Chemistry 10: Gas Laws | Applied chemistry

May 11 - May 15

Time Allotment: 40 minutes per day

Student Name: ________________________________

Teacher Name: ________________________________

Academic Honesty

I certify that I completed this assignment independently in accordance with the GHNO Academy Honor Code.	I certify that my student completed this assignment independently in accordance with the GHNO Academy Honor Code.
Student signature:	*Parent signature:*
___________________________	___________________________

Packet Overview

Date	Objective(s)	Page Number
Monday, May 11	*Review of ideal gas law and practice problems*	3
Tuesday, May 12	*Minor assessment: Ideal gas law problems (technical)*	8
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Thursday, May 14	*Chemical study: charging and re-charging the Lithium battery*	12
Friday, May 15	*Reading*	14

Additional Notes:

Hi all,

Two notes:

The quiz on Tuesday will be a practical quiz, focusing primarily upon using the $PV = nRT$ equation. You can use the review day in this packet as an exclusive resource when preparing for the quiz.

In the remainder of the week, you'll start to examine two exemplary contexts in which electrons play a major role. Since electrons are rarely found apart from atoms, you'll find that atomic properties and small differences between atoms can play a major role in determining how simple, miraculous, everyday processes work on an atomic level. My only desire for you in this week's work is that you enjoy the new insights into life and the beautiful things that your chemistry study affords.

Hoping you are well,

Mr. Luke

Monday, May 11

Chemistry Unit: Gas Laws
Lesson 1: Review for Quiz (technical)

Unit Overview

A Question for Lesson 1: What does the mass of a gas' molecules have to do with its pressure, temperature, and volume?

Objective

Review.

Introduction to Lesson 1

Some useful questions:

1. What are my givens? (e.g. pressure is 1.22 atm, volume is 2.3 Liters, etc)
2. What do I need to know? (I need to find V; I need to find the number of moles in order to calculate this unknown gas' molar mass, etc).
3. How do I get from what I have to what I know?
   Use the PV=nRT equation
   Work out the steps

   To find density, you need to know grams and volume. Work out how you'll find grams, then work out how you'll find volume, then calculate them and put them together.

   To find molar mass (in a problem with an unknown gas), you need to know grams and moles. Work out how you'll find the number of grams, then work out how you'll find the number of moles. In many cases you can just pick a mole amount and use it to calculate the gram amount, or one will be given to you. Calculate what you need and then divide grams by moles.

Some notes on solving ideal gas equation problems and the quiz tomorrow:

- **Notice that in most cases *R* is equal to 0.0821 L-atm/mol-K. *R* is a value you always look up or (on the quiz tomorrow) will be given to you.**
- **You'll have to convert all temperatures to Kelvin in order to solve these problems correctly. If the question asks for the answer in Celsius, you must do the work in Kelvins, then convert the answer to Celsius.**
- **You will have to know the ideal gas equation (PV = nRT), but you will also have to know how to find a gas' molar mass (grams per mole) or density (usually grams per liter, some mass amount over volume), using context clues and the information given.**

- **As always, be careful with units. You may have to do multiple conversions in order to "get things set up".**

- **Memorize the parameters known as "Standard Temperature and Pressure" (STP). These are: 273 K and 1.0 atm of pressure.**

The problems below are a good representation of the problems that will be given on the quiz tomorrow. Please solve them and check your answers. Show work below (or on a separate page if preferable).

1. **What is the number of moles of gas contained in a 3.0L vessel at 300K with a pressure of 3.00 atm? PV = nRT R = .0821 L*atm/mol*K**

A: .90 mol
B: .36 mol
C: 2.36 mol
D: 9.00 mol

2. **If the pressure exerted by a gas at 25C in a volume of .088L is 3.81 atm, how many moles of gas are present? R = .0821 L*atm/mol*K**

A: 138 mol
B: 13.8 mol
C: 1.38 mol
D: .138 mol

3. **Given: n = 4.98 mol, V = 1.00 L, P = 143 kPa, R = 8.314 L*kPa/mol* K, what is the temperature in degrees Celsius?**

A: -532 C
B: 1380 C
C: 13.80 K
D: -546 C

4. **Given: P = .900 atm V = unknown n = .323 mol R = .0821 L*atm/mol*K T = 265 K Find the volume.**

A: .781 L
B: 781 L
C: 7.81 L
D: 78.1 L

5. **Determine the kelvin temperature required for .0470 mol of gas to fill a balloon to 1.20L under .494 atm of pressure. R = .0821 L*atm/mol*K**

A: 136.5 K
B: 153.5 K
C: 186.5 K
D: 149 K

6. **The form of the Ideal Gas Law that uses density is: M = DRT/P, where D is the given density of a gas. Remember that density is mass/volume. M is the molar mass of the gas in question. What is the molar mass of a pure gas that has a density of 1.40g/L at STP? Remember that STP is standard temperature and pressure, which is 273 K and 1.00 atm. R = .0821 L*atm/mol*K**

A: 31.4 g/mol
B: 3.14 g/mol
C: 16.0 g/mol
D: 1.60 g/mol

7. **Given: D = 1.09 g/L P = 2.04 atm R = .0821 L*atm/mol*K T = 298 K Find the molar mass of the gas. Remember: M = DRT/P**

A: .522 g/mol
B: 5.22 g/mol
C: 522 g/mol
D: 52.2 g/mol

8. **What is the density of a gas at STP that has a molar mass of 44.0 g/mol? R = .0821 L*atm/mol*K D = MP/RT**

A: 196 g/L
B: 19.6 g/L
C: 1.96 g/L
D: .196 g/L

9. **Given the pressure of the gas as P = 1.00 atm, T = 546 K, R = .0821 L*atm/mol*K, M = 39.9 g/mol, what is its density, in grams per Liter?**

A: 3.56 g/L
B: 35.6 g/L
C: .356 g/L
D: 356 g/L

10. **Determine the density of chlorine gas at 317.0C and 1.00 atm of pressure. R = .0821 L*atm/mol*K Chlorine gas has a molar mass of 70.90 g/mol.**

A: 3.94 g/L
B: 5.9 g/L
C: 5.86 g/L
D: .0394 g/L

Answers: BDACBADCAC

Tuesday, May 12

Chemistry Unit: Gas Laws
Lesson 2: Technical quiz: using the ideal gas equation

Unit Overview

Objective:

Take the quiz.

Agenda

I. Take quiz on Google Classroom (estimate: no more than 30 minutes)
   a. If you have opted out of Google Classroom, take the quiz on the last page of this packet. Fill out answer sheet, then submit via preferred method.

II. Make a mental note of any questions you think you may have missed and check your notes or email Mr. Luke to go over those (estimate: 5-10 minutes)

Permitted materials: calculator, blank periodic table, pencil, scratch paper. Take this quiz as you would in class, without notes, in a quiet setting. Complete it in one sitting. Do not share answers via text, email, etc.

Wednesday, May 13

Chemistry Unit: Applied chemistry
Lesson 3: Chemical study: the anatomy of a rechargeable Lithium battery

Unit Overview

Objective:

Review Figure 1, then complete either I. the challenge activity or II. the review questions.

A Question for Lesson 3: What happens when you put two different metals touching side by side? Hint: what is the activity series?

Introduction to Lesson 3

Review the diagram below.

