Graphs and Charts – AP Exam Review

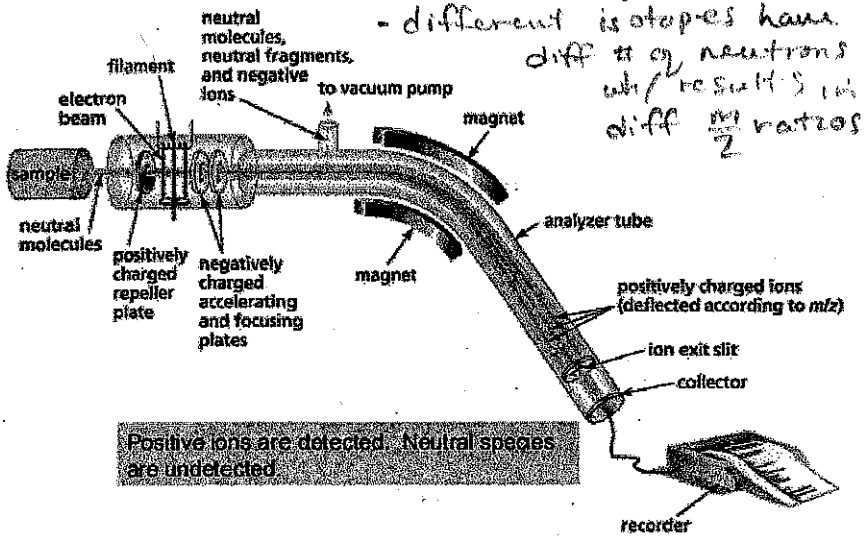
Spectrometry

Mass Spectroscopy

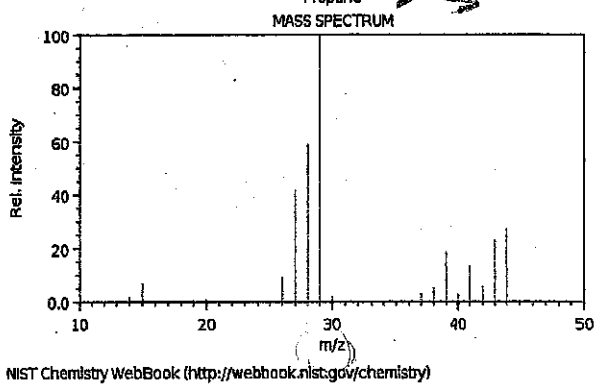
- a small amt of substance is vaporized & then bombarded w/ e⁻ to make ions
- ions are separated by their $\frac{\text{mass}}{\text{charge}}$ ratio $\rightarrow$ m/z
- different isotopes have diff # of neutrons w/ results in diff $\frac{m}{z}$ ratios

→ in ions with only one charge m/z can be regarded as mass

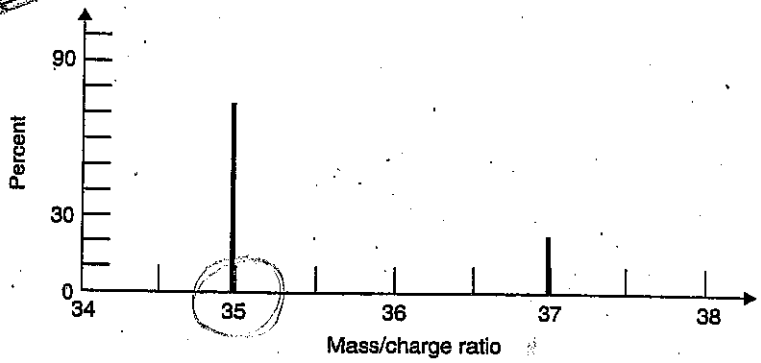
Mass Spectrometer



Positive ions are detected. Neutral species are undetected.

