the following extended solids is <u>not</u> isoelectronic with the others?

Sn
InSb

CdTe
**InTe**

218. Although pure diamonds are colorless, some diamonds have color because of dopants. The Hope diamond, for example, is blue due to nitrogen (N) dopants. Based on its position in the periodic table, N in diamond acts as a(n):

**donor**, acceptor

Complete the equilibrium reaction shown below for this dopant:

The charge on the product ion is:

**positive**, negative

The ionization of N leads to the production of a(n):

**electron**, hole

Which arrow shown below represents the electronic transition corresponding to the ionization of N?

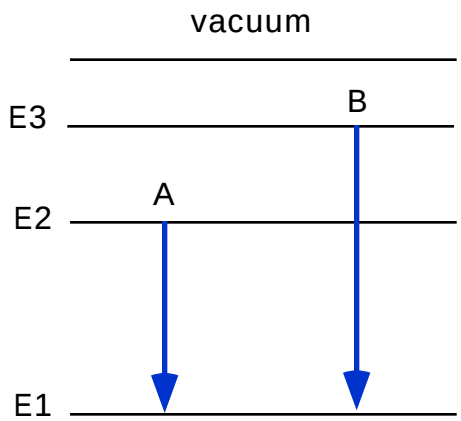
**A**, B

According to LeChatlier's Principle, adding boron (an acceptor) to N-doped diamond will shift the equilibrium of equation 1 toward the:

**products**, reactants

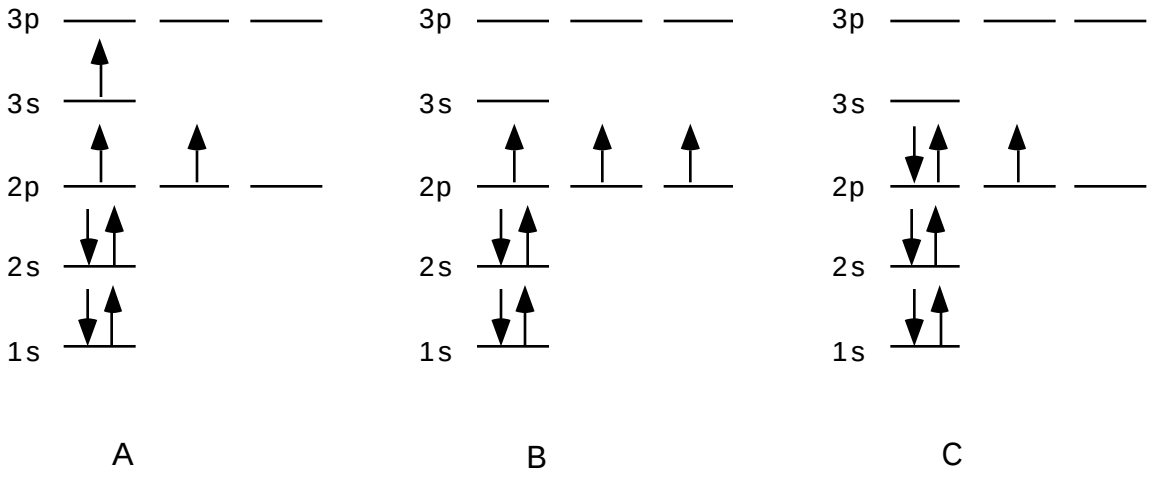
(A similar set of questions could be asked about doping with B, which can produce yellow diamonds.)

223. Which hydrogen atom transition will emit light with lower frequency?




**A**, B

224. Which of the following electron diagrams represents a correct ground state?




A, **B**, C

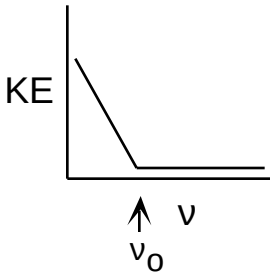
233. When intense red light strikes a sample of Cs metal in a photoelectric effect experiment, no electrons are ejected from the surface. In contrast, exciting the sample with weak blue light ejects electrons, whose kinetic energy can be measured.

These results are consistent with which of the following conclusions?

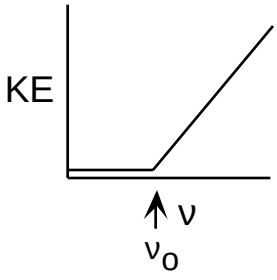
Red photons have more energy than blue photons.
**Red photons have less energy than blue photons.**
Red photons have the same energy as blue photons.

A plot of the kinetic energy of the ejected electron vs. incident photon frequency, ν, would look like

A.




**B.**




An equation describing this experiment is

$$h\nu = h\nu_o + (1/2mv^2)$$

$$h\nu = h\nu_o - (1/2mv^2)$$

$$h\nu = (1/2mv^2) - h\nu_o$$