

Life Science Questions

Life Science Questions

1. How do scientists 'know' and mediate uncertainty about what they know?
→ Scientists recognize uncertainty through:
 - **Measurement limits:** Instruments have margins of error (e.g., ± 0.01 mL in a pipette, or $\pm 0.2^\circ\text{C}$ in a thermometer).
 - **Biological variation:** No two organisms are identical; variation adds noise to data.
 - **Sampling error:** A sample of 50 tardigrades might not perfectly represent all tardigrades.
 - **Model assumptions:** Every model or hypothesis simplifies reality — and those simplifications introduce uncertainty.

Mediate uncertainty by:

- **Replication and Sample Size**
 - **Statistical Analysis**
2. **Peer Review and Reproducibility**
 3. **Error Bars and Confidence Intervals**
 4. **Open Discussion of Limitations**
5. Contrast observations with categorizations.
→ **Observations:**

Observations are **direct pieces of information** collected using the senses or instruments. They form the raw data that scientists record before drawing conclusions.

Example:

A biologist notes that a tardigrade contracts its body when exposed to a certain concentration of ethanol.

→ Observations are what you see, hear, or measure — facts that describe what is happening without interpretation.

Categorizations:

Categorizations involve **organizing observations into groups** or classes based on **shared traits or patterns**. This step introduces interpretation and helps scientists make sense of large or complex sets of observations.

Example:

After observing different tardigrades' reactions, a researcher categorizes them into "highly tolerant," "moderately tolerant," and "sensitive" groups.

→ Categorizations are how you organize or label observed data so that you can compare, analyze, and build theories.

6. Explain why hierarchical arrangements of organisation, for biological systems, are erroneous. Can you identify some benefits?

Hierarchical arrangements of organization are inherently based on some dimension that is used to organize things, when all biological systems inherently have many dimensions. Any hierarchical organizational system in biology must overlook several aspects of the things it is organizing, and is therefore erroneous. They also often make decisions based on fuzzy or unclear information, where multiple classifications could be concluded.

Some benefits of hierarchical organizational structures are that they make things much easier to understand, they keep things organized and it creates a clear way for scientists to discuss things. For example, when discussing cell types, we would think of first the organism it belongs to, and then the organ system, then the cell type. This makes it easy to list all the immune cells, or all the cells in the digestive system, which can enable discussions of how that system evolved, especially compared to other organisms.

The downfall of this model, is where certain cell types may belong to different systems, but may express similar genes, and function in a similar way. You can define cells based on the genes they express, but then it makes it very difficult to talk about any one particular system. This issue goes for every way you could think to organize a system hierarchically.

7. Can you define Paratry with examples?
8. Why is artificial selection natural selection? Why might we consider it different?

Consider co-evolution between species as well

9. Why is gene flow considered random with respect to fitness and therefore unable to drive adaptive evolution?
10. Why is studying biological systems from multiple perspectives more appropriate? Is this realistic?
11. What are other tools used to categorise and identify living things? Q before was about dichotomous keys
12. Compare bacteria with viruses. Substantiate whether members of these categories are alive

- 1) has DNA (or RNA), 2) can reproduce using their own machinery, 3) can evolve
 - Bacteria are unicellular organisms that meet the three requirements
 - Viruses need a host to reproduce and are therefore not alive
13. What is a dichotomous key? How are they useful? How are they biased?
- a. Other tools: Cladograms, phylogenetic trees, only phylogenetic trees take into account time. Cladograms r just characterising based off of shared characteristics (assume evolutionary relationship – homologous characteristics)
14. Describe why the study of evolution is an integrated science. Provide an example to substantiate your reasoning.
15. Distinguish meanings of evolution as a fact and evolution as a theory?
- a. Mechanism is the theory (natural selection/descent with modification)
 - i. Fossils, Homologous Characters, Vestigial Characters → all proof for theory as a fact
16. What are the components of a scientific study, are they the things included in a journal or something else?
- a. (its in the textbook)
17. How is diversity linked to biological organisations or complexity of life

** Sample Qs in sub-tab

LS Sample Qs

Question 1:

1. What is Life?

- a. How do scientists 'know' and mediate uncertainty about what they know?
- b. Contrast observations with categorizations.
- c. What are the principal determinants if something is alive?
- d. Compare bacteria with viruses. Substantiate whether members of these categories are alive.
- e. What are the main (taxonomic) categories for living organisms? How are organisms placed into these categories?
- f. What is bias? How has human bias been exhibited in the categorization of living things?
- g. What is a dichotomous key? How are they useful? How are they biased?