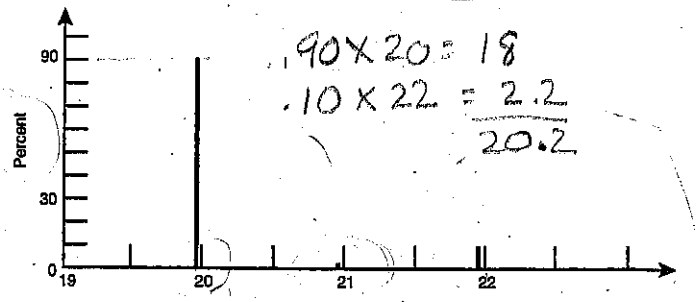


1. A mass spectrum of a naturally occurring Sample of an element is shown at the right. What is the element? Cl

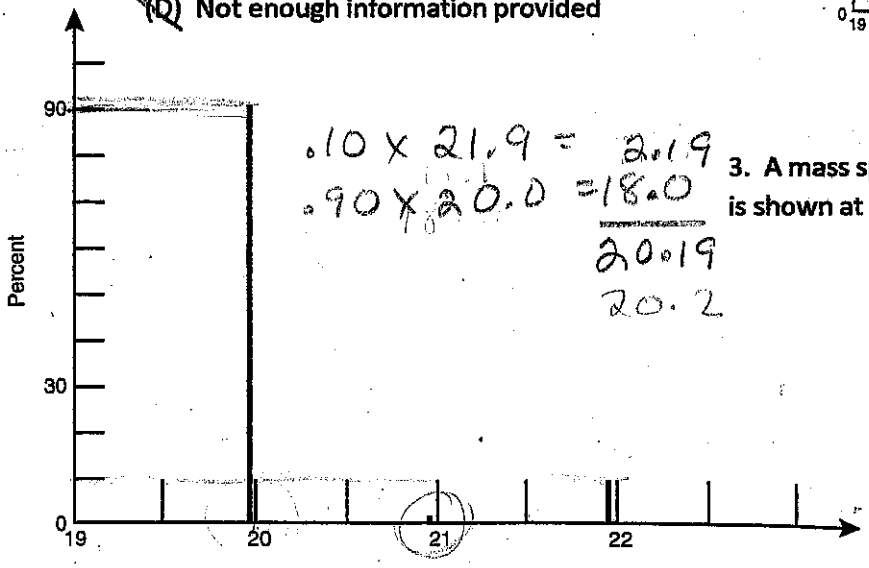


2. A portion of a mass spectrum of neon is represented at the right. Estimate the average mass of naturally occurring atoms of neon, assuming the height of each line represents the relative amount of each mass.

(A) 20.3
(B) 20.0
(C) 21.0
(D) Not enough information provided



.90 × 20 = 18
.10 × 22 = 2.2
20.2



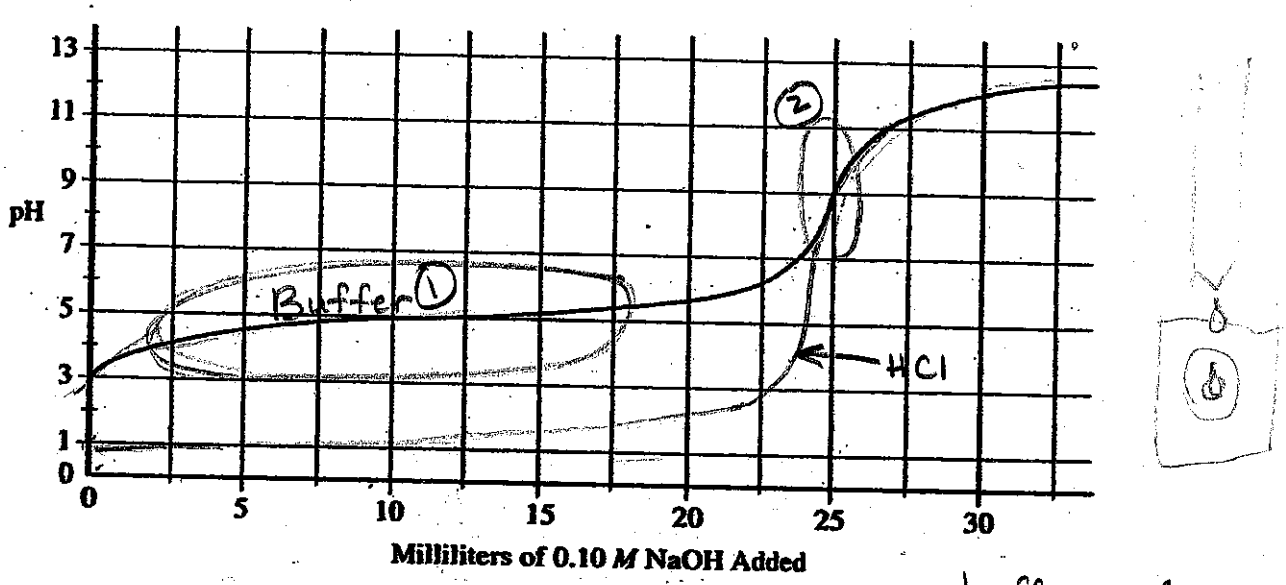
.10 × 21.9 = 2.19
.90 × 20.0 = 18.0
20.19
20.2

3. A mass spectrum of a naturally occurring element is shown at the left. What is the element?

Ne

1.

