

ANALYTICAL CHEMISTRY MIDTERM EXAM STUDY GUIDE 2019-2020

Topics to Review:

Unit 1: Properties of Matter

Scientific method, independent & dependent variables, control & experimental groups, constants, mass, volume, density, accuracy, precision, measurement, conservation of mass, percent error, particle diagrams, graphing,

Unit 2 – The Atom

Static electricity, Atomic models (Dalton, Thomson, Rutherford, Bohr, QMM), location, relative mass and charge for p,n,e; atomic number, mass number, atomic mass, isotope, ion, isotope notation, Honors - spectrographs

Unit 3 – Radioactivity

Nuclear radiation, nuclear force, radioactive decay, alpha, beta, gamma, half-life, fission/fusion, HONORS – decay equations

Unit 4 – Quantum Mechanics

Electromagnetic spectrum; light; wavelength, frequency and energy calculations; emission spectrum, QMM, electron configurations, orbital shapes, orbital diagrams, Bohr models

Unit 5 Periodic Table – arrangement of the periodic table, periodic table trends, atomic radius, electronegativity, ionization energy, valence electrons, metals, nonmetals, metalloids, properties, octet rule, groups/family names, Lewis Dot Structures, ion names

Unit 5b – Types of Matter– Element, Compound, Molecule, Mixture, Pure , Homogenous, Heterogeneous

How You Should Prepare for the Exam:

- First and most importantly, **STUDY !!!!!!!!!!!!!!!!!!!!!**
- **DO NOT CRAM FOR THE EXAM!!!!** Start reviewing several weeks in advance, so you will have time to ask the teacher for any additional explanation you might need on a topic you are having difficulty with.
- Review your notes, quizzes and tests. Rework any problems on the tests and quizzes and ask for additional explanation for material you don't understand.
- Understand the material and be able to write the main ideas down in your own words
- Make flash cards or study sheets.
- Finally **GET A GOOD NIGHT'S SLEEP** the night before the exam and **EAT A GOOD BREAKFAST** and **LUNCH** the day of the exam.

NOTE – THIS REVIEW CONTAINS EXAMPLE PROBLEMS. THIS IS NOT THE ONLY MATERIAL ON THE TEST.

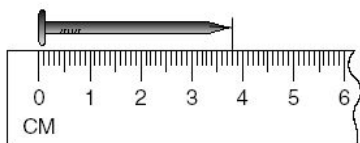
Unit 1: Properties of Matter

1. What is the difference between accuracy and precision?
2. A chemical reaction was carried out three separate times by a student and produced these product masses: 8.83 g; 8.84 g; 8.82 g. The true mass of products from the reaction is 8.60 g. Describe the measurements in terms of accuracy and precision.
3. If you measure the mass of a book at 125 grams and the accepted value is really 130 grams, what is your percent error?

$$\% \text{ error} = \frac{(\text{Accepted} - \text{Measured})}{\text{Accepted}} \times 100\%$$

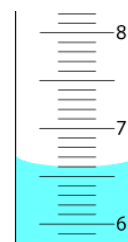
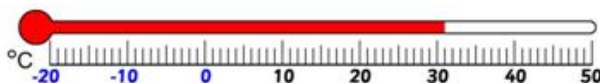
4. The classroom temperature is
is your % Error?

set at 26.0°C. You measured it to be just 24.0°C. What



5. What is the length of the nail?

6. What is the temperature?



7. What is the volume of the liquid?

8. If you have a Mass(g) vs. Volume (cm³ or mL) graph how can you determine the density?

9. Using the graph, answer the following:

a. What is the independent variable? What is the dependent variable?

b. Which substance has the greatest density? least?

c. Calculate the density of alcohol.

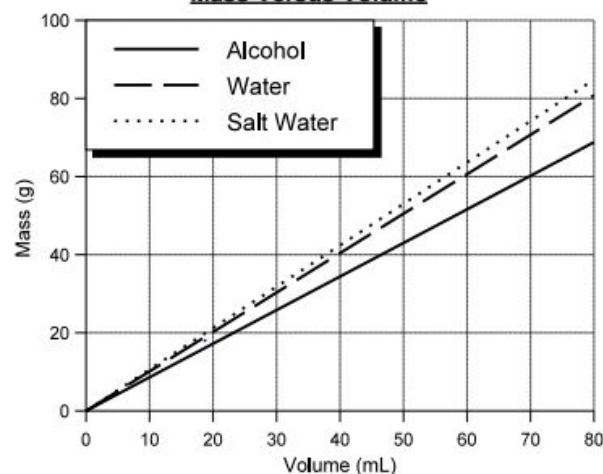
d. Write a “for every” statement for the slope for alcohol.

e. Using the slope, calculate the mass of 50ml of alcohol.

f. Using the graph, given 30 mL of water, what would it's mass be?

g. Which substance would occupy a larger volume if each had a mass of 70g? Explain.

