P13. In photography, aperture, shutter speed, and ISO are control variables to image exposure. Larger aperture allows more exposure. So does slower shutter speed. Larger ISO also does a similar effect, but with a grainier image. In addition, they all affect other aspects, e.g., depth of field (how farther away from camera an object still appear sharp in the image), overall image sharpness, sharpness of moving objects, overall brightness of an image, etc. Apertures may come in f/1.4, f/2, f/2.8, f/4, f/5/6, f/8, f/11, f/16, f/22. Since the number comes with f/, it is called f_{number}. Long story short: smaller f-number, larger aperture. For each step of the f-number goes up, the size of an aperture area goes down by half. Notice that f-number goes up by a squared root of 2. See the illustration below. Shutter speed may come in 1/4, 1/8, 1/15, 1/30, 1/60, 1/125, 1/250, 1/500, 1/1000, 1/2000, 1/4000. The numbers go from slowest to faster, 1/4 is the slowest and 1/4000 is the fastest. Each step gets twice as fast. ISO is the sensitivity of the sensor. The higher number, the more sensitive (picking up light better). ISO may come in 100, 200, 400, 800, 1600, 3200. ISO 100 is least sensitive. ISO 200 is double sensitive of ISO 100, and so on.

Given Aperture in f/1.4, f/2, f/2.8, f/4, f/5.6, f/8, f/11, f/16, f/22; Shutter speed in 1/4, 1/8, 1/15, 1/30, 1/60, 1/125, 1/250, 1/500, 1/1000, 1/2000, 1/4000, and ISO in 100, 200, 400, 800, 1600, 3200, write a function named cam_expos to take a "neutral setting" as a list of [f-number, shutter speed, and ISO] and a photographer's setting, also as a list of [f-number, shutter speed, and ISO], find out the difference in each variable, as well as the overall exposure, and return the finding in tuple. For example, camera may suggest [f/2.8, 1/500, 400]. A photographer chooses [f/5.6, 1/125, 200]. Then, the photographer choice is −2 +2 −1 = −1 (or 1 stop under neutral exposure).

Hint: (1) see list methods for ones that could be handy; (2) a tuple is similar to a list, just (...) instead of [...].

Example

When invoke by

```
res = cam_expos(['f/2.8', '1/500', '400'], ['f/5.6',
'1/125', '200'])
print(res)
```

it results

```
==========================================
(-2, 2, -1, -1)
==========================================
```

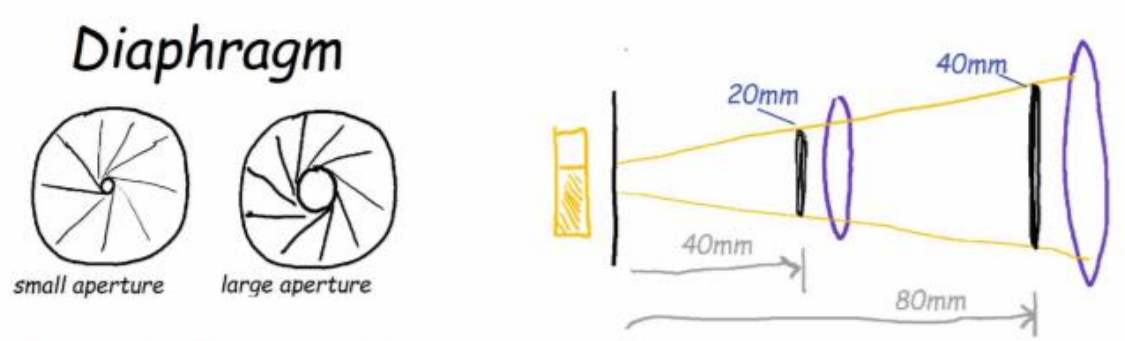
Example

When invoke by

```
res = cam_expos(['f/2.8', '1/500', '400'], ['f/1.4',
'1/60', '100'])
print(res)
```

it results

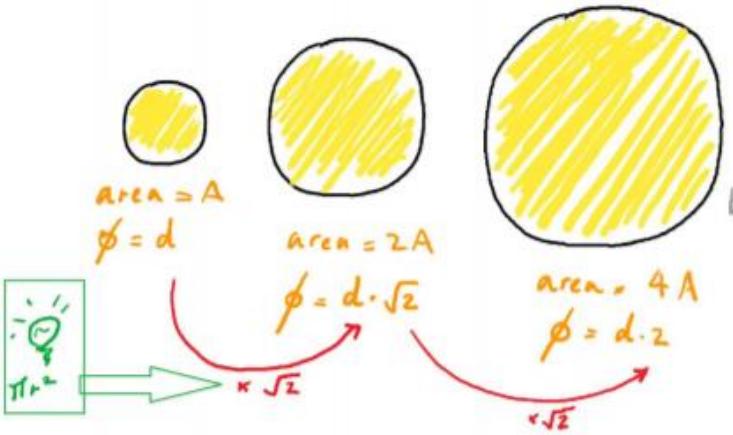
```
==========================================
(2, 3, -2, 3)
==========================================
```



Not only the size of diameter of the diaphragm, a focal length of the lense also plays a role. In short, a ratio between a focal length and a diameter determines an amount of light to the sensor.

$$\frac{f}{\phi} = \frac{40}{20} = 2 = \frac{80}{40}$$

$$\therefore \frac{f}{\phi} = x \Rightarrow \phi = \frac{f}{x}$$



E.g. $\phi_1 = \frac{f}{4}$

$\phi_2 = \sqrt{2}\frac{f}{4} = \frac{f}{2.8}$