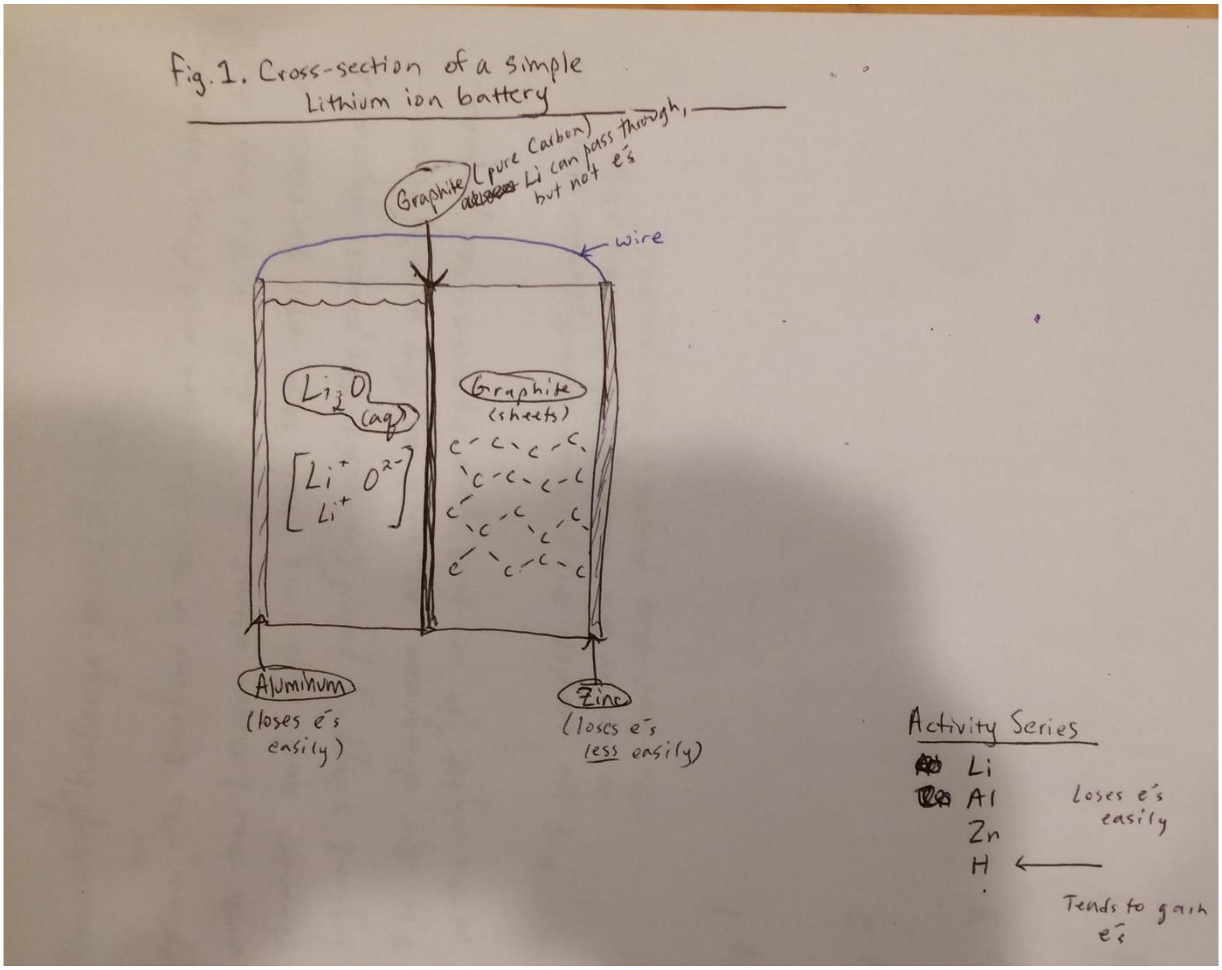
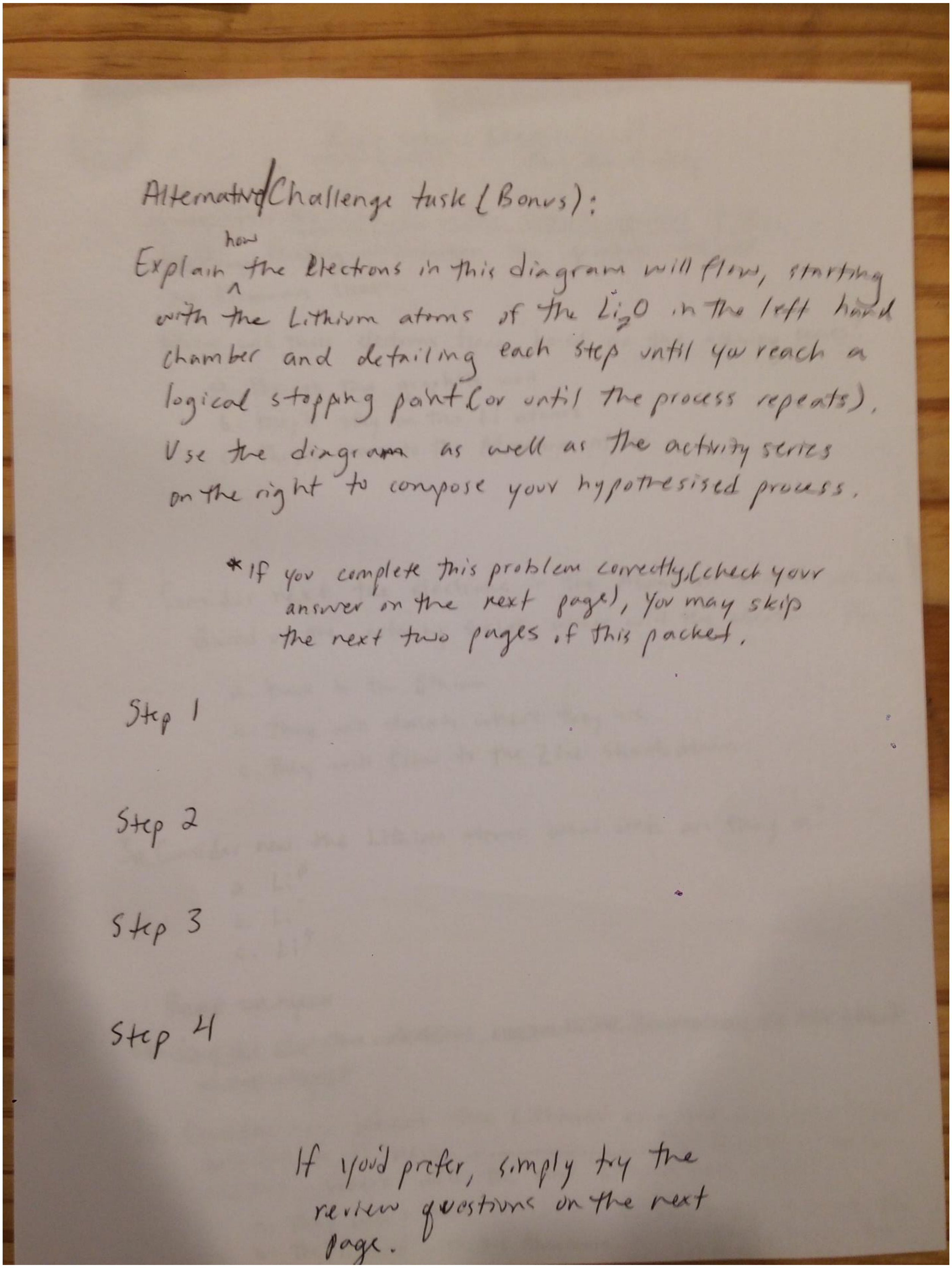


Fig. 1. Cross-section of a simple Lithium ion battery



Alternative/Challenge task (Bonus):

Explain how the Electrons in this diagram will flow, starting with the Lithium atoms of the Li_2O in the left hand chamber and detailing each step until you reach a logical stopping point (or until the process repeats). Use the diagram as well as the activity series on the right to compose your hypothesised process.

*If you complete this problem correctly (check your answer on the next page), you may skip the next two pages of this packet.

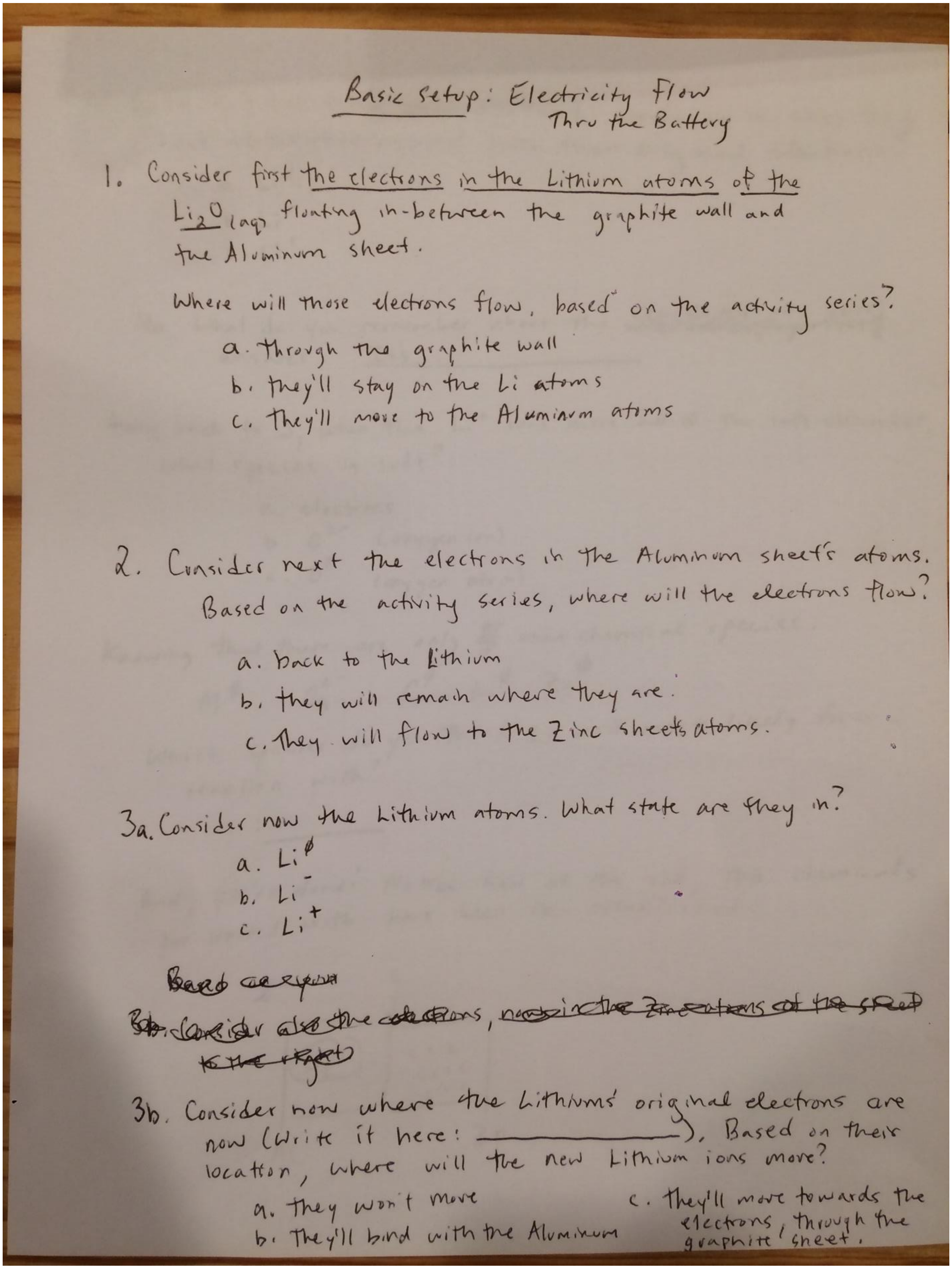
Step 1

Step 2

Step 3

Step 4

If you'd prefer, simply try the review questions on the next page.



Basic Setup: Electricity Flow
Thru the Battery

1. Consider first the electrons in the Lithium atoms of the $Li_2O_{(aq)}$ floating in-between the graphite wall and the Aluminum sheet.