Mass Versus Volume



10. All of the following apply to the dependent variable EXCEPT

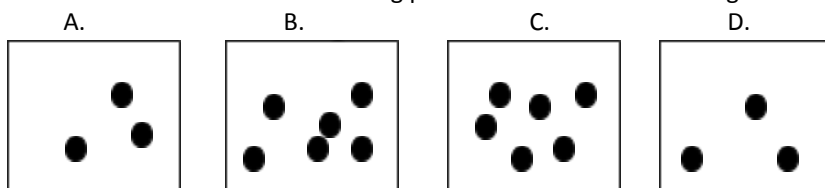
a. it is measured b. it is an effect c. it is varied d. it is plotted on the y-axis

11. All of the following apply to the independent variable EXCEPT

- a. it's being tested b. it's plotted on the y-axis c. it is varied d. it's plotted on the x-axis

12. A piece of iron (mass = 47.5 grams) is placed into a graduated cylinder filled with 50.0 ml of water. The new volume (with the metal) is 62.0 ml. Calculate the density of iron.

13. The 4 cm³ boxes below are each filled with 1g particles. Which box has the greatest density? Why?



14. **D=M/V** The density of a pure diamond is 3.5g/cm³. What is the mass of a diamond with a volume of 0.71cm³?

15. A cube of gold-colored metal with a volume of 54 cm³ has a mass of 980 g. The density of gold is 19.3 g/cm³. Is this sample of metal pure gold? Why or why not?

16. Determine the volume of an object with a mass of 8.1 g and a density of 2.4 g/ml.

17. You have two pieces of lead (11.4 g/ml). The large piece sinks to the bottom when placed in water. What will happen to the small piece when placed in water? Why?

18. Which object in the picture is the most dense?

19. Which liquid in the picture is the least dense?

20. Why are the popcorn kernels floating in corn syrup?

21. A student in class is asked to find the density of an orange rod. She uses the water displacement method to get the volume of the rod. The water level began at 25.4mL and after she put the rod in the water the water rose to 31.6mL. The mass of the rod is 8.31g. What is the density of the object?

22. Gary noticed that two plants of the same type were different in size after three weeks, even though they were initially the same size when his mother planted them on the same day. Since the larger plant was in the full sun all day and the smaller plant was in the shade of a tree for most of the day, Gary believed that the sunshine was responsible for the difference in plant size. In order to test this, Gary bought ten small plants of the same size and type. He also made sure they have the same amount and type of soil. Gary put a canvas roof over five of the plants, while the other five were out in the sun. Gary was careful to make sure that each plant received exactly the same amount of water and plant food every day. After 2 weeks, the plants grown in the sun were an average of 15.2 cm tall, while the plants in the shade were an average of 12.9 cm tall.

- a) Independent Variable _____
- b) Dependent Variable _____
- c) Experimental Group _____
- d) Control Group _____
- e) Constants _____

Claim:

Evidence:

Reasoning:

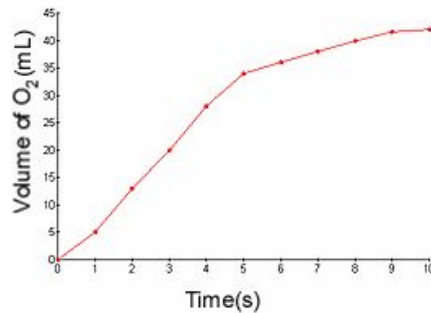
23. What happened to the volume of oxygen between 1s and 4s?

What happened to the volume of oxygen between 9s and 10s?

What is the IV?

What is the DV?

Write an appropriate title.