****Wants clarification on highlighted questions!**

Sign-up:

- Farah
- Farah
- Kaiya
- Kaiya
- Farah

→ Domain, Kingdom, Phylum, Class, Order, Family, Genus, Species (Dear King Phillip
Came Over For Good Soup)

→ placed in these categories through:

Morphological Characteristics

Genetic (Molecular) Evidence

Embryological Development

Biochemical and Physiological Traits

Evolutionary Relationships (Phylogenetics)

- Farah
- Farah

Question 2:

3. What is Biodiversity?

- a. What is diversity? How is diversity measured?
- b. What is the difference between alpha, beta, and gamma diversity?
- c. Differentiate species richness versus species evenness?
- d. What is a bioindicator species? What characteristics would identify a good bioindicator species?
- e. How is diversity linked to biological organisation or the complexity of life?

Sign-up:

- a) Kaiya
- b) Kaiya
- c) Kaiya

- Diversity is the measurement of the complexity of nature; however, it is more of a tool/concept
- Alpha diversity: local; within an abstract community or a specific site
- Beta diversity: differential; between sampling units/communities
- Gamma diversity: regional; diversity over a wide range of communities/habitats
- Richness: number of species (a high richness of a species means there are a lot of that species)
- Evenness: relative number of species; proportional diversity (a high evenness means species are all relatively equally distributed)

- d) Griffin
- e) Griffin

Question 3:

- Is adaptive radiation a mechanism for speciation?
- Is speciation considered a type of evolution?
 - o This is one of Chad's learning specs: "Identify 2 mechanisms for speciation and explain their links to evolution?"
- What does it mean some traits are non-adaptive – so does natural selection always lead to adaptive evolution
- How are the labs testable? What kinds of things should we know from them?

(could u also do "are all adaptations positive?")

Sign up:

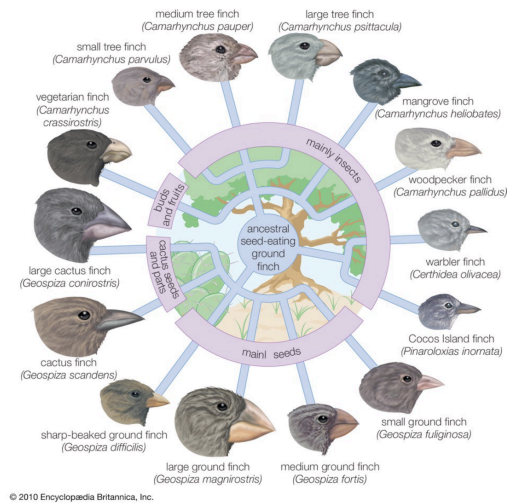
- a) Thomas

- b) Thomas
- c) Thomas
- d) Thomas

Q3 Answers:

1. Yes, divergent selection can lead to speciation through adaptive radiation. Adaptive radiation occurs when a single ancestral species diversifies into multiple new species, each new species is adapted to exploit different ecological niches.

Galapagos finches



2. Four mechanisms that can lead to evolution (evolution = changes in gene frequency over time):
 - Natural selection
 - Genetic drift
 - Gene flow
 - Mutations

Speciation has three main mechanisms (speciation = when gene flow between populations is decreased)

- Allopatry (geographic barrier)
- Parapatry (adjacent populations fill different ecological niches)
- Sympatry (same environment but reproductively isolated)

From these definitions, speciation (a decrease in gene flow between populations) occurs when evolution (changes in gene frequency) leads to

populations becoming genetically distinct enough from one another to the point they can no longer interbreed with each other.

3. Non-adaptive traits do not increase an organism's ability to survive / reproduce (can be neutral or negative).

Natural selection tends to lead to adaptive traits, but since most organisms are highly complex, traits that are beneficial in some ways can be detrimental in other ways.

- E.g. Sickle cell disease and malaria: Having one sickle cell allele and one non-sickle cell allele makes individuals more resistant to malaria, but having two sickle cell alleles causing sickle cell disease.

4. Ask Chad about labs, you should probably understand concepts that are central to the labs.

(I believe Chad did say it was testable material)
he did!

Yeah he said like make sure you know how micropipettes work and things like that

Physics Questions

Physics Questions

1. An average adult Tyrannosaurus rex had a mass of 10,000 kg and was 12 m tall. An average adult velociraptor had a mass of 15 kg. If we assume velociraptors and Tyrannosaurus rex's are isometric (same shape), and equal density, how many times more heat does an Tyrannosaurus rex lose compared to a velociraptor?