Where will those electrons flow, based on the activity series?

a. Through the graphite wall
b. they'll stay on the Li atoms
c. They'll move to the Aluminum atoms

2. Consider next the electrons in the Aluminum sheet's atoms. Based on the activity series, where will the electrons flow?

a. back to the Lithium
b. they will remain where they are.
c. They will flow to the Zinc sheet's atoms.

3a. Consider now the Lithium atoms. What state are they in?

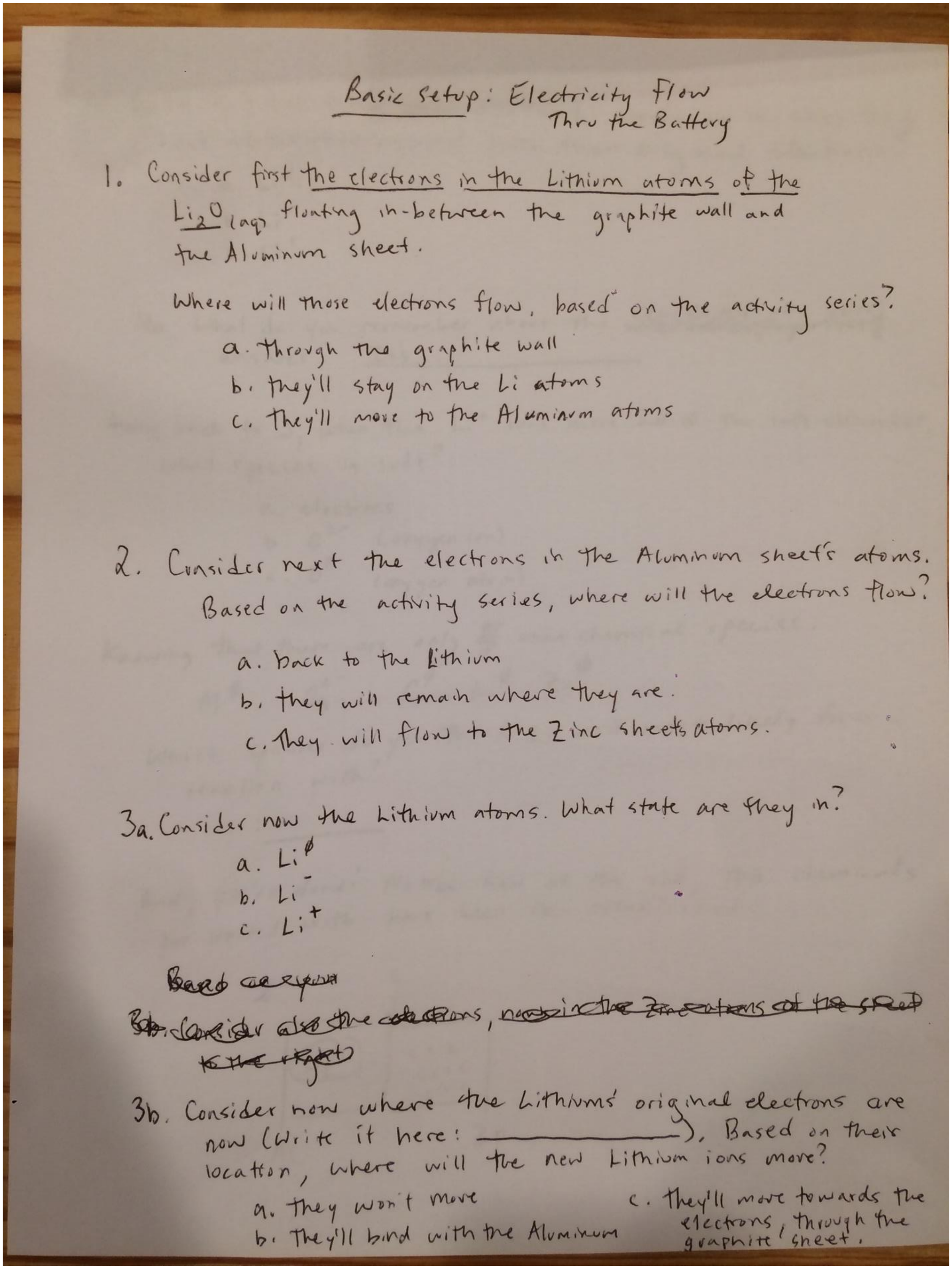
a. Li^0
b. Li^-
c. Li^+

~~Based on your~~

~~3b. Consider also the electrons, now in the Zinc atoms of the sheet to the right~~)

3b. Consider now where the Lithiums' original electrons are now (Write it here: ________________), Based on their location, where will the new Lithium ions move?

a. They won't move
b. They'll bind with the Aluminum
c. They'll move towards the electrons, through the graphite sheet.



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   b. Li^-
   c. Li^+

~~Based on your~~

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3b. Consider now where the Lithiums' original electrons are now (Write it here: ________________). Based on their location, where will the new Lithium ions move?

   a. they won't move
   b. They'll bind with the Aluminum
   c. They'll move towards the electrons, through the graphite sheet.

4. (after 3a & 3b) What state will the Li atoms be in after they have ~~reform~~ reconciled with their original electrons?

- a. Li^0
- b. Li^-
- c. Li^+

4a. What do you remember about the reactivity of your ~~chemical properties~~ answer? It's... ____________

Going back to 3, when the Li^+ ions move out of the left chamber, what species is left?

- a. electrons
- b. O^{2-} (oxygen ion)
- c. O^0 (oxygen atom)

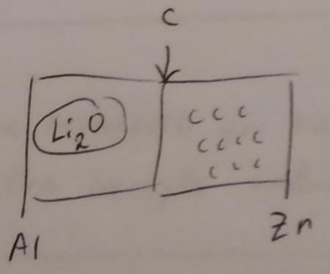
Knowing that there are only 5 main chemical species:

Al^0 O^{2-} C^0 Li^0 Zn^0

Which species do you think Li will most likely form a reaction with?

: ____________

And, you're done! Notice how at the end, the chemicals you started with have been re-established:



Correct answers: c, c, c, a, very reactive, b, O^{2-} (to re-form Li_2O).

Thursday, May 14

Chemistry Unit: Applied chemistry
Lesson 4: Chemical study: charging and re-charging the Lithium battery

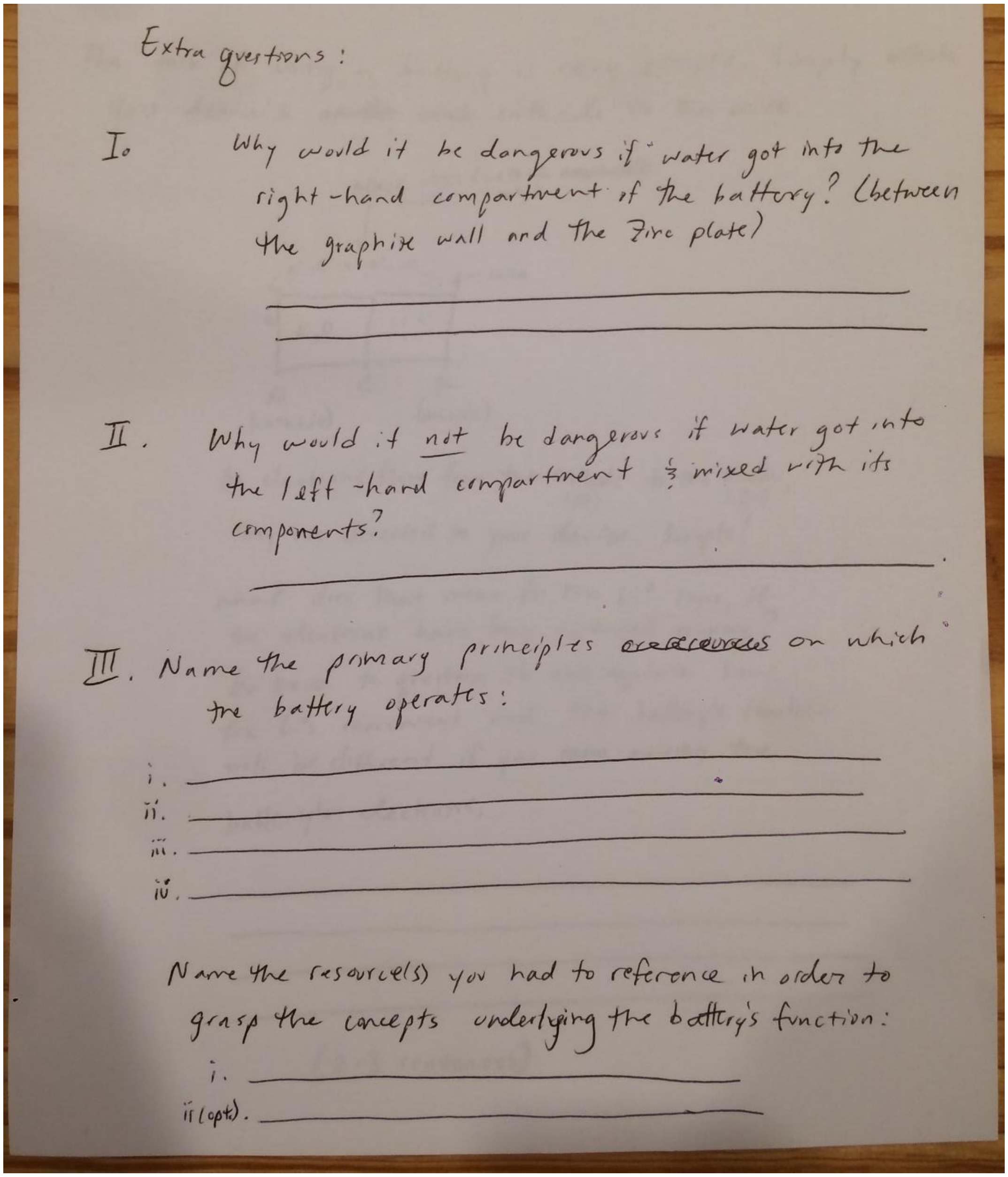
Unit Overview

Lesson 4 Socratic Question: How do I siphon flow out of the battery when I attach it to a device?

