2.4: UV-Visible Spectroscopy- Solutions.

Exercise 2.1.1

You observe a colored object. Estimate the wavelength of light that was absorbed by the object.

a) 700 nm (just an estimate, but maybe somewhere between 620 and 750 nm)

b) 425 nm c) 540 nm d) 580 nm

Exercise 2.1.2:

a) 590 nm b) 400 nm c) 500 nm d) 300 nm

Exercise 2.1.3

a) 590 nm (strong); that's all b) 400 nm (strong); 600 nm (weak)

c) 500 nm (strong); 350 nm (weak) d) 300 nm (strong); 450 nm (weak)

Exercise 2.1.4

Remember, here we are observing the photons directly, rather than the onew complementary to the absorbed photons.

copper > barium > sodium > calcium > lithium

Exercise 2.2.1:

a. 270 nm (strong, MLCT); 500 nm (weak, d-d)
b. < 200 nm* (very strong, MLCT); 275 nm (strong, MLCT); 400 nm (weak, d-d) *can't see exactly where because the peak is so tall that we can't see the top
c. < 200 nm* (very strong, MLCT); 275 nm (strong, MLCT); 660 nm (weak, d-d)
d. < 250 nm (strong, MLCT); 300 nm (strong, MLCT); 620 nm (weak, d-d)

Exercise 2.2.2:

a. absorbs blue-green; we see orange-red
b. absorbs violet; we see yellow
c. absorbs red; we see green
d. absorbs orange; we see blue

Exercise 2.2.3:

a) $A = \varepsilon cl = 14 L g^{-1} cm^{-1} \times 0.025 g L^{-1} \times 1 cm = 0.35$

a) $A = \varepsilon cl = 14 L g^{-1} cm^{-1} \times 0.011 g L^{-1} \times 1 cm = 0.15$

Exercise 2.2.4:

a. $A = \varepsilon cl \; or \; c = \frac{A}{\varepsilon l} = \frac{0.75}{14 L g^{-1} cm^{-1} \times 1 cm} = 0.054 g L^{-1}$
b. $A = \varepsilon cl \; or \; c = \frac{A}{\varepsilon l} = \frac{0.21}{14 L g^{-1} cm^{-1} \times 1 cm} = 0.015 g L^{-1}$

Exercise 2.2.5:

Based on our color wheel it absorbs both yellow and green; we see a mix of violet and red. ($KMnO_4$ is really a deep purple.)

Exercise 2.2.6:

$KMnO_4$ has MW = 158 g mol^{-1}

$$14 \frac{L}{g \, cm} \times 158 \frac{g}{mol} = 2212 \frac{L}{mol \, cm}$$

Exercise 2.2.7:

a) $A = \varepsilon cl = 2200 L mol^{-1} cm^{-1} \times 0.00015 mol L^{-1} \times 1 cm = 0.33$

b) $A = \varepsilon cl = 2200 L mol^{-1} cm^{-1} \times 0.00009 mol L^{-1} \times 1 cm = 0.20$

Exercise 2.2.8:

a. $A = \varepsilon cl \; or \; c = \frac{A}{\varepsilon l} = \frac{0.47}{2200 L mol^{-1} cm^{-1} \times 1 cm} = 2.1 \times 10^{-4} mol L^{-1}$

b. $A = \varepsilon cl \; or \; c = \frac{A}{\varepsilon l} = \frac{0.89}{2200 L mol^{-1} cm^{-1} \times 1 cm} = 4.1 \times 10^{-4} mol L^{-1}$

Exercise 2.3.1:

a) blue b) orange

Exercise 2.3.2:

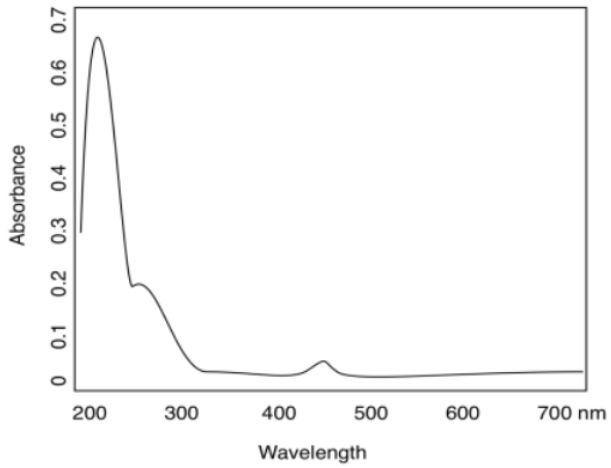
Add another 30 or 40 nm and you get to 270 or 280 nm.