4. The graph below shows the result of the titration of a 25 mL sample of a 0.10 M solution of a weak acid, HA, with a strong base (0.10 M NaOH).



(a) Describe two features of the graph above that identify HA as a weak acid. ① buffer region ② short vertical region

(b) Describe one method by which the value of the acid-base dissociation constant for HA can be determined using the graph above. eq pt → ½ eq pt → @ ½ eq pt pH = pKa $K_a = 10^{-pK_a}$

(c) On the graph above, sketch the titration curve that would result if 25 mL of 0.10 M HCl were used instead of 0.10 M HA.

(d) A 25 mL sample of 0.10 M HA is titrated with .20 M NaOH.

(i) What volume of base must be added to reach the equivalence point?

$M_aV_a = M_bV_b$

$(.10)(25) = (.20)V_b$

$\frac{2.5}{.2} = V_b$

$V_b = 12.25$ mL

(ii) The pH at the equivalence point of the titration is slightly higher than the pH at the equivalence point in the titration using 0.10 M NaOH. Explain.

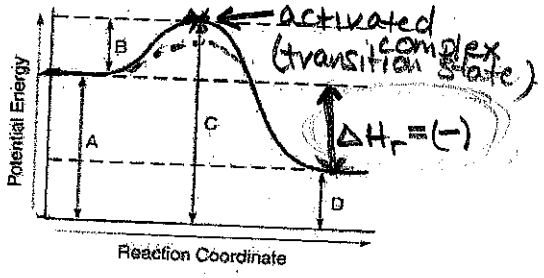
.20M

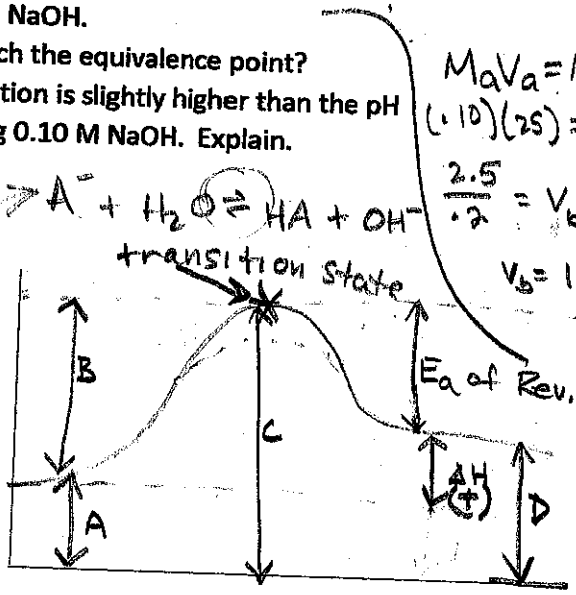
.10M 5.

HA	+	OH^-	→	A^-	+	H_2O
2.5		2.5		2.5		
2.5		2.5		2.5		

$2.5/5 \quad 2.5/5$

$A^- + H_2O \rightleftharpoons HA + OH^-$



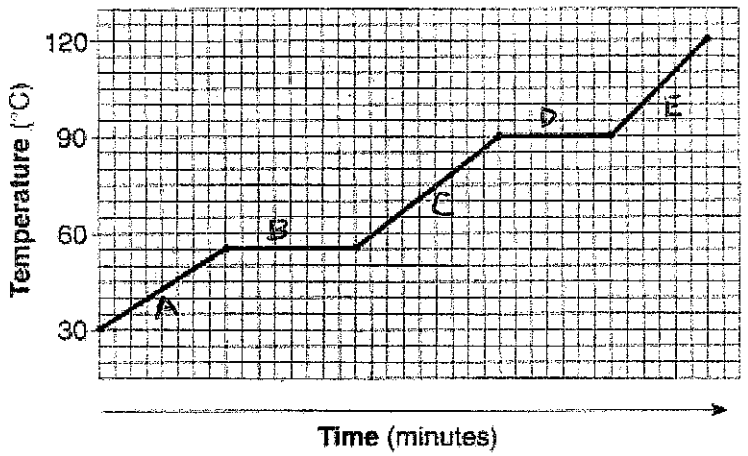


A

(a) What is represented by letters A-D? A = PE of Reactants B = E_a of Forward Rxn C = PE of the activated complex D = PE of Products

(b) How would A change if a catalyst were used. Represent the change with a dashed line. A would not change. C would be lower 2.