Unit 2 The Atom

1. Briefly describe & draw the atomic models below. Explain any important experiment associated with the model.

John Dalton

J. J. Thomson

Ernest Rutherford

Neils Bohr

QMM

Subatomic particle	Charge	Location	Mass
Proton			
Neutron			
Electron			

2. Fill in the table.

3. Define the following:

Ion

Isotope

Atomic number

Mass number

Average atomic mass

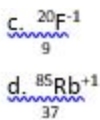
4. If the element Rubidium (Rb) has an average atomic mass of 85.468amu, which isotope is in greater abundance, ⁸⁵Rb or ⁸⁷Rb? How do you know?

5. C-12 and C-14 are isotopes. What does that mean? How many protons and neutrons in each?

6. Neutral atoms contain equal numbers of _____ and _____.

7. How many protons, neutrons, and electrons in the following:

- a. $^{32}_{15}\text{P}^{-3}$
- b. $^{41}_{20}\text{Ca}^{+2}$



8. Complete the table.

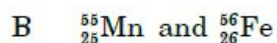
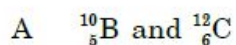
Isotope/Ion Name	Isotopic Notation	Atomic Number	Mass Number	# of Protons	# of Electrons	# of Neutrons
1. calcium-40						
2.		12	24			
3.				1		2
4.	$^{197}_{79}\text{Au}$					
5.					26	30
6.			201	80		
7.		17				18
8.	$^{32}_{15}\text{P}^{-3}$					
9.		9			10	10
10.			88	38	36	

9. Which model of the atom below correctly describes the location of protons and electrons in the QMM of the atom?

Model	Location of Protons	Location of Electrons
A	In the nucleus	Specific shells
B	In the nucleus	Regions of most probable location
C	Dispersed throughout atom	Specific shells
D	Dispersed throughout atom	Regions of most probable location

10. What were the two main conclusions of Rutherford's Gold foil experiment?

11. Which elements have the same number of neutrons?



12.

Each diagram below represents the nucleus of an atom.



How many different elements are represented

13. There are two isotopes of Lithium, Li-6 (7.50%) and Li-7 (92.5%). Calculate the atomic mass of lithium.
14. Calculate the average atomic mass for neon if its abundance in nature is 0.5% neon-20, 0.3% neon-21, and 9.2% neon-22.

15. **Natural Abundance of Two Gallium Isotopes**

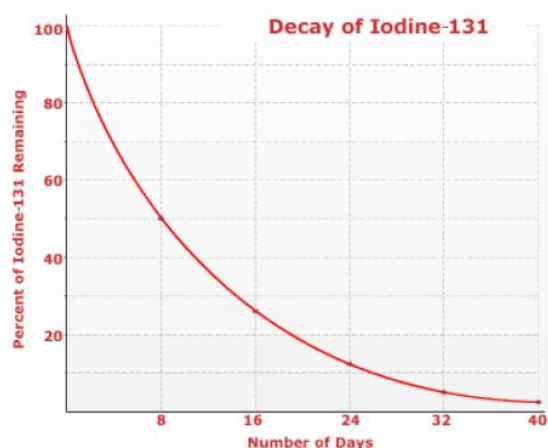
Isotope	Natural Abundance (%)	Atomic Mass (u)
Ga-69	60.11	68.926
Ga-71	39.89	70.925

Which numerical setup can be used to calculate the atomic mass of gallium?

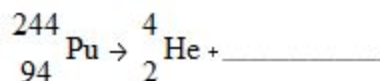
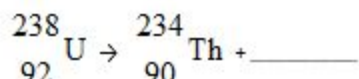
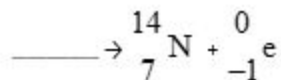
- (1) $(0.6011)(68.926 \text{ u}) + (0.3989)(70.925 \text{ u})$
 (2) $(60.11)(68.926 \text{ u}) + (39.89)(70.925 \text{ u})$
 (3) $(0.6011)(70.925 \text{ u}) + (0.3989)(68.926 \text{ u})$
 (4) $(60.11)(70.925 \text{ u}) + (39.89)(68.926 \text{ u})$

Unit 3 Nuclear Radiation

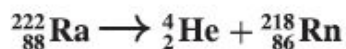
- What is the half life of I-131?
- The half-life of Au-198 is 2.69 days. How much of a 100 g sample of gold-198 remains radioactive after 10.76 days?
- The half-life of Rn-222 is 3.82 days. How many days are required for 200.0 grams of radon-222 to decay to 50.0 grams?
- What is the half-life of K-42 if 16 grams of K-42 decayed into 2 grams after 37.2 hours?
- What is fission? Name two examples.
- What is fusion? Name two examples.
- What makes an atom radioactive?
- Rank the three types of radiation from most to least penetrating. (beta, alpha, gamma)
- Why does the atom need a strong nuclear force?
- After decaying for 48 hours, 1/16 of the original mass of a sample remains. What is the half-life of this radioisotope?