Exercise 2.3.3:

a) about 250 nm b) about 280 nm

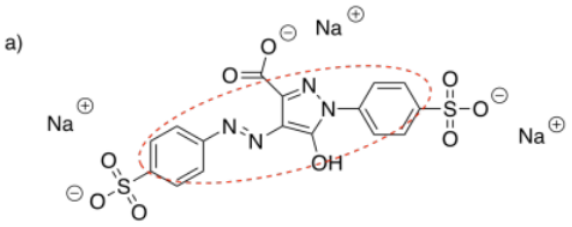
Exercise 2.3.4:

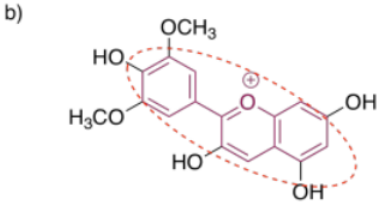
a)

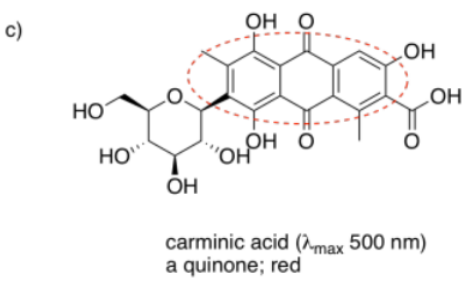


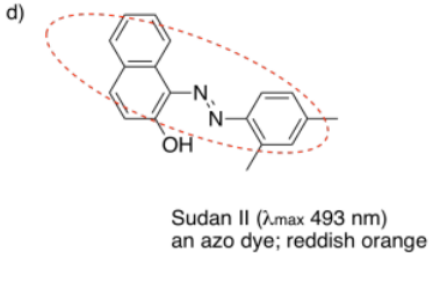
b) yellow

Exercise 2.3.5:

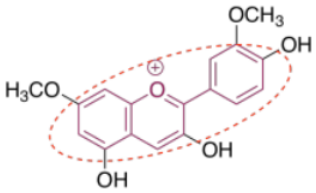






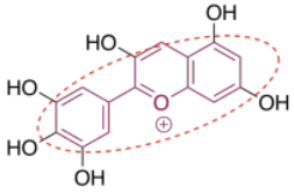


e)



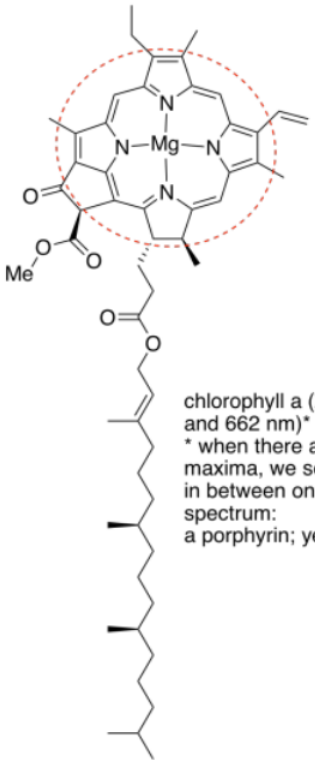
rosinidin (λ_{max} 524 nm)
an anthocyanin; red

g)



delphinidin (λ_{max} 544 nm)
an anthocyanin; purplish-red

f)



chlorophyll a (λ_{max} 430 and 662 nm)*
* when there are two maxima, we see the light in between on the spectrum:
a porphyrin; yellow-green