(c) In the space at B, draw a potential energy diagram and label A-D. for an endothermic reaction



6.

$q = (H_{fus})(mol)$

(a) What formula would be used to calculate the heat content of section B? Section A? $q = mC\Delta T$

(b) What would the specific heat indicate about the substance? heat required to raise the temp of 1g by 1 degree

(c) In terms of kinetic and potential energy, what is occurring at "A" and "B"? PE↑ KE constant

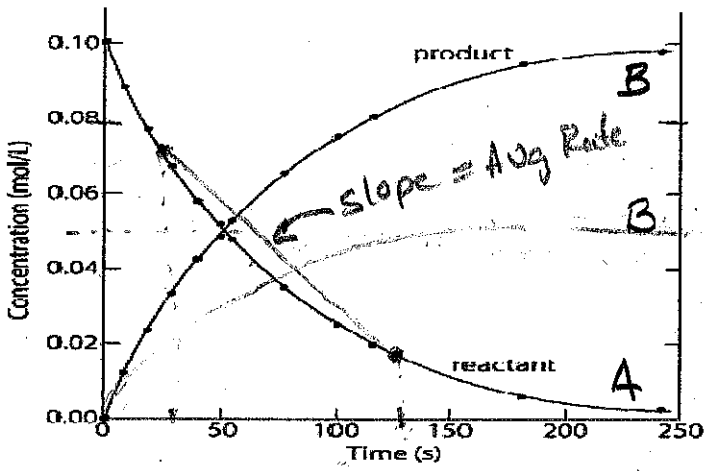
(d) What are the melting point and freezing point of this substance? KE↑ PE constant

55° 55°

Rate: $\frac{\Delta[\ ]}{\Delta t}$

$A \rightarrow B$

$2A \rightarrow B$



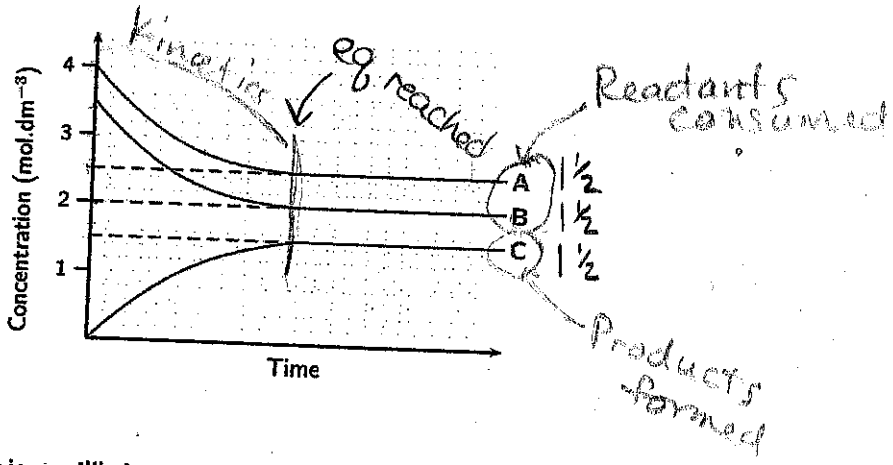
7.

(a) How might this graph be used to find the instantaneous rate of a reaction? slope of tangent line

(b) How might you find the average rate of the reaction between two points in time?

(c) If this graph represents the reaction A → B, what would it look like if the reaction were 2A→ B? Draw any changes in the graph with a dashed line.