- A. 8.73
- B. 76.3
- C. 96.3
- D. 152
- E. 193

Molly

Q20. Physics Girl is running a marathon (42.2 km) that consists of two equal laps around a lake. She runs her first lap at 3.0 m/s, but knows she needs to speed up to try to win. She does a quick calculation in her head to determine that in order to win the marathon, she needs an average speed of 6.0 m/s over the whole two-lap race. How fast must she run her second lap to achieve this average speed?

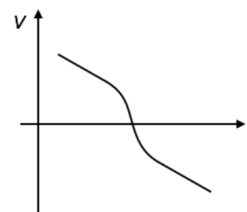
- A. 6.0 m/s
- B. 7.5 m/s
- C. 9.0 m/s
- D. More information is needed to calculate the answer.
- E. It is impossible for her to achieve this average speed.

Q20. Pam and Jim are standing on a bridge 50.0 m above a river. Pam throws a rock straight down with a speed of 20.0 m/s. Jim, at exactly the same instant of time, throws a rock straight up with a speed of 20.0 m/s. How much time elapses between the first splash and the second splash? (ignore air resistance)

- A. 8.08 s
- B. 7.08 s
- C. 6.08 s
- D. 5.08 s
- E. 4.08 s

Q12. The velocity versus time graph for a ball in motion is shown. Which of the scenarios below best describes the motion of the ball as shown by the graph? Assume that the positive direction is upward.

- A. The ball is rising, hits the ceiling, and falls down.
- B. The ball is rising, is caught, and is thrown up with greater speed.
- C. The ball is rising, reaches its maximum height, and then falls back down.
- D. The ball is falling, hits the floor, and bounces up.
- E. The ball is falling, is caught, and is thrown down with a greater speed.



P Sample Qs

Question 1:

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- A. 8.73
- B. 76.3
- C. 96.3
- D. 152
- E. 193

Question 2:

The speed of a bullet as it travels down the barrel of a rifle toward the opening is given by the following equation:

$$v = (-5.00 \times 10^7)t^2 + (3.00 \times 10^5)t$$

where v is in metres per second and t is in seconds. The acceleration of the bullet just as it leaves the barrel is zero. Determine the time interval over which the bullet is accelerated.

- A. 3.00 ms
- B. 4.69 ms
- C. 6.09 ms
- D. 7.52 ms
- E. 9.12 ms

Adam^^

Question 2:

The speed of a bullet as it travels down the barrel of a rifle toward the opening is given by the following equation:

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where v is in metres per second and t is in seconds. The acceleration of the bullet just as it leaves the barrel is zero. Determine the time interval over which the bullet is accelerated.

Handwritten solution:

$$v = x'$$

Power rule

$$v' = \frac{d}{dt} [(-5.00 \times 10^7)t^2 + (3.00 \times 10^5)t]$$
$$= 2 \cdot (-5.00 \times 10^7)t + 3.00 \times 10^5$$
$$a = -10.00 \times 10^7 t + 3.00 \times 10^5$$
$$0 = -10 \times 10^7 t + 3.00 \times 10^5$$
$$\frac{-3 \times 10^5}{-10 \times 10^7} = \frac{-10 \times 10^7 t}{-10 \times 10^7}$$
$$3 \times 10^{-3} = t$$
$$3 \text{ ms}$$

- A. 3.00 ms
- B. 4.69 ms
- C. 6.09 ms
- D. 7.52 ms

Question 3:

17. A catapult launches a test rocket vertical upward from a well, giving the rocket an initial speed of 80.0 m/s at ground level. The engines then fire, and the rocket accelerates upward at 4.00 m/s^2 until it reaches an altitude of 1 km. At that point, its engines fail and rocket goes into free fall. For what time interval is the rocket in motion above the ground?

Total time = 41.1 s

Can we assume that the time for part 2: where the catapult goes from v_2 (the point where its engines stop) to the peak ($v_3 = 0$) is the same as part 3: where the catapult goes from the peak to the same distance (1km above ground)



Shaiya tests her new sports car by racing with Chad. Both start from rest, but Shaiya leaves the starting line 1.00 s after Chad does. Chad moves with a constant acceleration of 3.50 m/s^2 , while Shaiya maintains an acceleration of 4.90 m/s^2 . Find the time at which Shaiya overtakes Chad.

