

---

---

### Directions

---

---

1. Skim the entire exam before you begin so that you have a sense of the whole: what parts you can do quickly and what parts will require more time. The points for each problem are shown in parenthesis in the left margin. Try to use your time in proportion to the points assigned for each question.
2. You must show all the work necessary to arrive at your answer. **No credit will be given for numerical answers unless your work is shown.** (We want to be able to follow your thought process in order to be able to help make corrections and allot partial credit.)
3. Be sure to include the correct number of significant figures and the appropriate unit when reporting your answers.

---

---

### Academic Integrity Pledge

---

---

#### During the exam I will

- turn off my cell phone and put it away (out of sight and not on my person)
- close all books, notebooks, etc. and put them under the seat in which I sit
- use only a permitted calculator
- keep my eyes down and focused on my own paper
- write only in ink
- keep my answers covered
- sit in the area assigned to my section
- stop writing when the end of the exam is announced

#### During the exam I will not

- have any papers other than those provided
- have any writing on my clothing or person or desk
- talk to anyone other than a TA or the instructor

I understand that the *minimum consequence* of any behavior contrary to this pledge is that I will receive a **zero on this exam** that will not be replaced by the percent earned on my final exam.

Name (sign) \_\_\_\_\_

---

---

### Scoring

---

---

1	<u>2</u> / 15	5	<u>10</u> / 15	MC	<u>25</u> / 30
2	<u>5</u> / 15	6	<u>15</u> / 15		
3	<u>15</u> / 15	7	<u>15</u> / 15	Total	<u>117</u> / 150
4	<u>15</u> / 15	8	<u>15</u> / 15		