↓2 ↑1

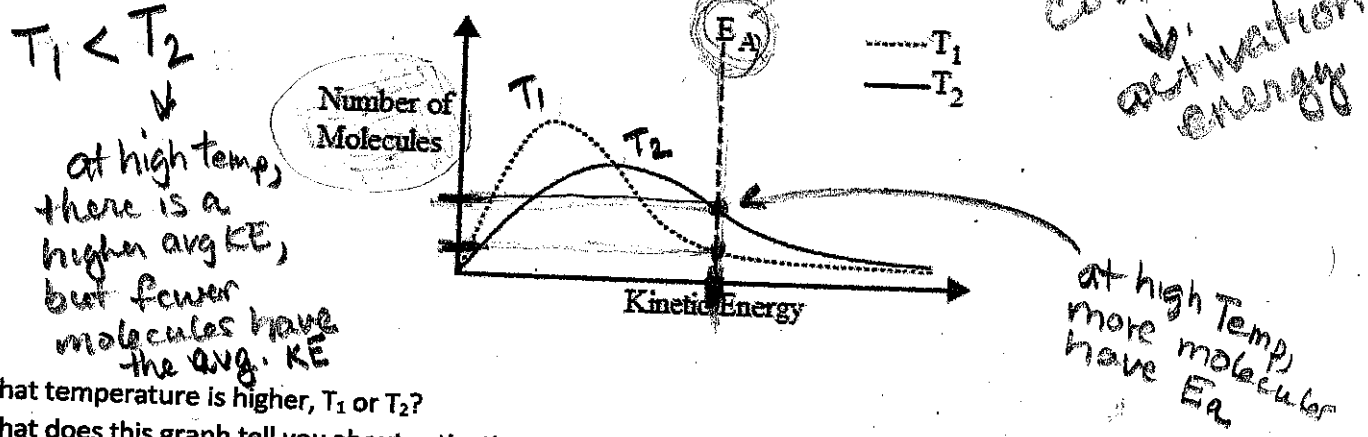


8.

(a) Based on this graph, how is equilibrium identified?

(b) Assuming all reactants and products are represented on the graph, what is the balanced equation for the reaction.

(c) Define equilibrium in terms of rate.

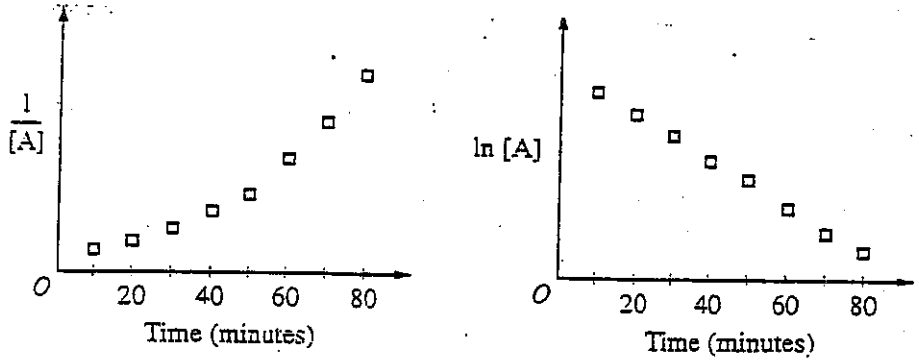


9.

(a) What temperature is higher, T_1 or T_2?

(b) What does this graph tell you about activation energy and number of molecules?

10. Data for the chemical reaction 2A→B+C were collected by measuring the concentration of A at 10-minute intervals for 80 minutes. The following graphs were generated from the data.

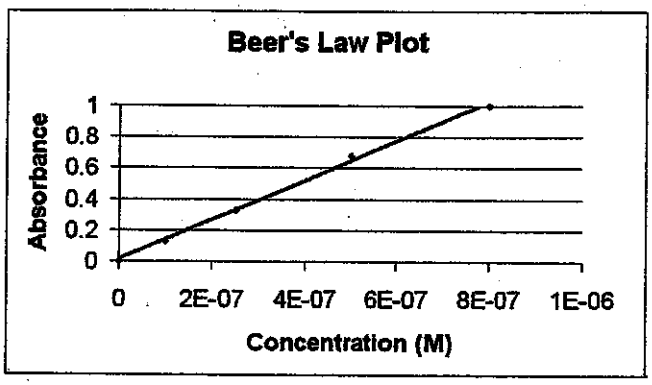


(a) Write the rate law expression for the reaction. Justify your answer.

(b) Describe how to determine the value of the rate constant for the reaction.

4.