- A. 1.09 s
- B. 2.18 s
- C. 4.37 s
- D. 5.46 s**
- E. 6.49 s

Michal^^

Question 4:

Alec

Question 5:

18. Consider the following calculation. The numbers in brackets are in scientific notation.

$$\frac{(1.400 \times 10^2) + 369.2}{43172 - (4.613 \times 10^4)}$$

What is the solution? Pay attention to the significant figures; your answer must be to the correct number of significant figures.

Specifically I'm a bit confused with the denominator

^^Michael

Question 6:

81. **III** A skateboarder starts up a 1.0-m-high, 30° ramp at a speed of 7.0 m/s. The skateboard wheels roll without friction. At the top she leaves the ramp and sails through the air. How far from the end of the ramp does the skateboarder touch down?

Answer: 7.04 m

For this question, I know that the acceleration on the ramp is not equal to just gravity. It doesn't seem to work, though, when I split into components.

Solution Below (The answer is also not 7.04m according to the answer key on the textbook this

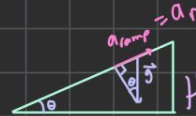
problem was from) **81. 3.8 m**
—

Physics PMV:

A skateboarder starts up a 1m high, 30° ramp at a speed of 7 m/s . The skateboard wheels roll with no friction. How far does she fly out.



$$v_i = 7 \frac{\text{m}}{\text{s}}$$



① Find the rate that the skateboarder slows down while going up the ramp

$$L = \frac{1\text{m}}{\sin 30^\circ} = 2\text{m}$$

$$a_r = -a_g \sin \theta = -4.905 \frac{\text{m}}{\text{s}^2}$$

$$\begin{aligned} V_L^2 &= v_i^2 + 2a\Delta x \\ V_L &= \sqrt{v_i^2 + 2a\Delta x} \\ &= \sqrt{v_i^2 + 2a_r L} \\ &= 5.42 \frac{\text{m}}{\text{s}} \end{aligned} \quad \left. \vphantom{\begin{aligned} V_L^2 &= v_i^2 + 2a\Delta x \\ V_L &= \sqrt{v_i^2 + 2a\Delta x} \\ &= \sqrt{v_i^2 + 2a_r L} \\ &= 5.42 \frac{\text{m}}{\text{s}} \end{aligned}} \right\} \text{launch velocity}$$

② Find Launch Velocity & break into components

$$V_{L,y} = V_L \sin \theta = 2.71 \frac{\text{m}}{\text{s}}$$

$$V_{L,x} = V_L \cos \theta = 4.6939 \frac{\text{m}}{\text{s}}$$

time of flight:

Skateboarder flies a bit after leaving ramp.

$$\Delta y = v_i t + \frac{1}{2} a t^2$$

$$0 = 1 + 2.71 - 4.905 t^2$$

$$t = 0.8055, -0.285 \rightarrow \text{reject}$$

} Find time of flight

$$\Delta x = v_{L,x} t + \frac{1}{2} a t^2$$

$$= 4.69 \cdot 0.8055$$

$$= 3.77\text{m}$$

$$= 3.8\text{m} \checkmark$$

$\uparrow$
Answer

} Finding Δx from ramp

Earth Science Questions

Earth Science Questions

Type your question here!

1. Do we need to know the specific numerical value for the density, volume and diameter of the inner rocky planets such as mercury and venus?
2. How do we get info on planetary age and composition? Is it only from meteorites and carbon dating?
3. How do you date geological materials and events? Is it through isotopic dating, if so can you explain further what that entails?
4. What is paleomagnetism and how has it been used to validate the theory of plate tectonics?
5. What is our current understanding of plate tectonics and on what scientific evidence is this based?
6. Why are zircons commonly used in geochronology
7. How can we tell if we are at risk of earthquakes in eastern North America?
8. Which areas of Canada are at risk from earthquakes?
9. What do we know about earthquakes in the Caribbean and the Global South?
10. What processes operate at plate boundaries?
11. Why do we need to know the plate tectonic history of North America?
12. Why do we need to know the plate tectonic history of South America and other parts of the Global South?
13. What assumptions are made in radiometric dating of rocks?
14. Can we predict earthquakes?
15. What are the best isotopes to use for dating geologic events?
16. Do we need to do calculations associated with half-life, or just generally know the idea?
17. What diagrams would you suggest to review? And what is the exam like format?
18. Would we have to do any math or equations like for dating?
19. Why is the Earth's surface constantly changing?
20. What is LITHOPROBE?