---

---

### Write Your Multiple Choice Answers Here

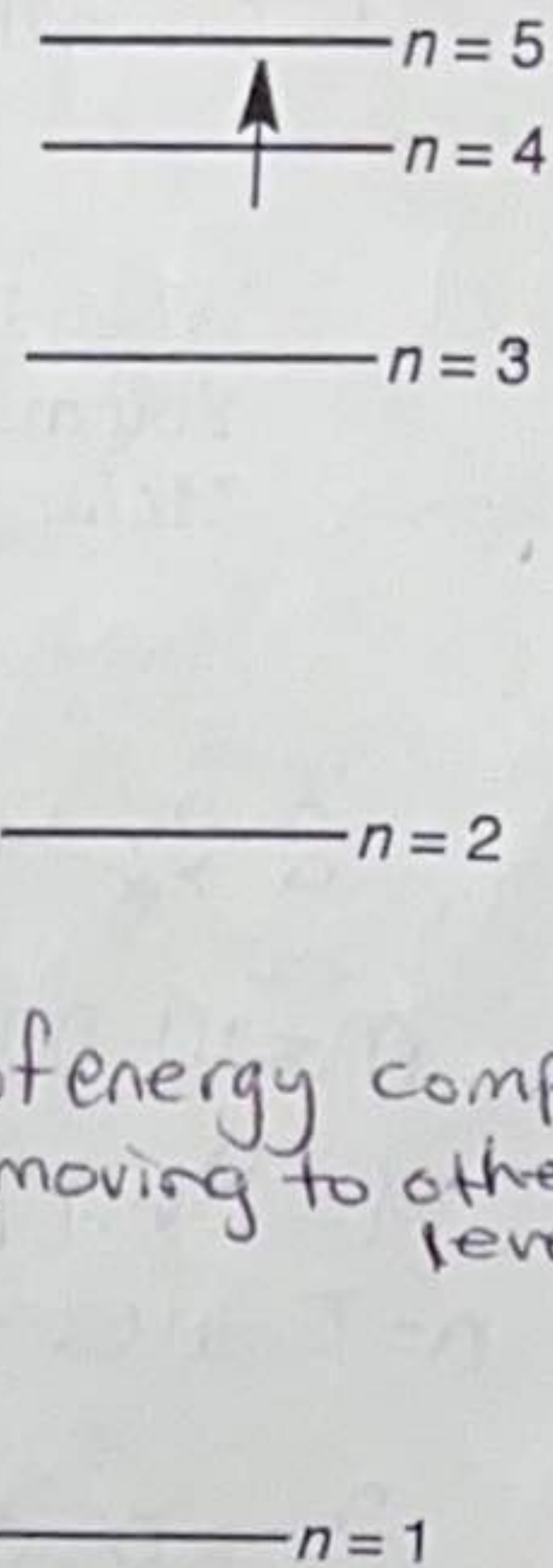
---

---

- |             |               |             |
|-------------|---------------|-------------|
| 1. <u>A</u> | 3. <u>E</u>   | 5. <u>E</u> |
| 2. <u>C</u> | 4. <u>C</u> ✓ | 6. <u>C</u> |



3. Given the following energy diagram for an atom that contains an electron in the  $n = 4$  level:



a. Which transition of the given electron will emit light of the highest frequency?

highest frequency means highest energy, means it will be from ~~n=4~~ to  $n=1$

b. Use only the levels depicted in the diagram, which transition of the electron would require the lowest-frequency of light?

Lowest frequency means lowest energy level, which means jumping from  $n=4$  to  $n=5$ . It will absorb the smallest amount of energy compared

c. If the transition from  $n=1$  to  $n=3$  emits green light, what color of light is absorbed when the electron makes the transition from  $n=3$  to  $n=1$ ?

everything but green

15

4. The red line in the lithium spectrum has a wavelength of 671 nm. You must show all your work to receive credit. **Circle your final answer.**

a. What is the frequency of the photon?

frequency is in Hz

$$\lambda = 671 \text{ nm} = 671 \times 10^{-9} \text{ m} = 6.71 \times 10^{-7} \text{ m}$$

