Chemistry Pretest 3.3

(Due to the large amount of advanced material that we have been covering, the test will be structured exactly like this pretest. Only the examples will change. So, in other words, question 1 on the test is also about calculating Bohr transitions; question 5 is about quantum numbers; question 10 is about getting the voltage; and it'll feature the same type of flashbacks)

red 620–750 nm
orange 590–620 nm
yellow 570–590 nm
green 495–570 nm
blue 464–495 nm
indigo 450 - 464 nm
violet 400–450 nm

1. Use Bohr's equation to find the color corresponding to an n = 3 to n = 2 transition in a hydrogen atom.

$$\Delta E = -2.178 \times 10^{-18} J \left(\frac{Z^2}{{n_f}^2} - \frac{Z^2}{{n_i}^2} \right)$$

Answer: $_1H$: Z = 1 = atomic number

$$\Delta E = -2.178 \times 10^{-18} J \left(\frac{1^2}{2^2} - \frac{1^2}{3^2} \right)$$

= - 3.01 X 10^{-19} J

E = hν

ν = E/h = 3.01 X 10^{-19} J/ 6.626 X 10^{-34} Js = 4.565 X 10^{14} s^{-1}

λν = c

λ= c / ν = (3.00 x 10^8m/s) /(4.565 X 10^{14} s^{-1}) = 6.57 X 10^{-7} m

6.57 X 10^{-7}m *10^9nm/m = 657 nm = red.

2. a) Is there a wave-particle duality for both light and matter?
   Yes, the behaviour of neither light nor small particles like electrons can be fully explained if we regard them solely as waves or particles.
   b) In explaining the photoelectric effect, is light viewed regarded as being a particle? Or a wave?
   It's viewed as a photon with particle-like properties but still having a frequency associated with it.

3. The following table reveals the longest wavelength that can induce the photoelectric effect for various metals.

Surface	Wavelength (nm)
Sodium	491
Zinc	270
Copper	248

Surface	Wavelength (nm)
Platinum	185
Calcium	397

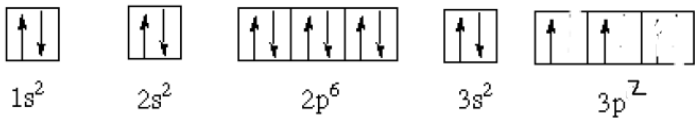
a) The wavelength needed for the photoelectric effect is not *exactly* related to the atom's ability to act as a reducing agent (because the ion formed after an electron pops out is not aqueous). But if you had to base your decision just on this data, which metal is the worst reducing agent?

Pt. (It has the shortest possible wavelength corresponds to the *longest* possible frequency ($\nu = c / \lambda$), meaning it needs the most energy. The more energy one needs to make an electron pop out, the harder it is for it to act as a reducing agent, which has to lose electrons in order to reduce something else.)

b) Will a photoelectric effect occur for sodium if we use a bright yellow light?

No. Yellow light has a wavelength range of 570 to 590 nm. That's longer than maximum of 491. Brightness won't help. If the frequency was energetic enough, the brightness would only make more photons pop out; it would not make the outcoming electrons more energetic.

4. Write the complete (using boxes) electron configuration for silicon.



5. Give the 14 sets of quantum number-quartets for each of Si's electrons

For $1s^2$: 1,0,0, +1/2 and 1,0,0, -1/2

For $2s^2$ 2,0,0, +1/2 and 2,0,0, -1/2

For $2p^6$ 2,1,-1, +1/2 2,1,0, +1/2 2,1,1, +1/2 and then 2,1,-1, -1/2 2,1,0, -1/2 2,1,1, -1/2

For $3s^2$ 3,0,0, +1/2 and 3,0,0, -1/2

For $3p^2$ 3,1,-1, +1/2 3,1,0, +1/2 (-1and 0 indicate different p orbitals, but both have +1/2 spin)

6. What is the maximum number of electrons held with a principal quantum number of n = 3? Maximum = $2n^2 = 2(3)^2 = 18$.

7. Balance the following redox reaction occurring in a ***basic*** solution by means of the half reaction method.

$S^{-2} + NO_3^{-1} \rightarrow NO_2 + SO_2$

$4OH^{-1} + S^{-2} \rightarrow SO_2 + 6e^- + 2\ H_2O$

$NO_3^{-1} + 1e^- + H_2O \rightarrow NO_2 + 2\ OH^{-1}$

Sum:

$S^{-2} + 6\ NO_3^{-1} + 4\ H_2O \rightarrow SO_2 + 6\ NO_2 + 8\ OH^{-1}$

8. In the third world, people were inadvertently poisoned by wells created near natural deposits of arsenic. After continuously drinking water with up to 4 ppm (4 mg per litre; maximum recommended amount is 0.01 ppm) people's skin erupted in disfiguring, leprosy-like lesions. Years later, cancerous growths began to appear. The Indian government then issued chlorination tablets that oxidized the arsenic from AsO_3^{-3} to AsO_4^{-3}, which formed an insoluble salt with Fe^{+3} found in water.
Source: Emsley, John. Nature's Building Blocks. Oxford Press. 2001