Objective:

Be able to answer all the questions below.

Introduction to Lesson 4



Extra questions:

I. Why would it be dangerous if water got into the right-hand compartment of the battery? (between the graphite wall and the Zinc plate)

____

____

II. Why would it not be dangerous if water got into the left-hand compartment & mixed with its components?

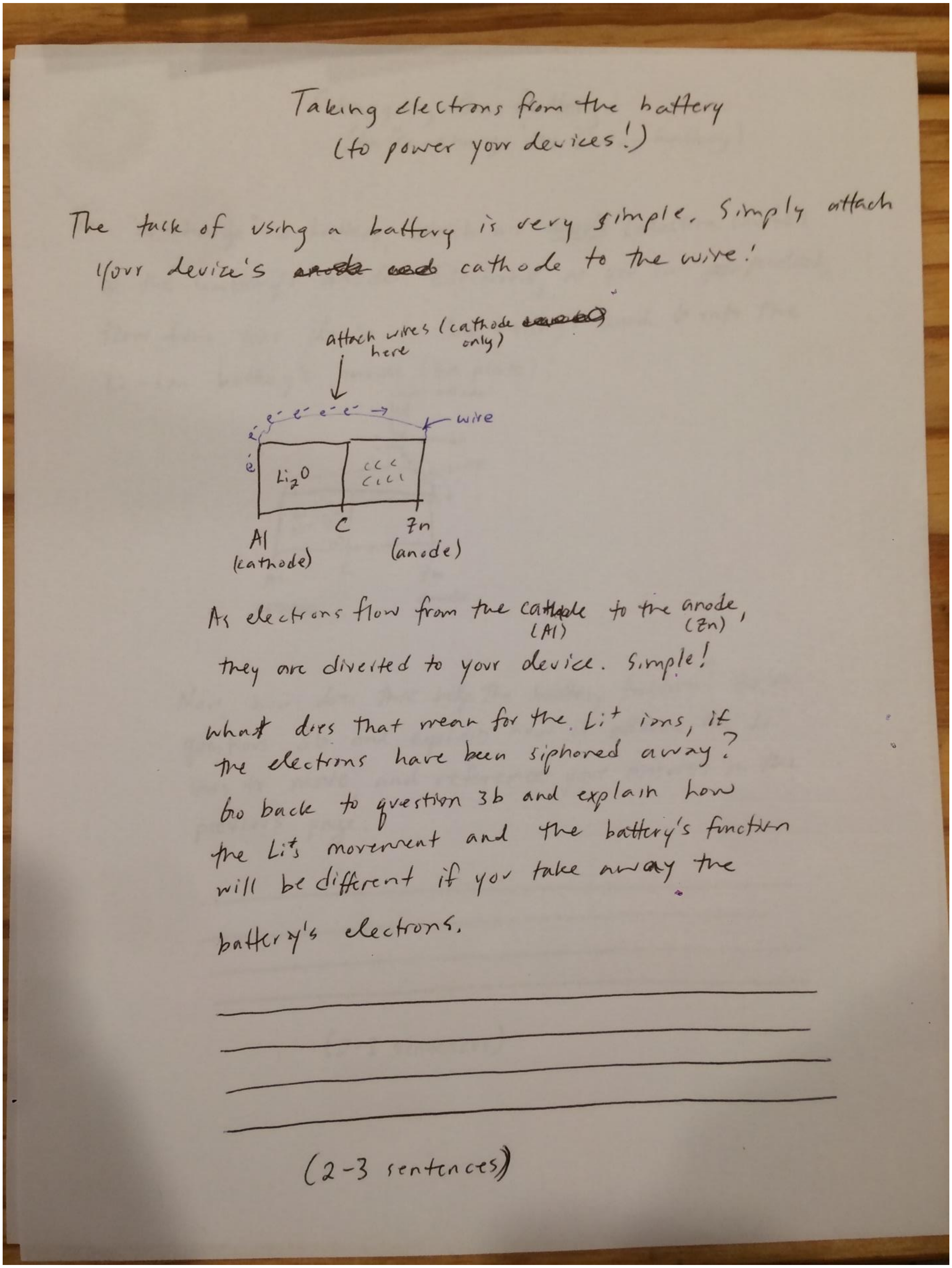
____

III. Name the primary principles [illegible] on which the battery operates:

i. ______________________________
ii. ______________________________
iii. ______________________________
iv. ______________________________

Name the resource(s) you had to reference in order to grasp the concepts underlying the battery's function:

i. ______________________________
ii (opt). ______________________________



Taking electrons from the battery
(to power your devices!)

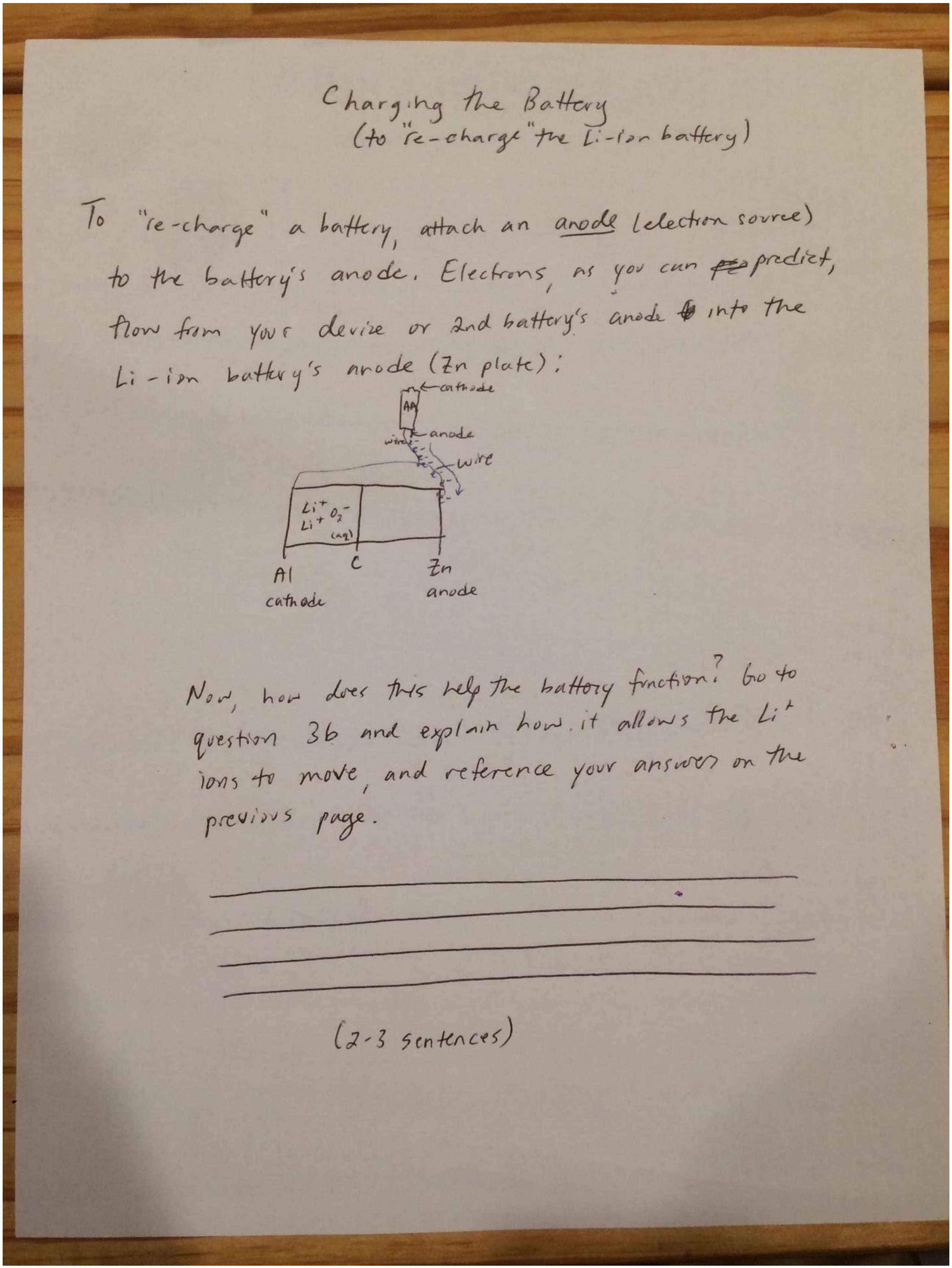
The task of using a battery is very simple. Simply attach your device's ~~anode and~~ cathode to the wire!

attach wires here (cathode ~~[illegible]~~ only)

As electrons flow from the cathode (Al) to the anode (Zn), they are diverted to your device. Simple!

What does that mean for the Li^+ ions, if the electrons have been siphoned away? Go back to question 3b and explain how the Li^+'s movement and the battery's function will be different if you take away the battery's electrons.

(2-3 sentences)



Charging the Battery
(to "re-charge" the Li-ion battery)

To "re-charge" a battery, attach an anode (electron source) to the battery's anode. Electrons, as you can ~~pre~~predict, flow from your device or 2nd battery's anode into the Li-ion battery's anode (Zn plate):

Now, how does this help the battery function? Go to question 36 and explain how it allows the Li^+ ions to move, and reference your answers on the previous page.

(2-3 sentences)

Friday, May 15

Chemistry Unit: Applied chemistry
Lesson 5: Reading

Unit Overview

Two Socratic Questions: How does life depend on chemical processes?