$$\lambda = \frac{c}{\nu}$$

$$6.71 \times 10^{-7} = \frac{2.998 \times 10^8}{\nu}$$

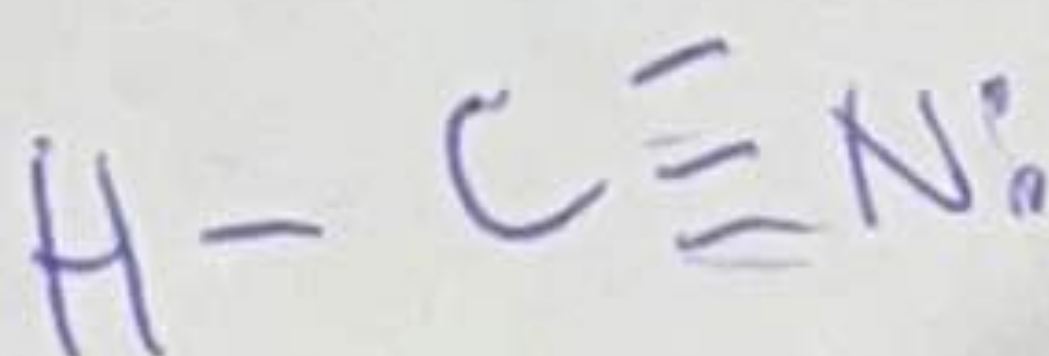
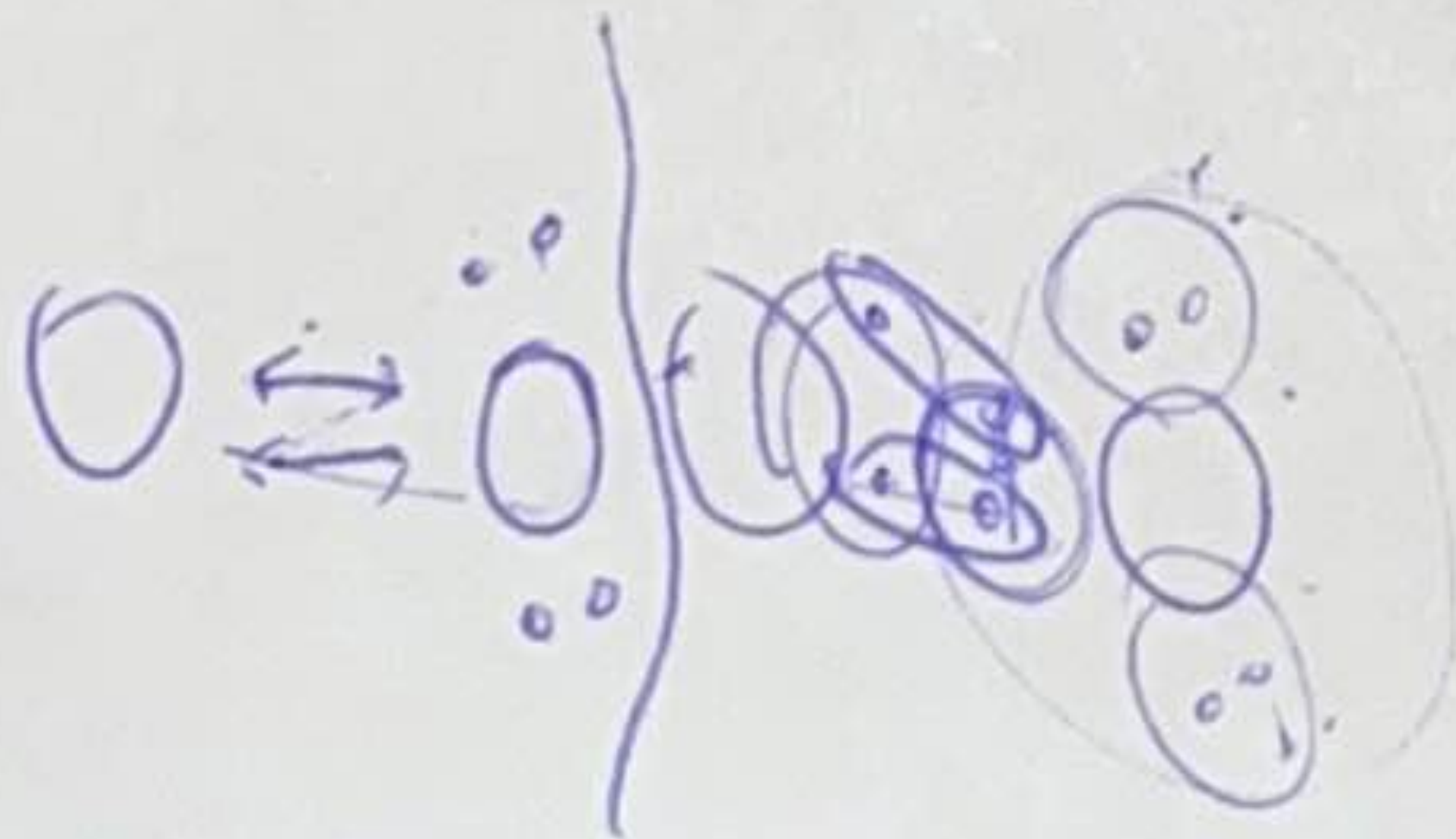
$$\nu = 4.47 \times 10^{14} \text{ Hz}$$

b. What is the energy of the photon?

$$E = h\nu$$

$$E = (6.626 \times 10^{-34}) (4.469 \times 10^{14})$$

$$E = 2.96 \times 10^{-19} \text{ J}$$



1264

2568

5. An electron in a hydrogen atom undergoes a transition from  $n = 6$  to  $n = 1$ .

You must show all your work to receive credit. **Circle your final answer.**

a. What is the energy of the photon involved?

$$E = -R_H \left( \frac{1}{n_f^2} - \frac{1}{n_i^2} \right)$$

$$E = (-2.179 \times 10^{-18}) \left( \frac{1}{1^2} - \frac{1}{6^2} \right)$$

$$E = -2.118 \times 10^{-18} \text{ J}$$

initial  
final

~~10~~

b. The photon is (circle one) ABSORBED or EMITTED.