21. What is our current understanding of plate tectonics and on what scientific evidence is this Based?
22. Do the definitions have to be stated word for word or is hitting the key points okay?
23. Do we have "word banks" for fill-in-the-blanks?
24. Can you explain the differences between the seismic waves, body waves, s and p waves, love and Rayleigh
25. Can you explain what the "pole reversal" means? Why exactly does it occur?
26. How important is knowing the seismogram?

ES Sample Qs

None lol

Math Questions

Math Questions

1. Type your question here!

M Sample Qs



38. Use the Squeeze Theorem to show that

$$\lim_{x \rightarrow 0} \sqrt{x^3 + x^2} \sin \frac{\pi}{x} = 0$$

Illustrate by graphing the functions f , g , and h (in the notation of the Squeeze Theorem) on the same screen.

Alec

25–28 Prove the statement using the precise definition of a limit.

$$\mathbf{25.} \lim_{x \rightarrow 2} (14 - 5x) = 4$$

$$\mathbf{26.} \lim_{x \rightarrow 0} \sqrt[3]{x} = 0$$

$$\mathbf{27.} \lim_{x \rightarrow 2} (x^2 - 3x) = -2$$

$$\mathbf{28.} \lim_{x \rightarrow 4^+} \frac{2}{\sqrt{x} - 4} = \infty$$

(If anyone is comfortable with this one) Farah

Chemistry Questions

Chemistry Questions

1. Bromine has two stable isotopes with natural abundances of 50.69% (^{79}Br) and 49.31% (^{81}Br). How many atoms of ^{79}Br are there in a 3.45 g sample of BrF_3 ?

→ Myan

$$1. \text{}^{79}\text{Br} = 50.69\%$$

$$\text{}^{81}\text{Br} = 49.31\%$$

$$m(\text{BrF}_3) = 3.45 \text{ g}$$

$$M_m(\text{BrF}_3) = 3(18.998) + 79.904$$

$$= 136.898 \text{ g/mol}$$

$$n(\text{BrF}_3) = \frac{3.45 \text{ g}}{136.898 \frac{\text{g}}{\text{mol}}} = 0.0252 \text{ mol}$$

$$n(^{79}\text{Br}) = 0.0252 \text{ mol} \cdot 0.5069 = 0.01277 \text{ mol}$$

$$n(^{81}\text{Br}) = 0.0252 \text{ mol} \cdot 0.4931 = 0.01243 \text{ mol}$$

$$N = n \times N_A$$

$$N(^{79}\text{Br}) = 0.01277 \text{ mol} \times 6.022 \times 10^{23} \frac{1}{\text{mol}} = 7.69 \times 10^{21} \text{ atoms}$$

$$N(^{81}\text{Br}) = 0.01243 \text{ mol} \times 6.022 \times 10^{23} \frac{1}{\text{mol}} = 7.48 \times 10^{21} \text{ atoms}$$

2. Consider the charge minimized Lewis structure for the iodate ion (IO_3^-). What is the average I-O bond order, number of resonance structures for the ion, and number of lone pairs of electrons on iodine? Can you work it out please?

→ Amelie

3. I found this in an old midterm, is this content we could be tested on:

When equal volumes of the following pairs of solutions are mixed, which produces the strongest electrolyte solution?

A) $\text{Mg}(\text{NO}_3)_2$ (1 M) + AgClO_4 (2 M)

B) $\text{Ba}(\text{OH})_2$ (2 M) + MgSO_4 (2 M)

C) NaBr (1 M) + NH₄NO₃ (1 M)

D) HBr (3 M) + KOH (3 M)

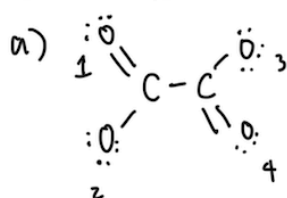
→ Amelie

4. What will be considered the topics for the "longer" questions on the exam?

→ I think your first midterm is only multiple choice (Myan)

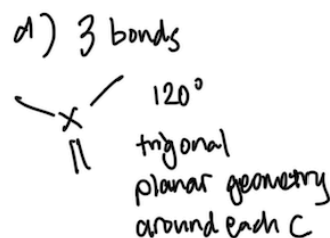
5. Oxalic acid, (COOH)₂, has two ionizable hydrogens and contains a carbon-carbon single bond. When one mole of oxalic acid reacts with one mole of calcium hydroxide, Ca(OH)₂, the salt CaC₂O₄ is formed. a) Draw adequate Lewis structures to represent the bonding in the oxalate ion, C₂O₄²⁻ b) What is the average carbon-oxygen bond order in oxalate ion? c) What is the average formal charge on each oxygen atom in oxalate ion? d) Give the shape around each C atom in the oxalate ion.