Objective:

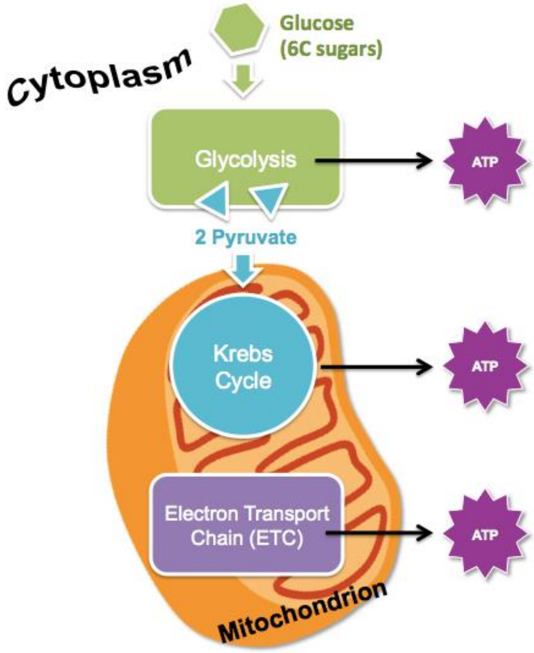
Read and annotate.
Answer all the questions below by the end of this lesson.

Introduction to Lesson 5

Today, you're going to review aerobic respiration, with a fresh eye for the chemical aspects of this biochemical process.

Take a look; read and annotate the review material below. When you've finished, review the (fun) attached reading.

Cellular Respiration (Stage 3 only)



Stage 3: The Electron Transport Chain (ETC)

This stage will generate 34 ATP molecules and H_2O from the carrier molecules that were produced in the first two stages.

The electron transport chain is a group of proteins embedded in the inner mitochondrial membrane, or cristae.

There are two events in the electron transport chain:

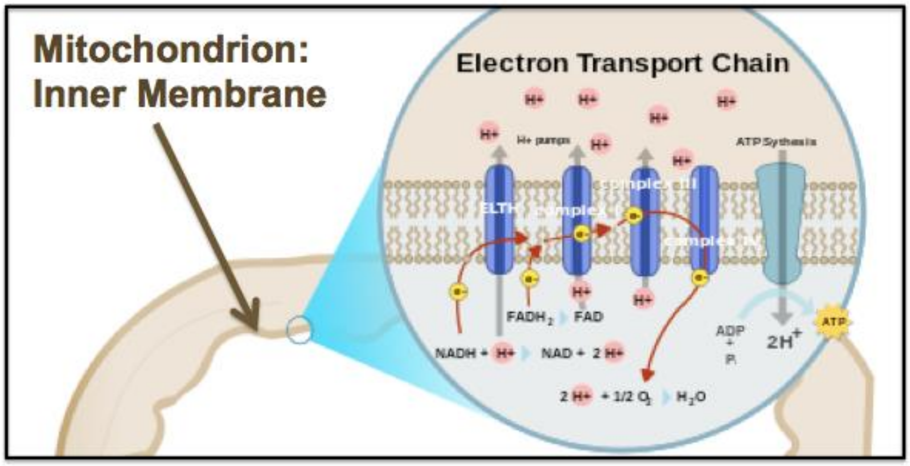
Electron Donation (setting up a gradient):

1. High energy electrons from NADH and $FADH_2$ (from Stages 1 and 2) are transferred to the ETC proteins.
2. The electrons are passed along this chain of proteins and their energy is used to pump protons (H+) present in the matrix to the intermembrane space.
3. The electrons reaching the end of the chain are donated to O_2 and are used to create H_2O molecules. Oxygen is therefore the final electron acceptor.
4. This sets up a proton gradient where there are much more protons in the intermembrane space than in the matrix.

> **Stop and Think:** Why do we breathe oxygen? What would happen if we could not supply our mitochondria with oxygen?

ATP Synthesis (making ATP):

1. The gradient created in the last step is a source of potential energy; to reach equilibrium across the membrane, the protons need a pathway. **ATP Synthase** is a *channel* protein also embedded in the membrane. Protons move back through the membrane, down their concentration gradient (passive transport).
2. ATP Synthase is also an *enzyme* (note that it ends in "ase"). It uses the flow of protons to generate molecules of ATP from ADP and free phosphates.
3. For each NADH, ATP synthase makes 3 ATP. For each $FADH_2$, ATP Synthase makes 2 ATP.



Based on the reading above, write the function of each species and how it furthers the goal of making more ATP.

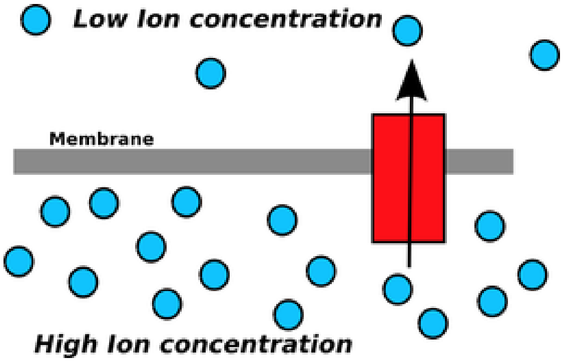
- high energy electrons

- Protons (H^+)

- NADPH

- water

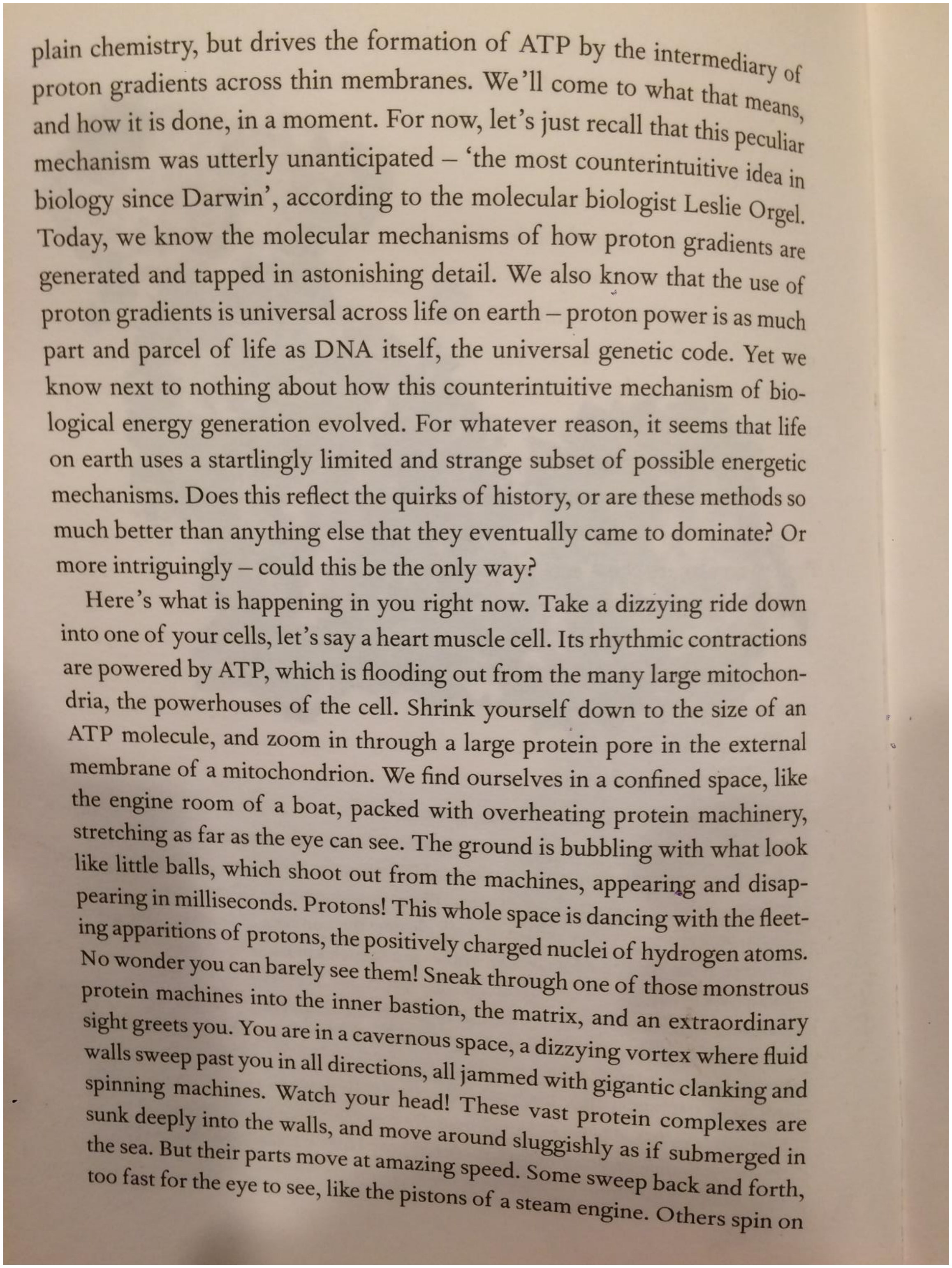
The end of the electron transport chain is to construct a proton gradient across the mitochondrion's inner and matrix membrane. A simplified diagram of the membrane, with protons drawn, is below:



Explain, using the phrases "high concentration" and "low concentration", to explain why protons (blue) flow from the lower side of the membrane to the other side.