6. What is the wavelength, in pm, of a NEUTRON when its velocity is 4.15 km/s?

You must show all your work to receive credit. **Circle your final answer.**

$$1 \text{ pm} = 10^{-12} \text{ m}$$

$$1 \text{ pm} = 1 \times 10^{-12} \text{ m}$$

$$\lambda = ?$$

$$V = 4.15 \text{ km/s} \quad 1 \text{ km} \rightarrow 1000 \text{ m}$$

$$4.15 \times 1000 = 4150 \text{ m/s}$$

$$\lambda = \frac{h}{mv}$$

$$\lambda = \frac{h \text{ (Js)}}{mv \text{ (kg m/s)}}$$

$$m_{\text{neutron}} = 1.6749286 \times 10^{-27} \text{ kg}$$

$$\lambda = \frac{6.6260755 \times 10^{-34}}{(1.6749286 \times 10^{-27})(4150)}$$

$$= 9.53 \times 10^{-11} \text{ m}$$

↓ not final answer

$$= 95.3 \text{ pm}$$

atomic right to left increasing  
top to bottom increasing

7. Circle the correct answer for each of the following:

- a. Circle the element with the largest atomic radius: F, S, Cl
- b. Circle the element with the smallest atomic radius: F, S, Cl
- c. Circle the element with the largest ionization energy: Ne, Li, F, B
- d. Circle the element with the smallest ionization energy: Ne, Li, F, B
- e. Circle the element that forms the more stable -1 ion: Cl or S
- f. Circle the element with that forms the more stable -1 ion Se or K

15

8. Label each of the following as ground state (GS), excited state (ES) or not allowed (NA). Briefly explain your answer for any ES or NA (be sure to include quantum numbers in your answer)

a.  $1s^2 2s^1 2p^2$

Not allowed because  $\checkmark$  subshell can hold only max 6 electrons

b.  $1s^2 2d^2$

Not allowed  $\rightarrow$  There is no 2d subshell, because  $l$  is  $n-1$ , and  $l$  is always a 2 for d shells but that cannot work here, as  $2-1$  would be 1, and  $l$  could only be max of 1

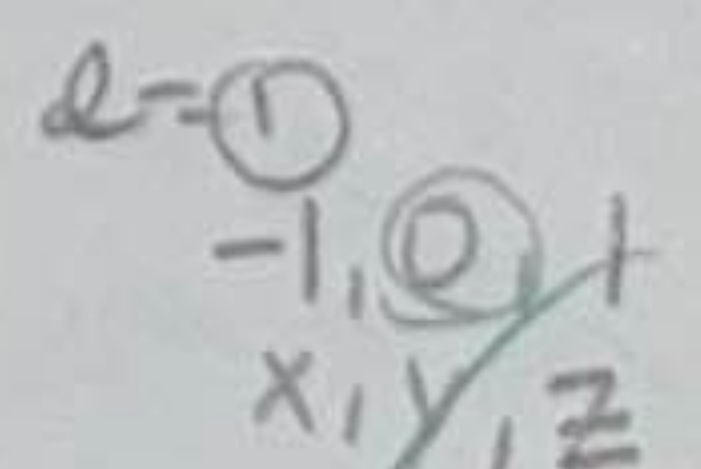
c.  $n=3, l=3, m_l=2, m_s=0$

$l$  is always  $n-1$ , so  $l$  and  $n$  cannot possess the same number.  $l$  would be a max of  $3-1$ , or 2

d.  $n=2, l=1, m_l=0, m_s=-1/2$

Allowed

It is a  $2p_x$  subshell



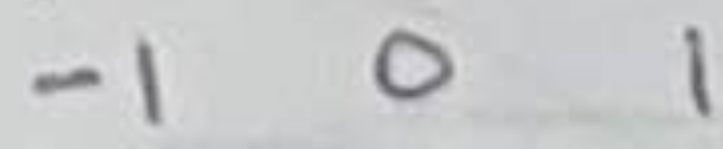
ground state  $\rightarrow 2p_x$

e.  $n=2, l=1, m_l=1, m_s=-1/2$

Allowed

It is a

$2p$  subshell again, it is  $2p_z$



$2p_x 2p_y 2p_z$

ground state

$n=2$   
 $l=1 \rightarrow p$   
 $2p_z$