5. (COOH)₂ oxalate ion C₂O₄²⁻



Total e⁻

$$\begin{aligned} \text{C: } 4e^- \times 2 &= 8e^- \\ \text{O: } 6e^- \times 4 &= 24e^- \\ &+ 2e^- \\ \hline &34e^- \end{aligned}$$



b) avg bond order = $\frac{\sum \text{b.o.}}{\# \text{ bonds}}$

4 C-O bonds

$$= \frac{2+1+2+1}{4} = \frac{6}{4} = 1.5$$

c) avg formal charge - valence e⁻ - #bonds - lone pairs e⁻

$$\text{O}_1: 6 - 2 - 4 = 0$$

$$\text{O}_2: 6 - 6 - 1 = -1$$

$$\text{O}_3 = \text{O}_2; \text{O}_4 = \text{O}_2$$

$$= \frac{-1 + 0 + 0 + (-1)}{4} = -0.5$$

Total

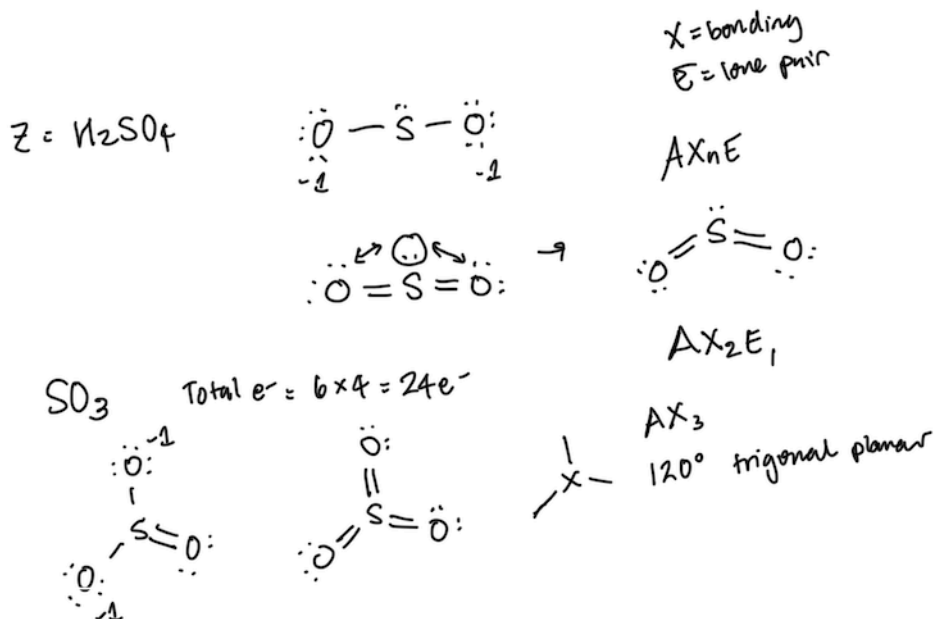
6. A gaseous molecule "X" is made by burning sulfur in air. "X" is converted to "Y" by reaction with oxygen in the presence of a

catalyst. "Y" reacts vigorously with water to produce "Z" which turns litmus red.

- Identify "X", "Y", and "Z"
- Write a balanced equation for each reaction
- Draw Lewis diagrams of the molecules "X" and "Y"

Determine their AX_nE_m VSEPR classes and name the molecular shapes. Indicate the bond angles, and if they are ideal or less than ideal. Are the "X" and "Y" molecules polar or non-polar? d) When 1 mole of "Z" is titrated with 2 moles of NaOH, a soluble salt "W" forms. Write an appropriate Lewis electron dot structure for the anion of this salt.

Myan



7. Describe the VSEPR shape of OCS. Draw a diagram.

→ Amelie

C Sample Qs

50.00 g of propane (C_3H_8) (g) is added to a 25.0 L rigid vessel at 25.0 °C. Next, O_2 (g) is added to this vessel to increase the *total pressure* in the vessel to 7.00 bar (also at 25.0 °C). A combustion reaction is then initiated, and at the end of the reaction, the temperature of the vessel has increased to 200. °C. At the end of the reaction, what is the **partial pressure (in bar)** of any remaining O_2 (g)?

A) 0.40

B) 0.00

C) 0.79

D) 1.69