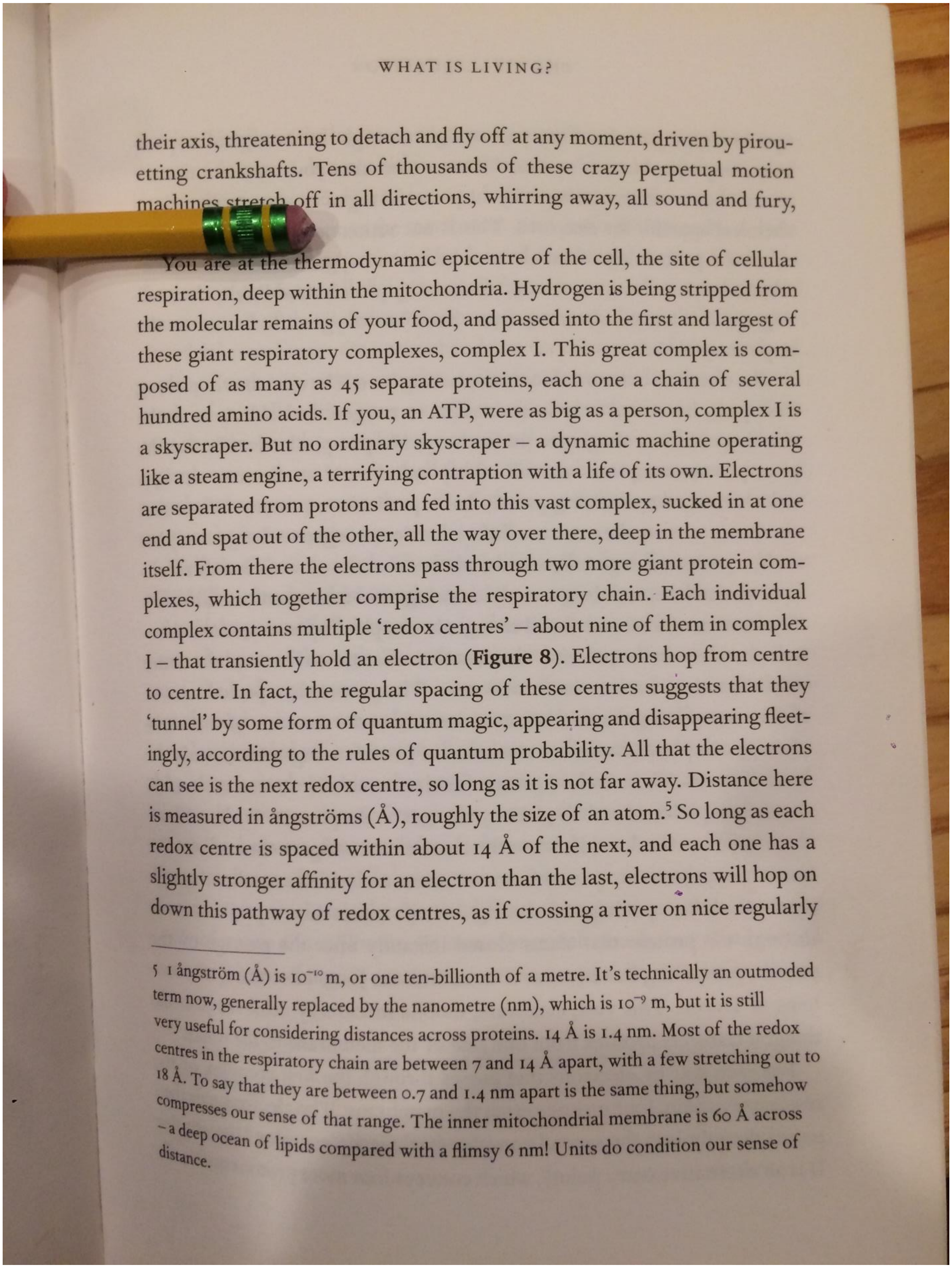
Attached reading

Read and annotate the reading below. Heads up: the reading contains a pop culture reference. Knowledge of this reference is not required to understand the material.



plain chemistry, but drives the formation of ATP by the intermediary of proton gradients across thin membranes. We'll come to what that means, and how it is done, in a moment. For now, let's just recall that this peculiar mechanism was utterly unanticipated – 'the most counterintuitive idea in biology since Darwin', according to the molecular biologist Leslie Orgel. Today, we know the molecular mechanisms of how proton gradients are generated and tapped in astonishing detail. We also know that the use of proton gradients is universal across life on earth – proton power is as much part and parcel of life as DNA itself, the universal genetic code. Yet we know next to nothing about how this counterintuitive mechanism of biological energy generation evolved. For whatever reason, it seems that life on earth uses a startlingly limited and strange subset of possible energetic mechanisms. Does this reflect the quirks of history, or are these methods so much better than anything else that they eventually came to dominate? Or more intriguingly – could this be the only way?

Here's what is happening in you right now. Take a dizzying ride down into one of your cells, let's say a heart muscle cell. Its rhythmic contractions are powered by ATP, which is flooding out from the many large mitochondria, the powerhouses of the cell. Shrink yourself down to the size of an ATP molecule, and zoom in through a large protein pore in the external membrane of a mitochondrion. We find ourselves in a confined space, like the engine room of a boat, packed with overheating protein machinery, stretching as far as the eye can see. The ground is bubbling with what look like little balls, which shoot out from the machines, appearing and disappearing in milliseconds. Protons! This whole space is dancing with the fleeting apparitions of protons, the positively charged nuclei of hydrogen atoms. No wonder you can barely see them! Sneak through one of those monstrous protein machines into the inner bastion, the matrix, and an extraordinary sight greets you. You are in a cavernous space, a dizzying vortex where fluid walls sweep past you in all directions, all jammed with gigantic clanking and spinning machines. Watch your head! These vast protein complexes are sunk deeply into the walls, and move around sluggishly as if submerged in the sea. But their parts move at amazing speed. Some sweep back and forth, too fast for the eye to see, like the pistons of a steam engine. Others spin on



their axis, threatening to detach and fly off at any moment, driven by pirouetting crankshafts. Tens of thousands of these crazy perpetual motion machines stretch off in all directions, whirring away, all sound and fury,

You are at the thermodynamic epicentre of the cell, the site of cellular respiration, deep within the mitochondria. Hydrogen is being stripped from the molecular remains of your food, and passed into the first and largest of these giant respiratory complexes, complex I. This great complex is composed of as many as 45 separate proteins, each one a chain of several hundred amino acids. If you, an ATP, were as big as a person, complex I is a skyscraper. But no ordinary skyscraper – a dynamic machine operating like a steam engine, a terrifying contraption with a life of its own. Electrons are separated from protons and fed into this vast complex, sucked in at one end and spat out of the other, all the way over there, deep in the membrane itself. From there the electrons pass through two more giant protein complexes, which together comprise the respiratory chain. Each individual complex contains multiple 'redox centres' – about nine of them in complex I – that transiently hold an electron (**Figure 8**). Electrons hop from centre to centre. In fact, the regular spacing of these centres suggests that they 'tunnel' by some form of quantum magic, appearing and disappearing fleetingly, according to the rules of quantum probability. All that the electrons can see is the next redox centre, so long as it is not far away. Distance here is measured in ångströms (Å), roughly the size of an atom.[5] So long as each redox centre is spaced within about 14 Å of the next, and each one has a slightly stronger affinity for an electron than the last, electrons will hop on down this pathway of redox centres, as if crossing a river on nice regularly