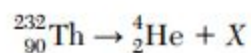
11. Complete the following decay equations.



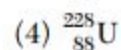
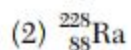
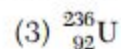
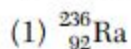
12. What type of decay is depicted?



13. Given the equation representing a nuclear reaction in which X represents a nuclide:



Which nuclide is represented by X?



Unit 4 – Electrons and the QMM

1. How are wavelength and frequency of light related?

2. How are frequency and energy of light related?

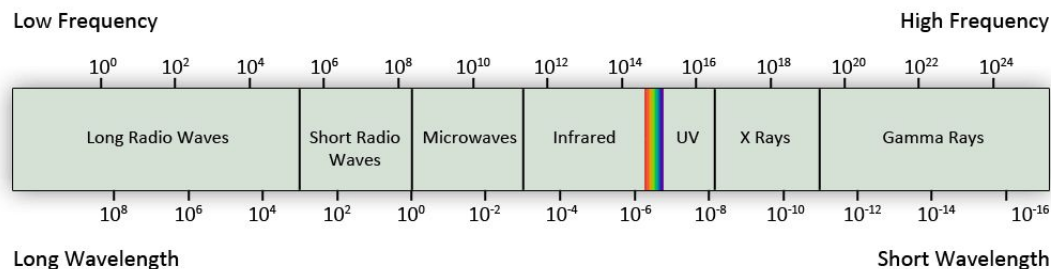
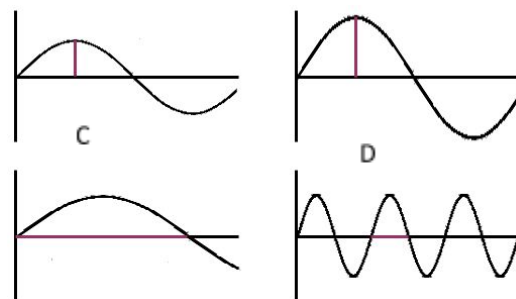
3. List the colors of the visible spectrum in order from largest to smallest wavelength. Which has the highest energy?

4. Low energy radiation has _____ frequency and a _____ wavelength.

5. Which diagram shows a wave with the highest frequency?

6. Which diagram shows the longest wavelength?

7. Which diagram shows a wave with the lowest energy?



8. Which radiation has a longer wavelength, cosmic rays or radio waves?

9. Which radiation has a more energy, x-rays or microwaves?

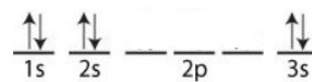
10. Which of the following types of electromagnetic radiation has the highest frequency?

- a. X rays b. infrared light c. ultraviolet light d. microwaves

11. The quantum mechanical model states the location with the highest probability of finding an electron is the _____.

12. What is a line spectrum and why is it called “the fingerprint for an element”?

13. When an electron jumps from the ground to the excited state, it has _____ energy.
14. A _____ is the fixed amount of energy that can be gained or lost by an atom as it moves from one energy level to another.
15. Explain how this orbital diagram violates Hund's Rule?



16. Explain how this orbital diagram violates the Aufbau Principle?

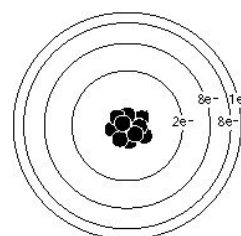


17. Explain how this orbital diagram violates the Pauli Exclusion Principle?

18. Write electron configurations and Bohr notations for...

- sodium –
- iodine –
- iron –

- 19.. What element is depicted in the Bohr model to the right?