11. The graph below is a Beer's Law plot for $Ni(NO_3)_2$.



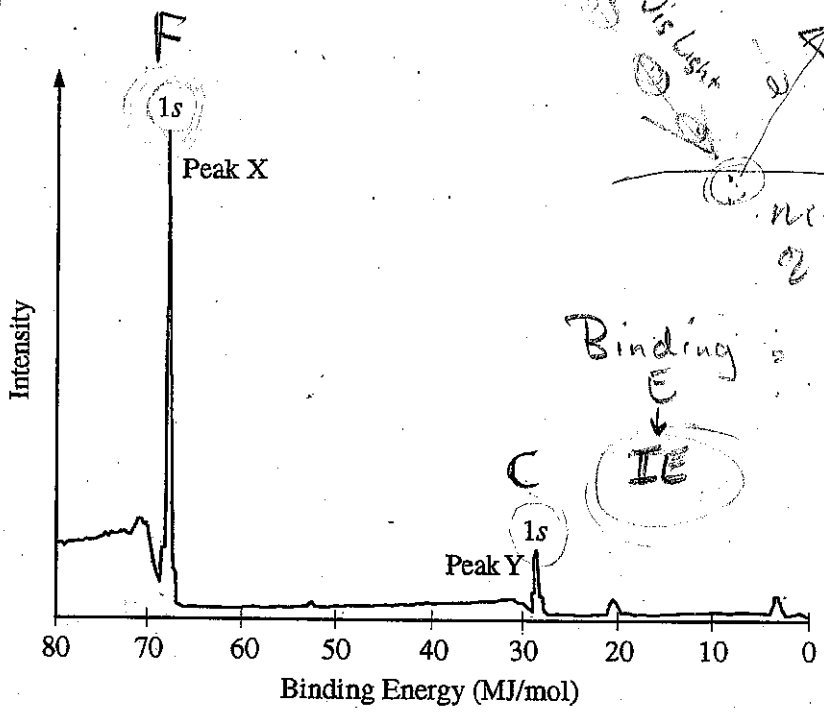
$A = abc$ → conc. → path length
Abs. → constant (molar absorptivity)

(a) How can the concentration of a solution of $Ni(NO_3)_2$ be determined from the slope of the line?

(b) If the cuvettes used in the spectrophotometer have a diameter of 1.0 cm, how would you calculate the value of the molar absorptivity?

$a = \frac{A}{bc}$

photoelectric effect



UV, X-ray, Vis light

measure the KE of the ejected e⁻

Binding E = $E_{incoming\ photon} - E_{emitted\ electron}$

IE

31. A sample containing atoms of C and F was analyzed using x-ray photoelectron spectroscopy. The portion of the spectrum showing the 1*s* peaks for atoms of the two elements is shown above. Which of the following correctly identifies the 1*s* peak for the F atoms and provides an appropriate explanation?

(A) Peak X, because F has a smaller first ionization energy than C has.
(B) Peak X, because F has a greater nuclear charge than C has.
(C) Peak Y, because F is more electronegative than C is.
(D) Peak Y, because F has a smaller atomic radius than C has.

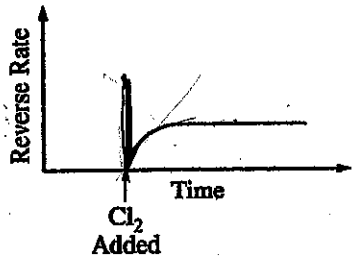
5.

13. $PCl_5(g)$ decomposes into $PCl_3(g)$ and $Cl_2(g)$ according to the equation below.

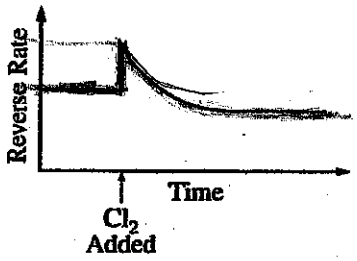
$$PCl_5(g) \leftrightarrow PCl_3(g) + Cl_2(g)$$

Additional $Cl_2(g)$ is injected into the system at equilibrium. Which of the following graphs best shows the rate of the reverse reaction as a function of time? Assume that the time for injection and mixing of the additional Cl_2 is negligible.

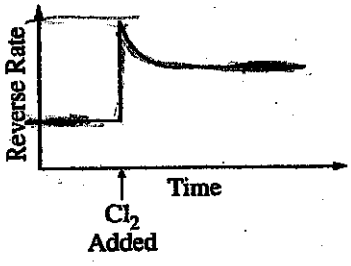
(A)



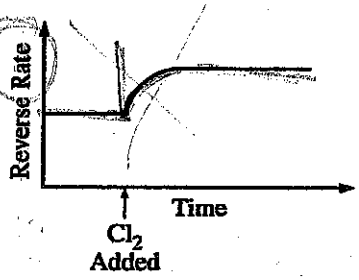
(C)



(B)



(D)



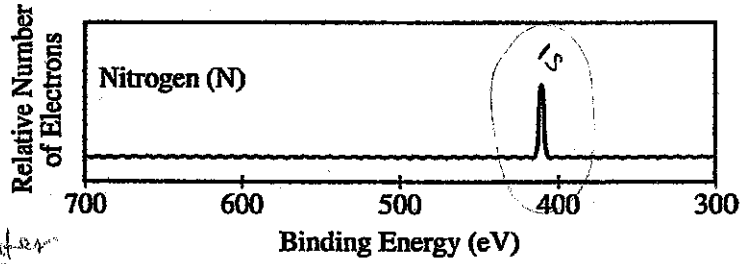
14. The photoelectron spectra below show the energy required to remove a 1s electron from a nitrogen atom and from an oxygen atom. Which of the following statements best accounts for the peak in the upper spectrum being to the right of the peak in the lower spectrum?