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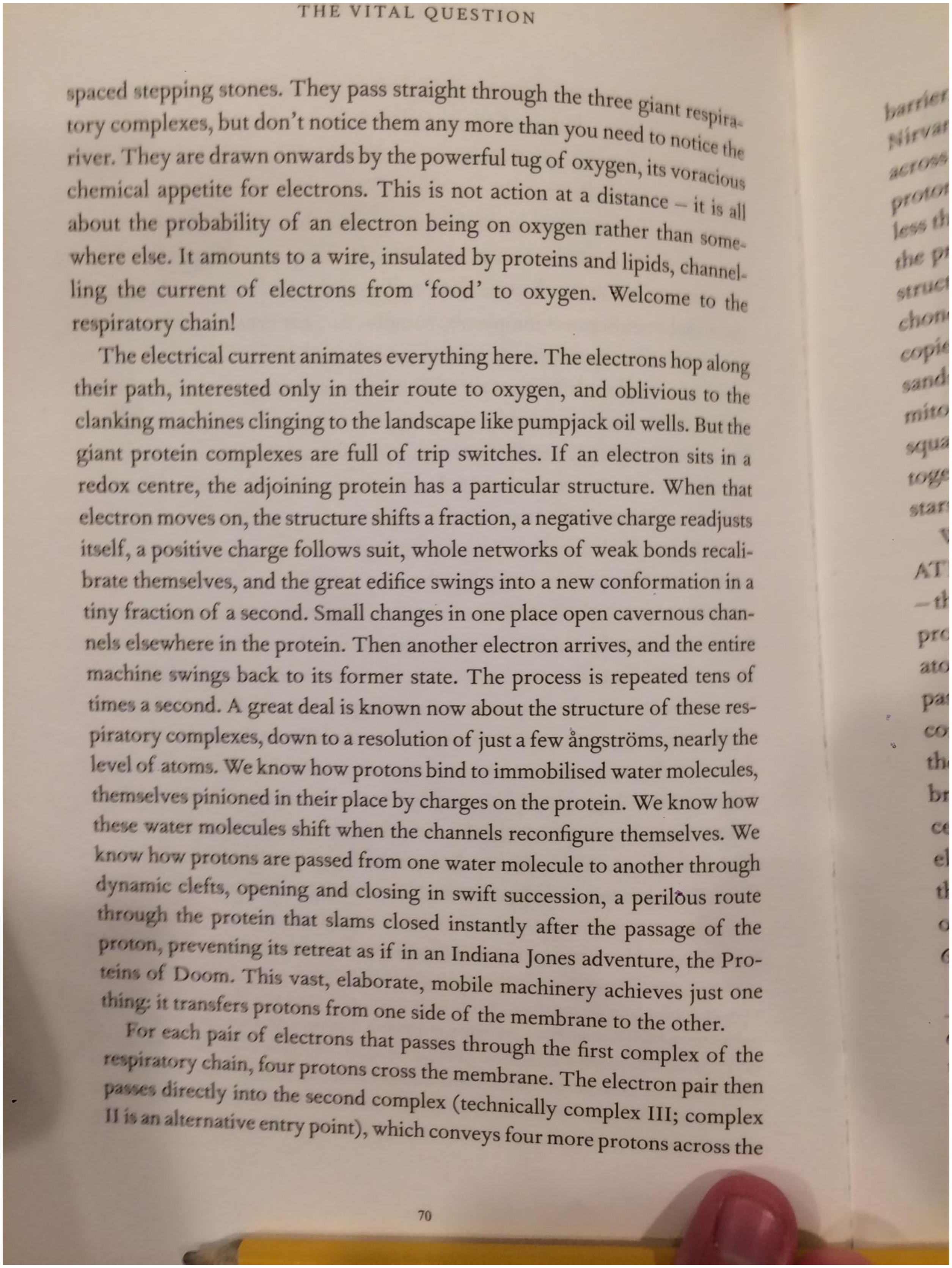
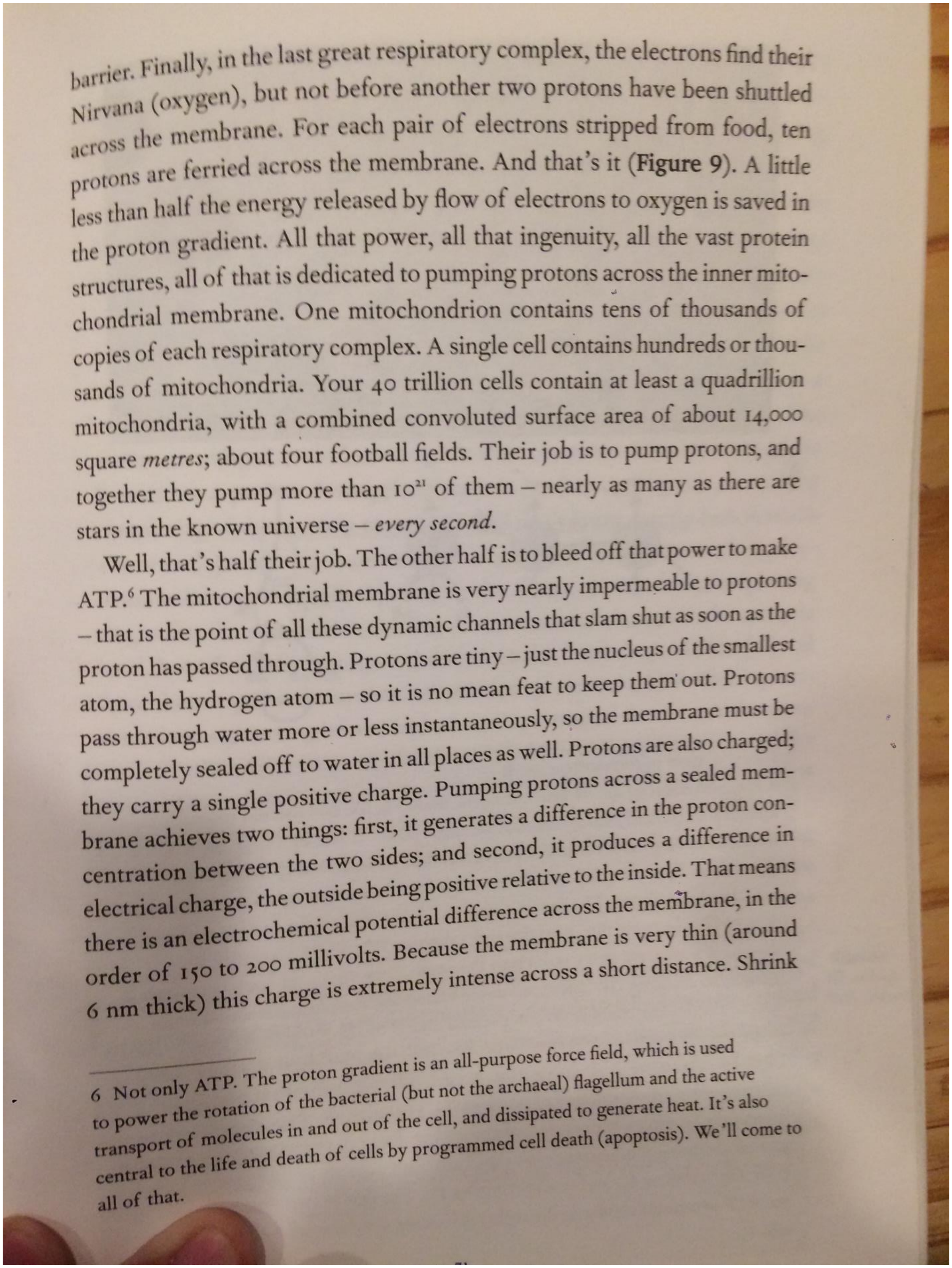
[5] 1 ångström (Å) is 10^{-10} m, or one ten-billionth of a metre. It's technically an outmoded term now, generally replaced by the nanometre (nm), which is 10^{-9} m, but it is still very useful for considering distances across proteins. 14 Å is 1.4 nm. Most of the redox centres in the respiratory chain are between 7 and 14 Å apart, with a few stretching out to 18 Å. To say that they are between 0.7 and 1.4 nm apart is the same thing, but somehow compresses our sense of that range. The inner mitochondrial membrane is 60 Å across – a deep ocean of lipids compared with a flimsy 6 nm! Units do condition our sense of distance.



spaced stepping stones. They pass straight through the three giant respiratory complexes, but don't notice them any more than you need to notice the river. They are drawn onwards by the powerful tug of oxygen, its voracious chemical appetite for electrons. This is not action at a distance – it is all about the probability of an electron being on oxygen rather than somewhere else. It amounts to a wire, insulated by proteins and lipids, channelling the current of electrons from 'food' to oxygen. Welcome to the respiratory chain!

The electrical current animates everything here. The electrons hop along their path, interested only in their route to oxygen, and oblivious to the clanking machines clinging to the landscape like pumpjack oil wells. But the giant protein complexes are full of trip switches. If an electron sits in a redox centre, the adjoining protein has a particular structure. When that electron moves on, the structure shifts a fraction, a negative charge readjusts itself, a positive charge follows suit, whole networks of weak bonds recalibrate themselves, and the great edifice swings into a new conformation in a tiny fraction of a second. Small changes in one place open cavernous channels elsewhere in the protein. Then another electron arrives, and the entire machine swings back to its former state. The process is repeated tens of times a second. A great deal is known now about the structure of these respiratory complexes, down to a resolution of just a few ångströms, nearly the level of atoms. We know how protons bind to immobilised water molecules, themselves pinioned in their place by charges on the protein. We know how these water molecules shift when the channels reconfigure themselves. We know how protons are passed from one water molecule to another through dynamic clefts, opening and closing in swift succession, a perilous route through the protein that slams closed instantly after the passage of the proton, preventing its retreat as if in an Indiana Jones adventure, the Proteins of Doom. This vast, elaborate, mobile machinery achieves just one thing: it transfers protons from one side of the membrane to the other.

For each pair of electrons that passes through the first complex of the respiratory chain, four protons cross the membrane. The electron pair then passes directly into the second complex (technically complex III; complex II is an alternative entry point), which conveys four more protons across the



barrier. Finally, in the last great respiratory complex, the electrons find their Nirvana (oxygen), but not before another two protons have been shuttled across the membrane. For each pair of electrons stripped from food, ten protons are ferried across the membrane. And that's it (**Figure 9**). A little less than half the energy released by flow of electrons to oxygen is saved in the proton gradient. All that power, all that ingenuity, all the vast protein structures, all of that is dedicated to pumping protons across the inner mitochondrial membrane. One mitochondrion contains tens of thousands of copies of each respiratory complex. A single cell contains hundreds or thousands of mitochondria. Your 40 trillion cells contain at least a quadrillion mitochondria, with a combined convoluted surface area of about 14,000 square *metres*; about four football fields. Their job is to pump protons, and together they pump more than 10^{21} of them – nearly as many as there are stars in the known universe – *every second*.

Well, that's half their job. The other half is to bleed off that power to make ATP.[6] The mitochondrial membrane is very nearly impermeable to protons – that is the point of all these dynamic channels that slam shut as soon as the proton has passed through. Protons are tiny – just the nucleus of the smallest atom, the hydrogen atom – so it is no mean feat to keep them out. Protons pass through water more or less instantaneously, so the membrane must be completely sealed off to water in all places as well. Protons are also charged; they carry a single positive charge. Pumping protons across a sealed membrane achieves two things: first, it generates a difference in the proton concentration between the two sides; and second, it produces a difference in electrical charge, the outside being positive relative to the inside. That means there is an electrochemical potential difference across the membrane, in the order of 150 to 200 millivolts. Because the membrane is very thin (around 6 nm thick) this charge is extremely intense across a short distance. Shrink