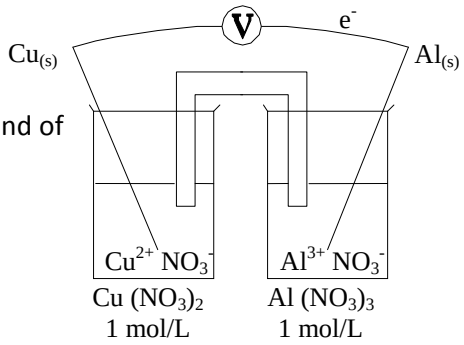
If the tablets contain ClO_3^{-1}, which of the following is the reducing agent: ClO_3^{-1} ? Or AsO_3^{-3} ?

Justify your choice.

AsO_3^{-3} is the reducing agent because As is oxidized from +3 to +5 as it loses electrons to the oxidizing agent, ClO_3^{-1}.

9. What is the periodic table's strongest oxidizing agent?

F



10. a)Indicate the direction of motion of the electrons in the wire and of the ions in the salt bridge;

b) Calculate the potential difference of the cell.

$2 \times (Al_{(s)} \rightarrow Al^{3+}_{(aq)} + 3e^-)$ $E° = 1.66$ V

$3 \times (Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu_{(s)})$ $E° = 0.34$ V

$2\ Al_{(s)} + 3\ Cu^{2+}_{(aq)} \rightarrow 2\ Al^{3+}_{(aq)} + 3\ Cu_{(s)}$ $E° = 2.00$ V

Do (b) first:

1) Electron flow

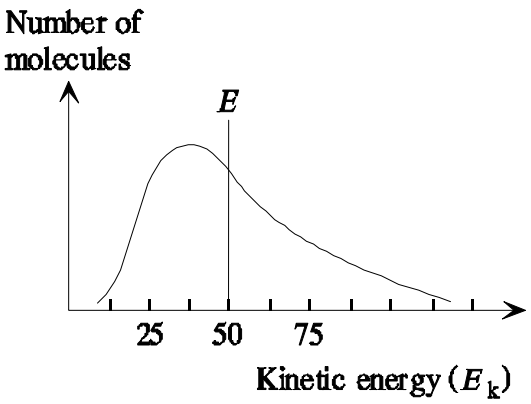
$Al_{(s)}$ electrode $\rightarrow$ $Cu_{(s)}$ electrode

2) Motion of the ions

Cations(+)the salt-bridge move towards cathode $Cu_{(s)}$ while anions(-) move towards the anode.

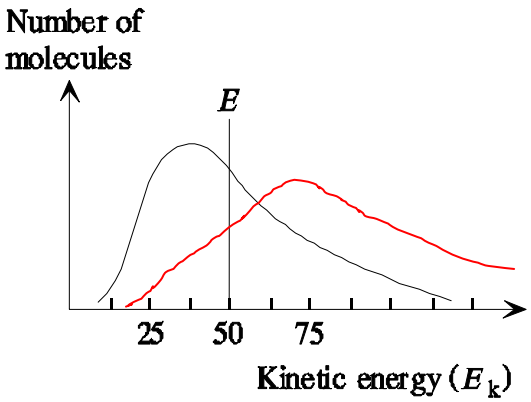
11. Given the system $A + B \rightarrow C + D$

The energy distribution graph for a given reaction is shown on the right.



Draw the distribution graph below showing the effect of an increase in temperature on the rate of this reaction.

Red curve is at a higher temperature, Notice the Ae does not change, but the average kinetic energy (middle of the curve is higher than the original)



12. A bathtub contained 200.0 kg of water. The water's temperature increased from 20.4 to 38.4 °C when it absorbed the heat from the combustion of 420.0 g of C_3H_6 . Find the molar ΔH for the combustion of

C_3H_6. Respect units, your 86 billion neurons (estimate based on average*) and significant figures.
c for water = 4.19 J/(g^{o}C)

(Ans: ΔH = - 1.51 X 10^3 kJ/mole; first get Q, change sign and then divide by moles of C_3H_6 . careful with kg)

*The method involves dissolving the cell membranes of cells within a brain from a donor and creating a homogeneous mixture of the whole lot. You then take a sample of the soup, count the number of cell nuclei belonging to neurons (as opposed to other cells in the brain such as glia) and then scale up to get the overall number. The great advantage of this method is that unlike counting the number of neurons in one part of the brain and then extrapolating from that, it gets over the problem that different brain regions may have more or less densely packed neurons.