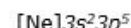
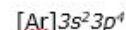
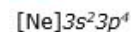
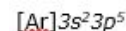


20. How many valence electrons does it have?

21. Which elements match the following configurations?

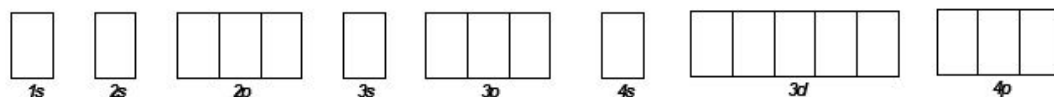
- $1s^2 2s^2 2p^6 3s^1$
- $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^2$
- $1s^2 2s^2 2p^6 3s^2 3p^2$
- $[\text{Kr}] 5s^2 4d^{10}$

22. Write the noble gas configurations for a. barium b. aluminum c. arsenic.



23. What is the correct noble-gas notation for the electron configuration of an atom of chlorine?

24. Fill in the orbital diagram for Ni.



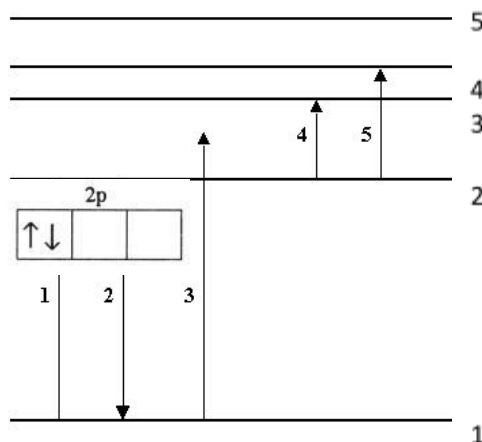
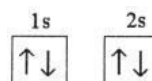
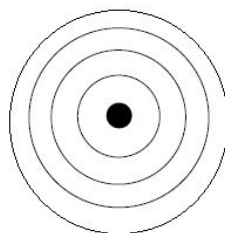
25. Which transition, as shown, is not possible?

26. Which transition(s) involve absorption of energy by the atom?

27. Which transition(s) involve emission of light energy by the atom?

28. Which transition(s) would involve the most energy?

29. Which transition would involve the least energy?



30. Draw the Bohr Model for Se.

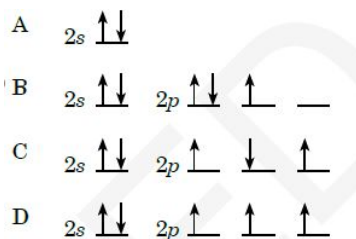
31. Why are emission spectrums discrete lines and not a continuous spectrum?

32. What is the atomic number of the element with the noble-gas notation $[\text{Kr}]5s^1$?

33. The electron configuration below represents a ground-state atom of which element? $1s^2 2s^2 2p^6 3s^2 3p^4$

34. The following electron configuration is for what element? $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5$

35. Which diagram shows the correct orbital notation for N?



36. Cations are _____ charged ions that _____ electrons and anions are _____ charged ions that _____ electrons.

37. The lowest energy state of an atom is its _____.

38. During a flame test, a lithium salt produces a characteristic fuchsia flame. This fuchsia color is produced when excited electrons _____.

$\lambda = c/v$ or $v = c/\lambda$ $c = 3.00 \times 10^8 \text{ m/s}$ $E = h\nu$ $h = 6.63 \times 10^{-34} \text{ Js}$ **Show all work including units.**

39. Calculate the wavelength of light with a frequency of $2.76 \times 10^{17} /s$.

40. Calculate the energy of light that has a wavelength of $4.7 \times 10^{-7} \text{ m}$.

Unit 5 Periodic Table

1. The _____ states that when elements are arranged according to atomic number, there is a repeating pattern in their physical and chemical properties.

2. Rows are called _____ and there are _____ of them.

3. Columns are called either _____ or _____ and there are _____ of them

4. Name the following groups of elements:

a. Group 1 –

b. Group 2–

c. Group 3 –

d. Group 4 -

e. Group 5 -

f. Group 6 -

g. Group 7 –

h. Group 8 –

i. elements on the staircase –

j. D-block elements (3-12)