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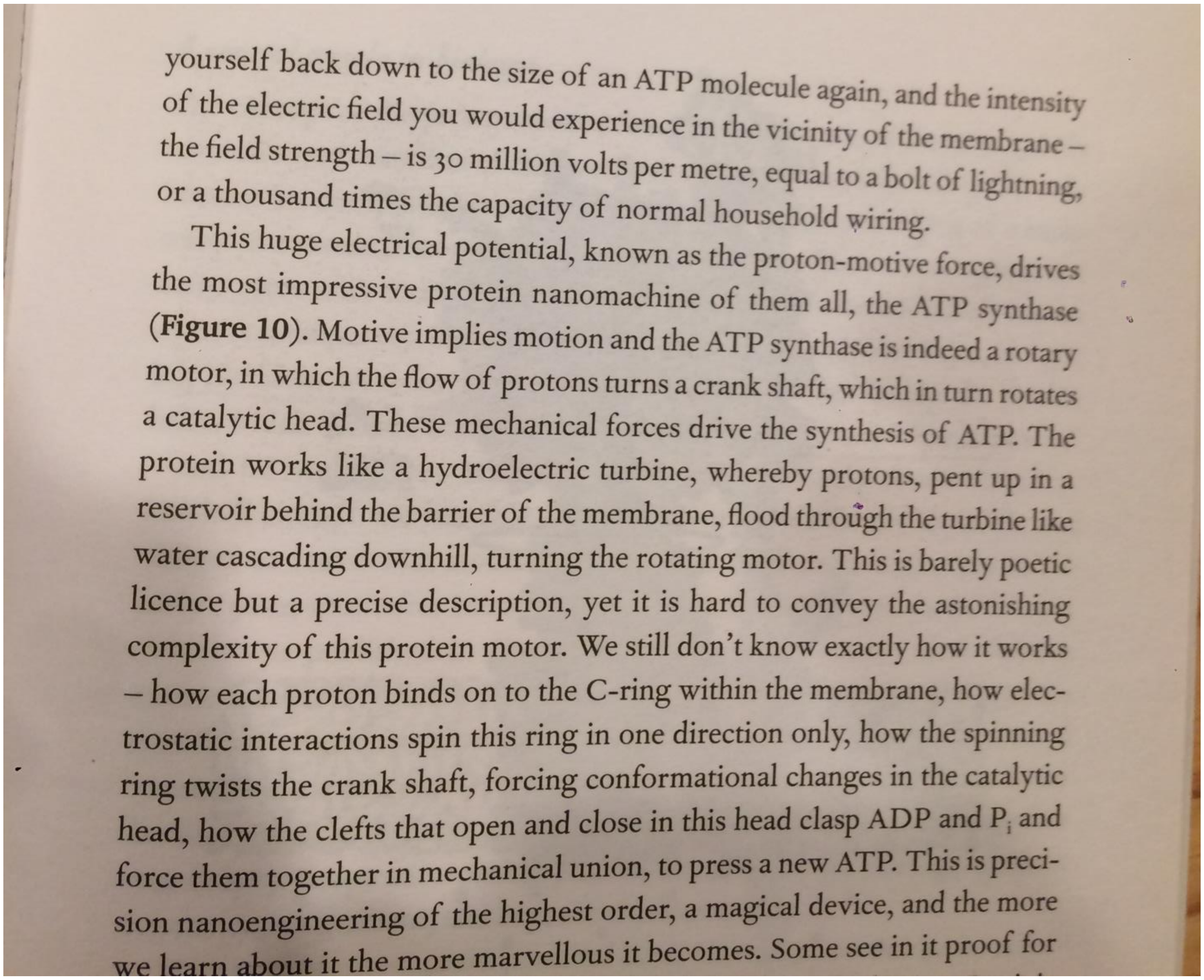
[6] Not only ATP. The proton gradient is an all-purpose force field, which is used to power the rotation of the bacterial (but not the archaeal) flagellum and the active transport of molecules in and out of the cell, and dissipated to generate heat. It's also central to the life and death of cells by programmed cell death (apoptosis). We'll come to all of that.



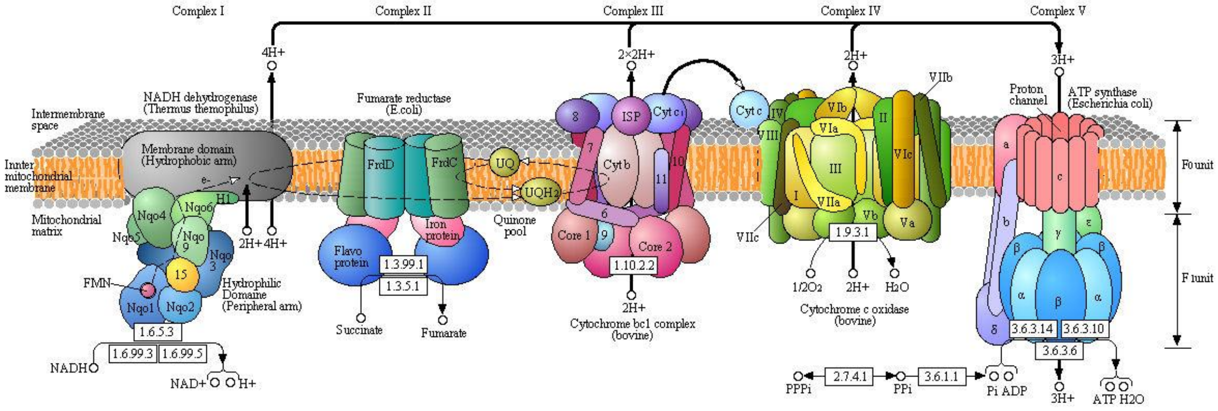
yourself back down to the size of an ATP molecule again, and the intensity of the electric field you would experience in the vicinity of the membrane – the field strength – is 30 million volts per metre, equal to a bolt of lightning, or a thousand times the capacity of normal household wiring.

This huge electrical potential, known as the proton-motive force, drives the most impressive protein nanomachine of them all, the ATP synthase (**Figure 10**). Motive implies motion and the ATP synthase is indeed a rotary motor, in which the flow of protons turns a crank shaft, which in turn rotates a catalytic head. These mechanical forces drive the synthesis of ATP. The protein works like a hydroelectric turbine, whereby protons, pent up in a reservoir behind the barrier of the membrane, flood through the turbine like water cascading downhill, turning the rotating motor. This is barely poetic licence but a precise description, yet it is hard to convey the astonishing complexity of this protein motor. We still don't know exactly how it works – how each proton binds on to the C-ring within the membrane, how electrostatic interactions spin this ring in one direction only, how the spinning ring twists the crank shaft, forcing conformational changes in the catalytic head, how the clefts that open and close in this head clasp ADP and P_i and force them together in mechanical union, to press a new ATP. This is precision nanoengineering of the highest order, a magical device, and the more we learn about it the more marvellous it becomes. Some see in it proof for

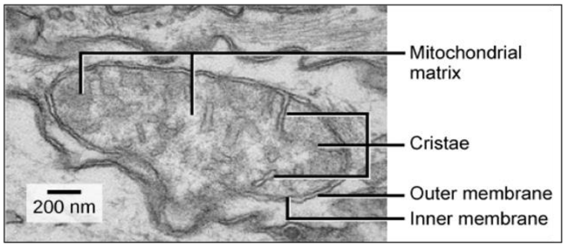
When you finish, please make sure you've completed the reading questions from the review material above.

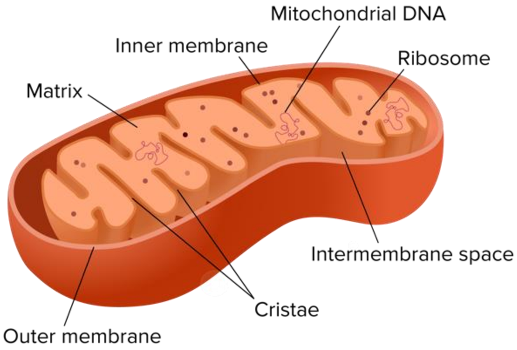
Supplemental diagrams:

A current research diagram of the electron transport chain, including the "proton pump" and the ATP synthase molecule:



A diagram of the mitochondria, to give context (circle an area of the wall (membrane) where this process is occurring).





Ideal gas law quiz

Permitted materials: calculator, blank periodic table, pencil, scratch paper. Take this quiz as you would in class, without notes, in a quiet setting. Complete it in one sitting. Do not share answers via text, email, etc.

1. What is the number of moles of gas contained in a 3.0L vessel at 300K with a pressure of 1.50 atm? (R = 0.0821 L*atm/mol*K)

   a. 4.50 mol
   b. 0.45 mol
   c. 1.18 mol
   d. 0.18 mol

2. If the pressure exerted by a gas at 25C in a volume of 0.044L is 3.81 atm, how many moles of gas are present? R = 0.0821 L*atm/mol*K *

   a. 69 mol
   b. 6.9 mol
   c. 0.069 mol
   d. 0.69 mol

3. Given: n = 2.49 mol; V = 1.00 L; P = 143 kPa; and R = 8.314 L*kPa/mol* K, what is the temperature in degrees Celsius? *

   a. 690 C
   b. 6.90 K
   c. -273 C
   d. -266 C

4. Given: P = .900 atm; n = .323 moles; R = .0821 L*atm/mol*K, and T = 265 K, find the volume. *

   a. 0.781 L
   b. 7.81 L
   c. 781 L
   d. 78.1 L

5. Determine the temperature, in Kelvin, that corresponds to 0.0470 moles of gas in a balloon. The gas takes up 1.20 L under 0.988 atm of pressure (R = .0821 L*atm/mol*K). *

   a. 307 K
   b. 273 K
   c. 373 K
   d. 298 K

6. What is the molar mass of a pure gas that has a density of 1.40g/L at STP? (remember the conditions of (S)tandard (T)emperature and (P)ressure to solve this problem) *

    a. g/mol
    b. 31.4 g/mo
    c. 16.0 g/mol
    d. 1.60 g/mol

7. Given: D = 1.09 g/L P = 1.02 atm, R = 0.0821 L*atm/mol*K, and T = 298 K, find the molar mass of the gas (in grams per mole). *

    a. 0.261 g/mol
    b. 2.61 g/mol
    c. 26.1 g/mol
    d. 261 g/mol

8. What is the density of a gas at STP that has a molar mass of 44.0 g/mol? (R = 0.0821 L*atm/mol*K) *

    a. 196 g/L
    b. 19.6 g/L
    c. 1.96 g/L
    d. 0.196 g/L

9. Determine the density of chlorine gas when the temperature is 22.0C and at 1.00 atm of pressure. R = .0821 L*atm/mol*K. (chlorine gas has a molar mass of 70.90 g/mol). *

    a. 1.97 g/L
    b. 2.95 g/L
    c. 2.93 g/L
    d. 0.0197 g/L

Answer form: Ideal gas law quiz

Name: ________________

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