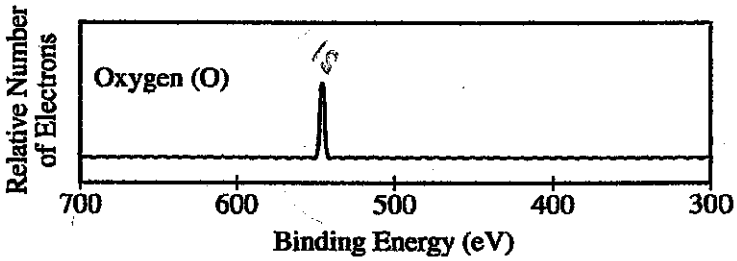
(A) Nitrogen atoms have a half-filled p subshell.

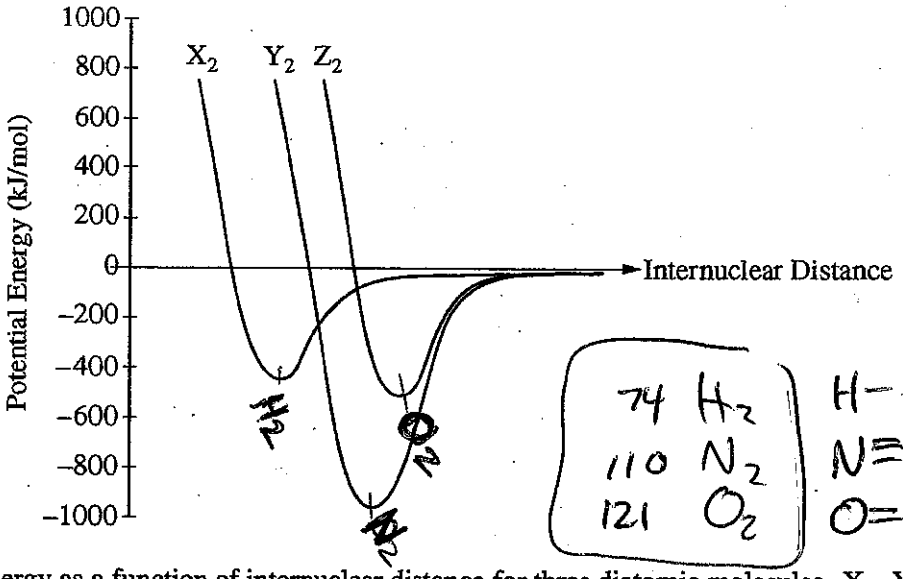
(B) There are more electron-electron repulsions in oxygen atoms than in nitrogen atoms.

(C) Electrons in the p subshell of oxygen atoms provide more shielding than electrons in the p subshell of nitrogen atoms.

(D) Nitrogen atoms have a smaller nuclear charge than oxygen atoms.



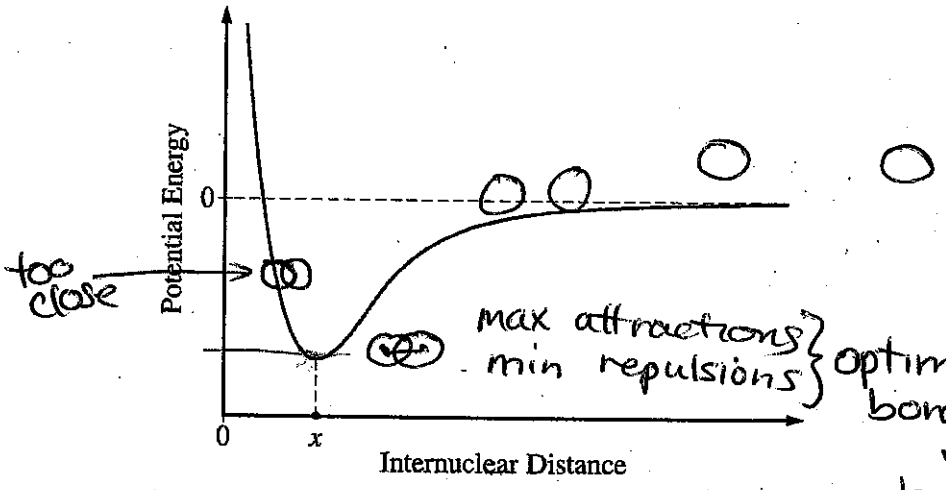




74 H_2 H–H
110 N_2 N≡N
121 O_2 O=O

17. The potential energy as a function of internuclear distance for three diatomic molecules, X_2, Y_2, and Z_2, is shown in the graph above. Based on the data in the graph, which of the following correctly identifies the diatomic molecules, X_2, Y_2, and Z_2?

