This print-out should have 8 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering. The due time is Central time.

Msci 09 0305
13:06, general, multiple choice, > 1 min, fixed.
001
What is the bond order in C_2^-?

1. 1.0

2. 2.0

3. 2.5 **correct**

4. 3.0

5. 3.5

Explanation:

$$\text{Bond order} = \frac{\# \text{ elec}_{\text{bond}} - \# \text{ elec}_{\text{antibond}}}{2}.$$

The molecule C_2^- contains 9 bonding electrons and four antibonding electrons (include the net negative charge of the molecule). Applying these values to the bond order equation, we get a bond order of 2.5.

Msci 09 0412
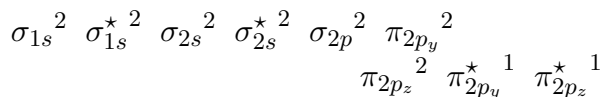13:06, general, multiple choice, > 1 min, fixed.
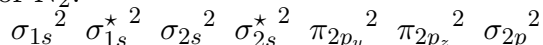**002**
Molecular oxygen and molecular nitrogen are

1. both diamagnetic.

2. oxygen is paramagnetic, nitrogen is diamagnetic. **correct**

3. both paramagnetic.

4. oxygen is diamagnetic, nitrogen is paramagnetic.

Explanation:
The molecular orbital configurations are
For O_2:

$\sigma_{1s}^{\,2}\ \sigma_{1s}^{\star\,2}\ \sigma_{2s}^{\,2}\ \sigma_{2s}^{\star\,2}\ \sigma_{2p}^{\,2}\ \pi_{2p_y}^{\,2}$
$\pi_{2p_z}^{\,2}\ \pi_{2p_y}^{\star\,1}\ \pi_{2p_z}^{\star\,1}$

For N_2:
$\sigma_{1s}^{\,2}\ \sigma_{1s}^{\star\,2}\ \sigma_{2s}^{\,2}\ \sigma_{2s}^{\star\,2}\ \pi_{2p_y}^{\,2}\ \pi_{2p_z}^{\,2}\ \sigma_{2p}^{\,2}$

ChemPrin3e T03 58
13:10, general, multiple choice, < 1 min, fixed.
003
Which of the following would have the longest bond?

1. B_2 **correct**

2. C_2

3. N_2

4. C_2^{2-}

5. N_2^{2-}

Explanation:
In B_2, the bond order is 1. All others are higher.

Mlib 03 1161
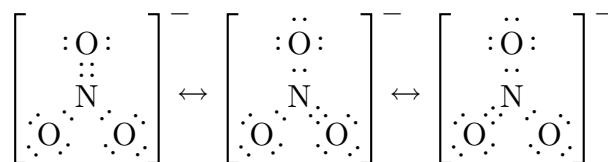13:09, general, multiple choice, > 1 min, fixed.
004
Which of the following species possesses a delocalized bond?

1. H_2S

2. NO_3^- **correct**

3. H_2O

4. NCl_3

5. No molecule given here possesses a delocalized bond.

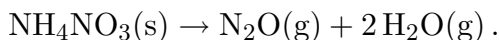**Explanation:**
Only for NO_3^- can resonance structures be drawn.

ChemPrin3e T04 39
14:08, general, multiple choice, < 1 min, fixed.
005
Ammonium nitrate can decompose according to the equation

$$NH_4NO_3(s) \rightarrow N_2O(g) + 2\,H_2O(g)\,.$$

How much GAS is produced by decomposition of 160 g of ammonium nitrate at STP?

1. 44.8 L

2. 6.00 L

3. 22.4 L

4. 134 L **correct**

5. 67.2 L

Explanation:
$m_{NH_4NO_3} = 160$ g NH_4NO_3 $P = 1$ atm
$T = 0°C + 273.15 = 273.15$ K
   For the NH_4NO_3,

$$n_{NH_4NO_3} = (160 \text{ g } NH_4NO_3)$$
$$\times \frac{1 \text{ mol } NH_4NO_3}{80.0434 \text{ g } NH_4NO_3}$$
$$= 1.99892 \text{ mol } NH_4NO_3$$

   The question asks for the number of moles of GAS; *i.e.*, mol of N_2O AND H_2O:

$$n = (1.99892 \text{ mol } NH_4NO_3) \frac{3 \text{ mol gas}}{1 \text{ mol } NH_4NO_3}$$
$$= 5.99675 \text{ mol gas}$$

   The ideal gas law is

$$PV = n\,R\,T$$
$$V = \frac{n\,R\,T}{P}$$
$$= \frac{(5.99675 \text{ mol gas}) \left(0.08206 \frac{\text{L·atm}}{\text{mol·K}}\right)}{1 \text{ atm}}$$
$$\times (273.15 \text{ K})$$
$$= 134.415 \text{ L gas}$$

ChemPrin3e T04 60
14:10, basic, multiple choice, < 1 min, fixed.
006
Which of the following gases will have the largest root mean square speed at $100°C$?

1. water

2. argon

3. methane **correct**

4. nitrogen

5. oxygen

Explanation:

Mlib 04 1011
14:04, general, multiple choice, > 1 min, fixed.
007
A 6.35 L sample of carbon monoxide is collected at $55°C$ and 0.892 atm. What volume will the gas occupy at 1.05 atm and $20°C$?

1. 1.96 L

2. 5.46 L

3. 4.82 L **correct**

4. 6.10 L

5. 6.68 L

Explanation:
$P_1 = 0.892$ atm $T_1 = 55°C + 273 = 328$ K
$P_2 = 1.05$ atm $T_2 = 20°C + 273 = 293$ K
$V_1 = 6.35$ L

   We can use the combined gas law and solve for V_2:

$$\frac{P_1\,V_1}{T_1} = \frac{P_2\,V_2}{T_2}$$
$$V_2 = \frac{P_1\,V_1\,T_2}{T_1\,P_2}$$
$$= \frac{(6.35 \text{ L})\,(0.892 \text{ atm})\,(293 \text{ K})}{(328 \text{ K})\,(1.05 \text{ atm})}$$
$$= 4.82 \text{ L}$$

ChemPrin3e T04 66

14:13, general, multiple choice, < 1 min, fixed.

008

Which of the following gases would you predict to have the largest value of the van der Waals coefficient b?

1. $C_2F_2Cl_4$

2. CO_2

3. C_2F_6

4. Cl_2

5. C_2FCl_5 **correct**

Explanation: