Directions: Read all questions and instructions carefully. Check to make sure that this exams contains **21** pages. Please budget your time across the entire exam and attempt all questions.

Good Luck!

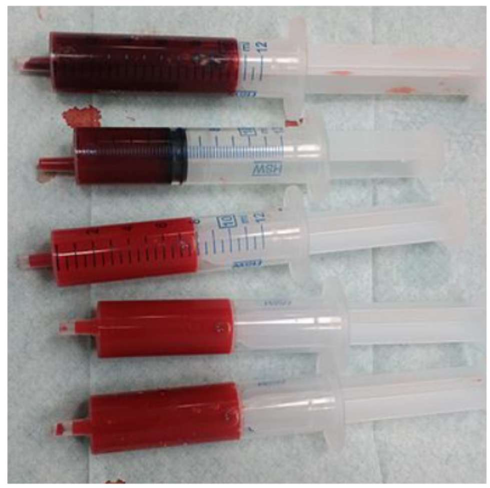
Exam Total	/100

1. (2 points) Do you understand SRJCs academic integrity policy and agree to follow all exam procedures during this exam? If you have any question about what is and is not allowed, you agree that you must email me during the exam time where I will gladly clarify.

(a) Yes
(b) No

(a) (2 points) YES! Please don't cheat!

2. (2 points) When blood is exposed to air (oxygenated in the lungs) the color of blood changes. At the top is venous blood (darker) and at the bottom is arterial (brighter) blood. Notice the subtle change in red blood cell's outfit!!!!

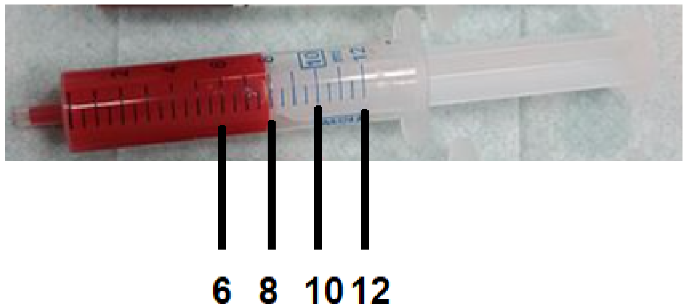


What type of change is this?

(a) Chemical Change
(b) Oil Change
(c) Operating System Change
(d) Physical Change
(e) Spare Change

(a) (2 points) The change in color of blood is a chemical change.

3. (2 points) Shown below is a syringe containing blood. Which of the following is considered a reasonable recording of the volume? The readings are in mL.

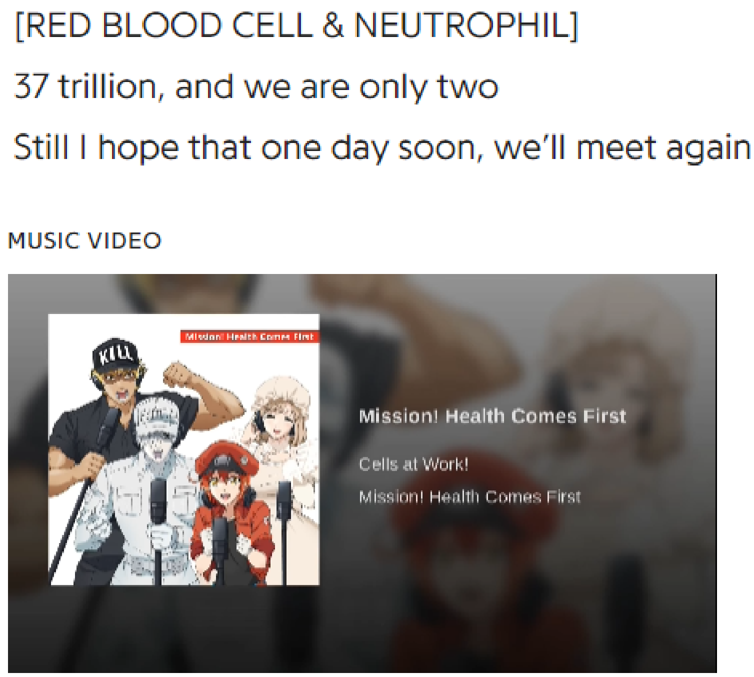


(a) 7.0 mL
(b) 7.51 mL
(c) 7.9 mL
(d) 8 mL
(e) 8.4 mL

(c) (2 points)
Each marking is an interval of 0.5 mL. We can see that the blood is in-between 7.5 mL and 8.0 mL. This eliminates (a) and (e). Perhaps the volume is indeed at 8.0 mL, but 8 mL is throwing out one level of added precision (intervals read to the hundredth) so this rules out (d). 7.51 mL would be very close to 7.5 mL and the volume is quite close to 8.0 mL so this throws out (b). However, we know the volume is in-between 7.5 mL and 8.0 mL so we can approximate it as in-between 7.9 mL.

You may be wondering why not 7.95 mL? This is because all the hash marks read to the nearest tenth place. By having a three hash marks in-between 6 and 8 mL, this means we have 6.5 mL, 7.0 mL, and 7.5 mL as these three has marks. Thus, the 6 mL and 8 mL must also be 6.0 mL and 8.0 mL. This is in contrast to most scientific glassware where the minor (not as long) hash marks read to one additional decimal place. Once realizing all has marks read to the hundredth place, we can see that we know the answer is not 7.5 mL and not 8.0 mL. Thus, the closest answer that reads to the tenth place is 7.9 mL. Note how 8.0 mL was not an option since this could also be a reasonable answer given that the volume mark is so close to the 8.0-mL hash mark.

4. (2 points) There are over 37 trillion (37,000,000,000,000) cells in the human body. Report this number in scientific notation.



(a) 37×10^{-12}
(b) 37×10^{-11}
(c) 37×10^{3}
(d) 37×10^{11}
(e) 37×10^{12}

(e) (2 points) 37 trillion = 37×10^{12}. We use +12 as the exponent since we need to still keep our number large.

5. (2 points) Most red blood cells have a diameter of $6-8\ \mu$m. What does μ mean mathematically.

(a) $\times 10^{-9}$
(b) $\times 10^{-6}$
(c) $\times 10^{-3}$
(d) $\times 10^{3}$
(e) $\times 10^{6}$

(b) (2 points) $\mu = \times 10^{-6}$

6. (2 points) How do you say μ?

(a) milli
(b) nano
(c) micro
(d) pico
(e) fempto

(c) (2 points) μ means "micro".

7. (2 points) A white blood cell is $12 - 17\ \mu$m in diameter. Report $12\ \mu$m in general (not scientific) notation.

(a) 0.00000012 m
(b) 0.0000012 m
(c) 0.000012 m
(d) 0.00012 m
(e) 0.0012 m

(c) (2 points)

$$12\ \mu\text{m} = 12 \times 10^{-6}\ \text{m}$$

$$12\ \mu\text{m} = 0.000012\ \text{m}$$

8. (2 points)
Esinophils are a type of white blood cells that are produced during an allergic response.

A typical concentration of esinophils is 300. esinophils per 1 μL of blood. How much blood (in μL) contains 2125 esinophils?

(a) 5.560 μL
(b) 6.042 μL
(c) 7.083 μL
(d) 7.765 μL
(e) 6.348×10^5 μL

(c) (2 points)

$$V = 2125 \text{ esinophils} \times \frac{1\mu\text{L blood}}{300 \text{ esinophils}}$$

$$V = 7.083\ \mu\text{L blood}$$

9. (2 points) A neutrophil (type of white blood) cell 13 μm in diameter. Report the neutrophil's diameter in mm.

(a) 0.0013 mm
(b) 0.00130 mm
(c) 0.0130 mm
(d) 0.013 mm
(e) 0.130 mm

(d) (2 points)
Since the reported diameter has two significant figures, the calculated diameter must have two significant figures as well.

$$d = 13 \times 10^{-6}\ \text{m} \times \frac{1000\ \text{mm}}{1\ \text{m}}$$

$$d = 13 \times 10^{-3}\ \text{mm}$$

$$d = 0.013\ \text{mm}$$

10. (2 points) A blood donor donates 2.00 pints of blood in one year. How much blood for the year was donated in mL? 1 pt = 16 fl. oz and 1 fl. oz = 29.57 mL.

(a) 872.0 mL
(b) 872 mL
(c) 946 mL
(d) 9.5×10^2 mL
(e) 1000. mL

(c) (2 points)

$$V = 2.00\ \text{pt} \times \frac{16\ \text{fl. oz}}{1\ \text{pt}} \times \frac{29.57\ \text{mL}}{1\ \text{fl. oz}}$$

$$V = 946\ \text{mL}$$

11. (2 points) It takes 0.15 hours to donate 0.125 gallons of blood. What is the blood donation rate in mL per second? 1 gallon = 3785 mL.

(a) $0.83\ \frac{\text{mL}}{\text{s}}$
(b) $0.88\ \frac{\text{mL}}{\text{s}}$
(c) $0.90\ \frac{\text{mL}}{\text{s}}$
(d) $0.92\ \frac{\text{mL}}{\text{s}}$
(e) $0.94\ \frac{\text{mL}}{\text{s}}$

(b) (2 points)

$$R = \frac{0.125\ \text{gal}}{0.15\ \text{hr}} \times \frac{3785\ \text{mL}}{1\ \text{gal}} \times \frac{1\ \text{hr}}{60\ \text{min}} \times \frac{1\ \text{min}}{60\ \text{s}}$$

$$V = 0.876\ \frac{\text{mL}}{\text{s}}$$

$$V = 0.88\ \frac{\text{mL}}{\text{s}}$$

12. (2 points) In the lab blood can be frozen. Under one set of conditions (Condition A) the blood was frozen down to $-78\ ^\circ\text{C}$. Under different conditions (Condition B), the blood was frozen down to 1 K. Which condition is at the lower temperature?

(a) Condition A
(b) Condition B

(b) (2 points) Condition B is the lower temperature since Condition B is just above absolute zero, which is the lowest temperature theoretically possible. We can also show this using math by converting the temperature of Condition A to Kelvin:

$$\text{K} =^\circ \text{C} + 273.15$$

$$\text{K} = -78 + 273.15$$

$$\text{K} = 195.15\ \text{K}$$

Following the sig fig rule for addition, we arrive at the following.

$$\text{K} = 195.15\ \text{K}$$

Since 1 K is greater than 195 K, Condition A is at the lower temperature.

13. (2 points) Red blood cells deliver O_2 throughout the body.

What element name corresponds to O?

(a) Iron
(b) Oganesson
(c) Osmium
(d) Oxygen
(e) Zinc

(d) (2 points) O is the symbol for oxygen.

14. (2 points) What type of element is O_2?

(a) Atomic
(b) Hard
(c) Molecular
(d) Soft
(e) Studious

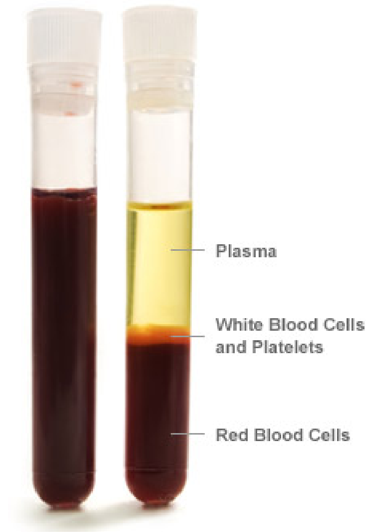
(c) (2 points) O_2 is a molecular element.

15. (2 points) Blood contains H_2O. What type of matter is water classified as?

(a) Compound
(b) Element
(c) Heterogeneous Mixture
(d) Healthy
(e) Mountain Spring

(a) (2 points) Water is a compound.

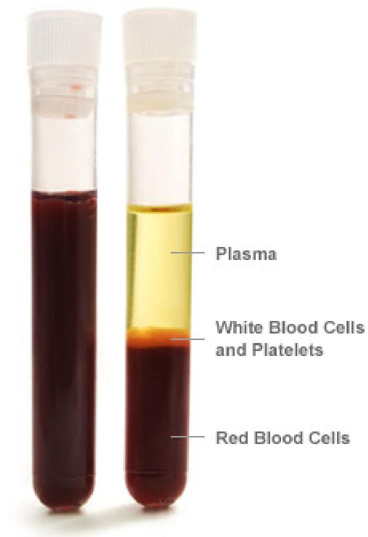
16. (2 points) Plasma is 92% water, 7% proteins, and 1% mineral salts, sugars, fats, hormones, and vitamins. What type of matter is plasma (see ***right*** test tube)?



(a) Compound
(b) Element
(c) Heterogeneous Mixture
(d) Homogeneous Mixture
(e) Pure Substance

(d) (2 points) Plasma contains multiple components so it is a mixture. The plasma looks like a single substance so it is a homogeneous mixture! The suspended blood cells in blood are not present in plasma.

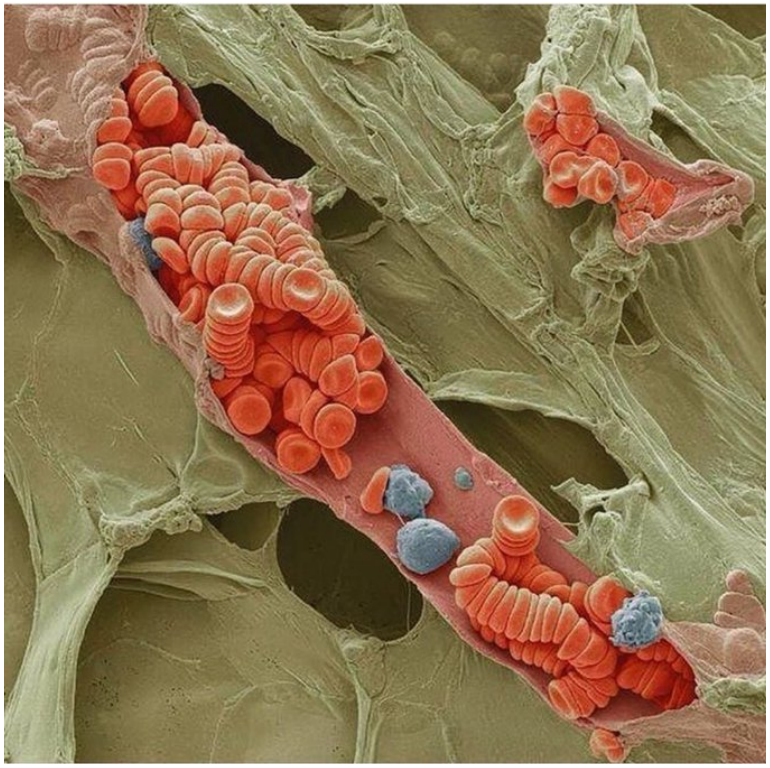
17. (2 points) Blood is a mixture of blood cells suspended in plasma. This suspension can be observed with a light microscope (see left test tube; you get this test tube after shaking the right test tube). What type of matter is blood (see ***left*** test tube)?



(a) Compound
(b) Element
(c) Hetereogeneous Mixture
(d) Homogeneous Mixture
(e) Pure Substance

(c) (2 points) Under observation with a light microscope, it can be seen that blood contains blood cells suspended in the plasma. Since the components can indeed be detected, blood is a heterogeneous mixture.

18. (8 points) Blood can also be visualized with an electron microscope: instead of using light, observation is achieved using electrons!! Shown below is a color-mapped scanning electron microscope (SEM) image of red and white blood cells in a blood vessel.



Fill in the blanks:

An electron has a charge of ***-2/-1/0/+1/+2***, a mass that is very ***small/large***, ***is/is not*** part of the nucleus, and is classified as a ***subatomic/macroatomic*** particle.

An electron has a charge of ***-1***, a mass that is very ***small***, ***is not*** part of the nucleus, and is classified as a ***subatomic*** particle.

19. (24 points) Testing a variety of elements present in red blood cells helps doctors identify numerous disorders either due to the element levels being too low or too high. For example, the typical level of zinc for an adult is $7.2 - 13.0\ \frac{\mu\text{g zinc}}{1\text{ g sample}}$. Listed below are some elements that can be tested.

(a) (6 points) Match each element symbol to its name.

Symbol	Name
Calcium	
Copper	
Iron	
Magnesium	
Phosphorous	
Potassium	

(b) (4 points)
Fill in the blanks:

Calcium is a ***metal/nonmetal***, copper is a ***metal/nonmetal***, iron is a ***metal/nonmetal***, and phosphorous is a ***metal/nonmental***.

(c) (2 point)
Fill in the blanks:

Magnesium ***gains/loses*** electrons in reactions and potassium is a ***conductor/insulator***.

(d) (2 points)
Fill in the blanks:

Calcium has ***1/2/3/4/5/6/7/8*** valence electron(s) and potassium has ***1/2/3/4/5/6/7/8*** valence electron(s).

(e) (4 points)
Rank calcium, magnesium, potassium, and phosphorous in order of increasing atomic radius. Note, 1 gets assigned to the atom with the smallest radius and 4 gets assigned to the atom with the largest radius.

Symbol	Rank
Calcium	
Magnesium	
Phosphorous	
Potassium	

(f) (2 points) An unknown element has a very low concentration in the blood. It has a mass number of 11 and 6 neutrons. What is the element's name?

(a) Beryllium
(b) Boron
(c) Carbon
(d) Nitrogen
(e) Oxygen

(g) (2 points) An atom has a mass number of 10 and 5 neutrons. It shares the same number of protons as the element in **(e)**. What is the relationship between the atom in **(e)** and the atom in this question?

(a) Different elements
(b) Ions of the same element
(c) Isotopes of the same element

(h) (2 points) Shown below is the symbol for an element found in the blood. How many neutrons does this element have?

$$^{55}_{25}\text{Mn}$$

(a) 15
(b) 20
(c) 25
(d) 30
(e) 55

(a) (6 points)

Symbol	Name
Calcium	Ca
Copper	Cu
Iron	Fe
Magnesium	Mg
Phosphorous	P
Potassium	K

(b) (4 points)

Calcium is a ***metal***, copper is a ***metal***, iron is a ***metal***, and phosphorous is a ***nonmental***.

(c) (2 points)

Magnesium ***loses*** electron in reactions and potassium is a ***conductor***.

(d) (2 points)

Calcium has ***2*** valence electron(s) and potassium has ***1*** valence electron(s).

(e) (4 points)

Symbol	Atomic Radius (pm)	Rank
Calcium	197	3
Magnesium	160	2
Phosphorous	115	1
Potassium	227	4

(f) (2 points) (b)

$$A = p + n$$

$$p = A - n$$

$$p = 11 - 6$$

$$p = 5$$

Boron has an atomic number of 5 so the element is boron.
(g) (2 points) (c)
When two atoms share the same number of protons, but have a different number of neutrons the relationship between the two is that the two atoms are isotopes of each other.

(h) (2 points) (d)

$$^{55}_{25}\text{Mn}$$

It is important to recall the following:

$$^{A}_{Z}\text{Mn}$$

Z is the atomic number, which tells us the number of protons.

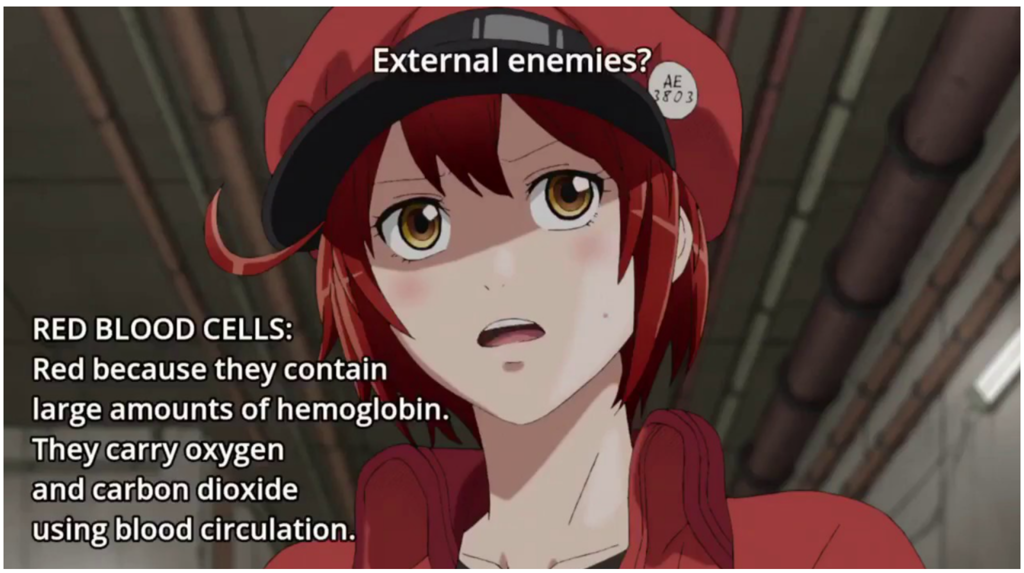
$$A = p + n$$

$$n = A - p$$

$$n = 55 - 25$$

$$n = 30$$

20. (2 points) Hemoglobin is an iron-containing metalloprotein present in red blood cells. Hemoglobin is responsible for oxygen transport. Iron exists in the blood with 26 protons and 24 electrons.



What is the correct way to represent iron in its ion form?

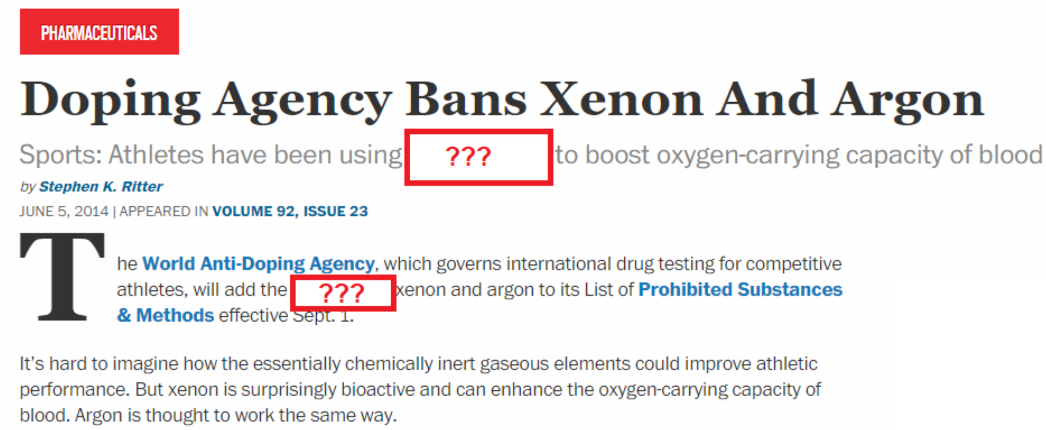
(a) Fe^{2-}
(b) Fe^{-}
(c) Fe
(d) Fe^{+}
(e) Fe^{2+}

(e) (2 points)
Since iron cation has 26 protons and 24 electrons, this means the iron cation has two extra positive charges since $26 - 24 = 2$.

21. (3 points) Now that we know iron a key component of hemoglobin and that hemoglobin is responsible for oxygen transport throughout the body. Explain what kind of signs may present themselves for a patient with iron deficiency (anemia) and ***why***. Explain your answer in no more than two sentences. Listing the symptoms will not receive full credit, as these symptoms must be linked to the chemical species discussed.

(3 points)
Without O_2, the body lacks an essential molecule for bodily reactions. As a result, body activity will slow down (tiredness) and the individual will experience shortness of breath since O_2 is not being delivered as efficiently.

22. (2 points) Shown below is the beginning of a chemistry article describing the classification of xenon and argon as performance-enhancing drugs since they increase the blood's capacity to carry oxygen.


PHARMACEUTICALS

Doping Agency Bans Xenon And Argon

Sports: Athletes have been using ??? to boost oxygen-carrying capacity of blood

by Stephen K. Ritter

JUNE 5, 2014 | APPEARED IN VOLUME 92, ISSUE 23

The World Anti-Doping Agency, which governs international drug testing for competitive athletes, will add the ??? xenon and argon to its List of Prohibited Substances & Methods effective Sept. 1.

It's hard to imagine how the essentially chemically inert gaseous elements could improve athletic performance. But xenon is surprisingly bioactive and can enhance the oxygen-carrying capacity of blood. Argon is thought to work the same way.

What word(s) is/are removed? Note, the word(s) removed are identical for each of the two boxes.

(a) Halogens
(b) Metals
(c) Noble Gases
(d) Nonmetals
(e) Semiconductors

(c) (2 points)
Xenon and argon are both noble gases.

23. (4 points) CN^- and SO_4^- are present in the bloodstream.
(a) (2 points) What is the name for CN^-?

(a) Carbonitride
(b) Cyanide
(c) Cyano
(d) Nitrile
(e) Nitrite

(b) (2 points) What is the name for SO_4^{2-}?

(a) Oxysulfate
(b) Oxysulfite
(c) Sulfate
(d) Sulfite
(e) Sulfito

(a) (2 points) (b) CN^- is cyanide.
(b) (2 points) (c) SO_4^{2-} is sulfate.

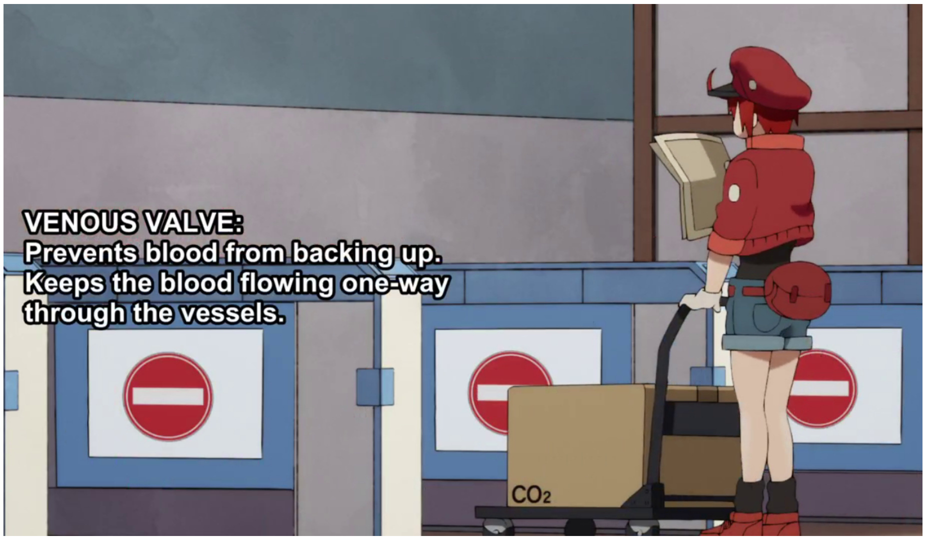
24. (2 points) NaF is added to drinking water to prevent the formation of cavities where F^- ions distribute in the plasma and blood cells.
Fill in the blanks:

F^- is a ***cation/anion*** and NaF is called ***sodium fluorine/monosodium monofluorine/sodium monofluoride/monosodium fluoride/sodium fluoride***.

(2 points)

F^- is an ***anion*** and NaF is called ***sodium fluoride***.

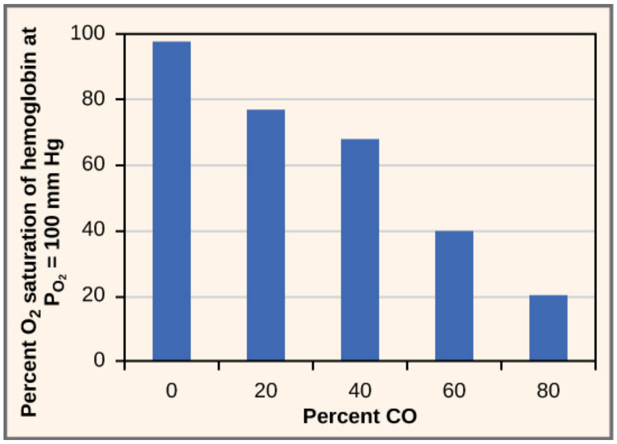
25. (18 points) The following seven questions deal with gas transport in the blood.
After delivering O_2, red blood cells "pick up" CO_2 and deliver this "package" to the lungs for exhalation.



(a) (2 points) Using the system discussed in class, what is the name for CO_2?

(a) Monocarbon dioxide
(b) Monocarbon oxide
(c) Carbon dioxide
(d) Carbon oxide
(e) Carbonic acid

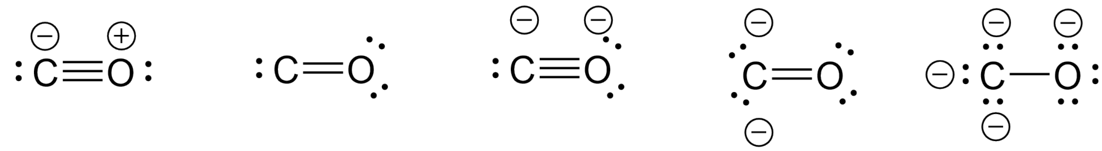
(b) (2 points)
Just as hemoglobin associates with O_2, hemoglobin can bind to CO_2; additionally, this binding is reversible. Furthermore, when CO is present, CO competes with O_2 for binding to hemoglobin. Since CO has a greater affinity for hemoglobin and its binding is ***not*** reversible, CO prevents O_2 from binding to hemoglobin. This effect is shown graphically below where the *y*-axis shows the amount of O_2 in the bloodstream.



Explain how the histogram below shows the effect of CO on the blood levels of O_2.
(c) (2 points) Using the system discussed in class, what is the name for CO?

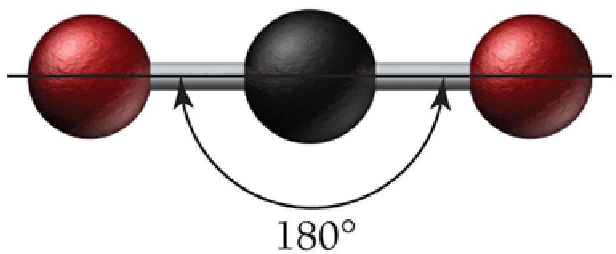
(a) Monocarbon monoxide
(b) Monocarbon oxide
(c) Carbon monoxide
(d) Carbon oxide
(e) Carboxide

(d) (2 points) Which of the following is the best Lewis structure for CO?



A B C D E

(e) (2 points) Explain your answer for **(d)**.
(f) (4 points) Shown below is a 3-D model of CO_2.



Fill in the blanks:

The C – O ***covalent/ionic*** bond has electron density more concentrated near the ***carbon/oxygen*** atom.

(g) (4 points) Is CO_2polar or nonpolar? Use the terms ***bond dipole*** and ***dipole moment*** in your answer. Refer to the linear, molecular geometry shown in **(f)**.

(a) (2 points) (c) CO_2 is carbon dioxide.
(b) (2 points) As the percent CO increases the saturation of O_2 decreases.
(c) (2 points) (c) CO is carbon monoxide.
(d) and (e) (4 points) Structure A is the best Lewis structure since it is the only Lewis structure where both carbon and oxygen have full octets and use the available 10 valence electrons (6 from oxygen and 4 from carbon). Although Structures D and E have full octets on each atom they use too many electrons. Structure D has 12 electrons and Structure E has 14 electrons.
(f) (4 points)

The C – O ***covalent*** bond has electron density more concentrated near the ***oxygen*** atom.

(g) (4 points) Carbon dioxide is nonpolar since the bond dipoles cancel out.

26. (2 points)
Assume a human has a blood cell count of 5.00×10^6 red blood cells per 1 microliter of blood. What volume of blood (in femptoliters) contains one red blood cell? Note 1 fL $= 1 \times 10^{-15}$ L.

(a) 0.0200 fL
(b) 0.200 fL
(c) 2.00 fL
(d) 20.0 fL
(e) 200. fL

Volume (in femptoliters):

$$V = 1 \text{ red blood cell} \times \frac{1\times10^{-6}\text{ L blood}}{5\times10^{6}\text{ red blood cells}}$$

$$V = 2 \times 10^{-13}\text{ L blood} \times \frac{1\text{ fL}}{1\times10^{-15}\text{ L}}$$

$$V = 200\text{ fL}$$

Volume (in cubic micrometers):

$$V = 200 \times 10^{-15}\text{ L} \times \frac{1000\text{ mL}}{1\text{ L}} \times \frac{1\text{ cm}^3}{1\text{ mL}} \times \frac{1^3\text{ m}^3}{100^3\text{ cm}^3} \times \frac{1^3\ \mu\text{m}^3}{\left(1\times10^{-6}\right)^3\text{ m}^3} = 200\ \mu\text{m}^3$$

$$V = 200\ \mu\text{m}^3$$