5. A metal _____ electrons and becomes a _____ ion or _____.

6. Nonmetals normally _____ electrons and becomes a _____ ion or _____.

7. Define ionization energy and state its trend on the periodic table.

8. Define electronegativity and state its trend on the periodic table.

9. Define atomic radius and state its trend on the periodic table.

10. When K turns into K^{+1} , does it get larger or smaller? Why?

11. When O turns into O^{-2} , does it get larger or smaller? Why?

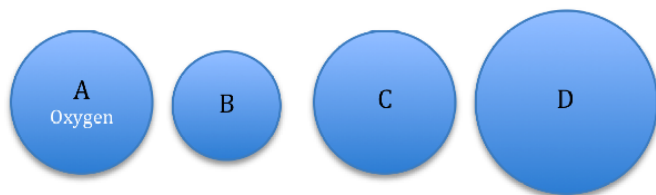
12. What is nuclear charge and how does it affect atomic radius and IE?
13. What are the reasons for the trends in atomic size, ionization energy, & electro negativity across the Periodic Table?
14. Given the following electron configuration: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^3$
 A. What element is it? _____
 B. What is the number of valence electrons? _____
15. What side of the periodic table are the metals? b. The nonmetals? c. Where are the metalloids?
16. Name 4 characteristics of both metals and nonmetals.
17. Identify each as a metal, nonmetal, or metalloid: K, Sb, Mo, I, Al
18. Which family is the most stable? Which family is the most reactive?
19. Complete the table below.
20. Which one has a higher electronegativity; C, N, or K? The lowest?
21. Which has a higher ionization energy; Na, K, Mg, or P? The lowest?
22. Which has a larger atomic radius; C, N, Mg, P, Na, or K? The smallest?
23. Why do elements in the same group have similar properties?
24. Why are noble gases unreactive? Why don't noble gases form ions?

25. What is the period and group of the element that has the electron configuration $[Ar] 4s^2 3d^{10} 4p^2$

Group	1	2	13	14	15	16	17	18
Number of Valence e-								
# e- lost or gained								
Charge of ion								

26. Write the electron configurations for a. Al^{+3} b. O^{-2} c. Ti^{+2}

27.



Given the representation of an oxygen atom, which circle might represent an atom of Neon?

28. From which atom in the picture above would it be easiest to remove an electron?

29. Which element has a larger electronegativity than Carbon? O B Be Li

30. Which Lewis electron-dot diagram represents a nitrogen atom in the ground state?



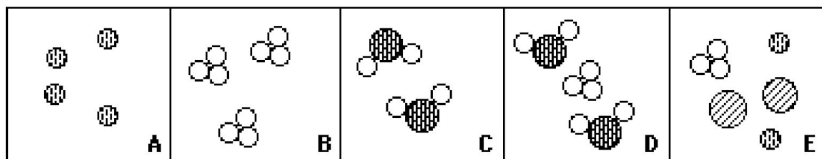
Which Lewis electron-dot diagram represents a fluoride ion?



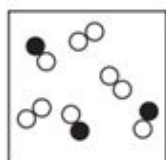
32. The element sulfur is classified as a _____ and it has _____ valence electrons.

Unit 6a Matter

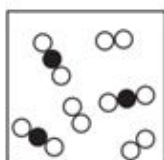
1. Use the picture to answer the questions below.



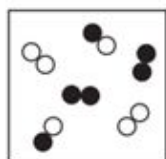
- What type of matter is represented in Figure A?
 - Does Figure B represent molecules of a compound or molecules of an element? Explain how you know.
 - Which diagrams show a mixture? _____
 - Which diagrams show only molecules of compounds? _____
 - Mixtures can be separated by _____ means and compounds can be separated by _____ means.
2. What is the difference in properties of elements in a mixture vs. a compound?
3. Name a homogeneous substance _____. Name a heterogeneous substance _____.
4. Which diagram represents a mixture of 3 substances? _____
5. Which diagram(s) represent sample of pure substances? _____



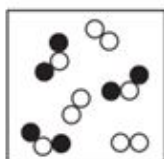
(1)



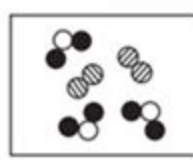
(3)



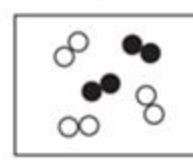
(2)



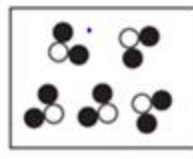
(4)



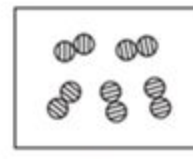
I



III



II



IV