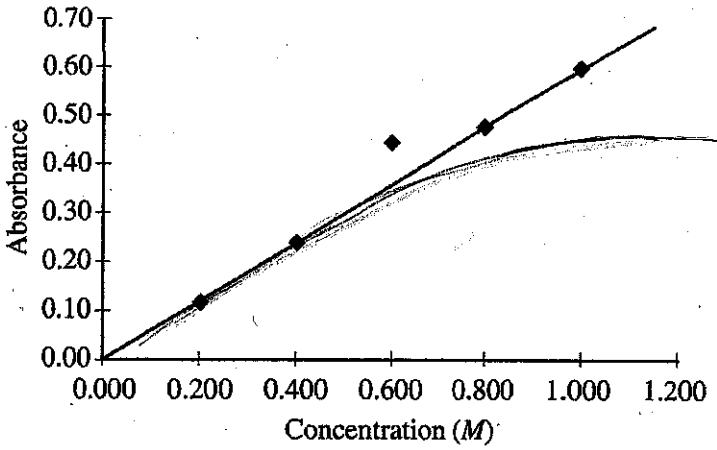
	X_2	Y_2	Z_2
(A)	H_2	N_2	O_2
(B)	H_2	O_2	N_2
(C)	N_2	O_2	H_2
(D)	O_2	H_2	N_2



47. The potential energy of a system of two atoms as a function of their internuclear distance is shown in the diagram above. Which of the following is true regarding the forces between the atoms when their internuclear distance is x?

(A) The attractive and repulsive forces are balanced, so the atoms will maintain an average internuclear distance x.
(B) There is a net repulsive force pushing the atoms apart, so the atoms will move further apart.
(C) There is a net attractive force pulling the atoms together, so the atoms will move closer together.
(D) It cannot be determined whether the forces between atoms are balanced, attractive, or repulsive, because the diagram shows only the potential energy.

7.

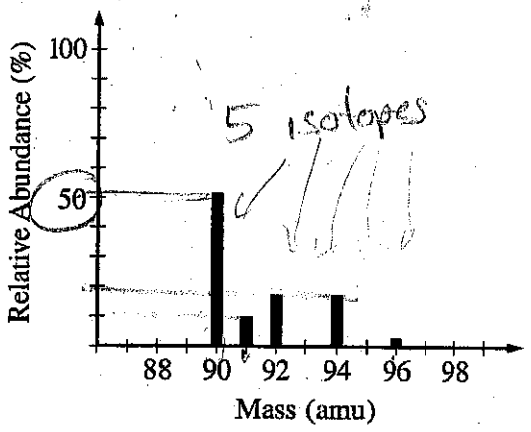


If more than one colored species present → does not follow Beer's Law

27. A student prepared five solutions of $CuSO_4$ with different concentrations, and then filled five cuvettes, each containing one of the solutions. The cuvettes were placed in a spectrophotometer set to the appropriate wavelength for maximum absorbance. The absorbance of each solution was measured and recorded. The student plotted absorbance versus concentration, as shown in the figure above. Which of the following is the most likely explanation for the variance of the data point for the 0.600 *M* $CuSO_4$ solution?

(A) The cuvette into which the 0.600 *M* solution was placed had some water droplets inside.
(B) The cuvette into which the 0.600 *M* solution was placed was filled slightly more than the other cuvettes.
(C) The wavelength setting was accidentally moved away from that of maximum absorbance.
(D) The cuvette used for the 0.600 *M* solution had not been wiped clean before being put in the spectrophotometer.

would make Abs too low



5 isotopes

% Abund → dec form

.5 × 90 =
.2 × 92 =
.2 × 94 =
.1 × 91 =
.05 × 96 =

Avg Atomic mass

8.

3. The mass spectrum of element X is presented in the diagram above. Based on the spectrum, which of the following can be concluded about element X?

(A) X is a transition metal, and each peak represents an oxidation state of the met
(B) X contains five electron sublevels.
(C) The atomic mass of X is 90.
(D) The atomic mass of X is between 90 and 92.