Team 3 ? W

Today: Exposure
GW report due Weds, to both FV.org and in canvas. Team First critique starts W. Will split
Weds and Fri. Teams 1-5 here, Teams 6-9 in HP Breakout W, DLC Collab (1B70) on F
Camera HW due tonight in Canvas.

4. EXPOSURE
   For a given light intensity, exposure = Total photons hitting the sensor: (aperture area) X
   (time shutter is open)
   Shutter speeds: 30 = 1/30th of a second etc.
                   5 = 1/5th of a second
                   30" = 30 seconds
                   T = time, click to open shutter and again to close
                   B = bulb, shutter stays open as long as button is pressed (or bulb is squeezed)

   Check your camera shutter speed options. What is the range? $\frac{1}{4000}$ $\frac{1}{2000}$ $\frac{1}{8000}$ $\frac{1}{23,000}$
   Tv or S = Time priority; you set the shutter speed and ISO, camera AE will choose the aperture.
   Av = aperture priority. You choose the aperture, camera will choose shutter speed.

Equivalent exposures: f/5.6, 1/100 sec
                      f/8, 1/50 sec
                      f/11, 1/25 sec

The effect of those photons depends on the sensor (CCD, CMOS etc) that converts photons
into a number (or three, RGB) for each pixel
   ISO = sensor sensitivity, gain
   1 EV = 1 stop = factor of 2 in ISO
   100 200 400 800 / 1600   3200   6400 | 12800   25000
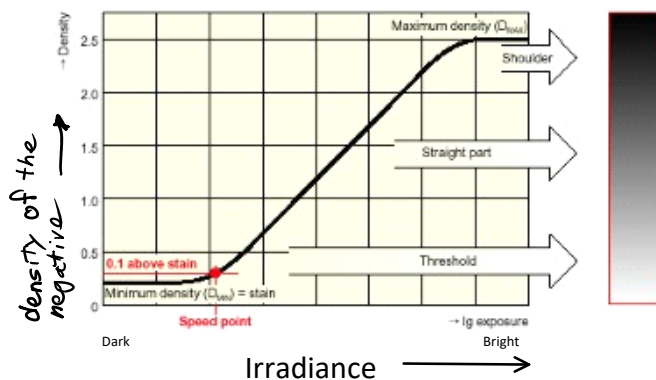   What is the highest ISO your camera has?
 25,600   6400   H
   Used to be called ASA for film.
   From American Standards Association (now named ANSI)

   ISO = International Organization for Standardization

Fixing the speed (B/W)

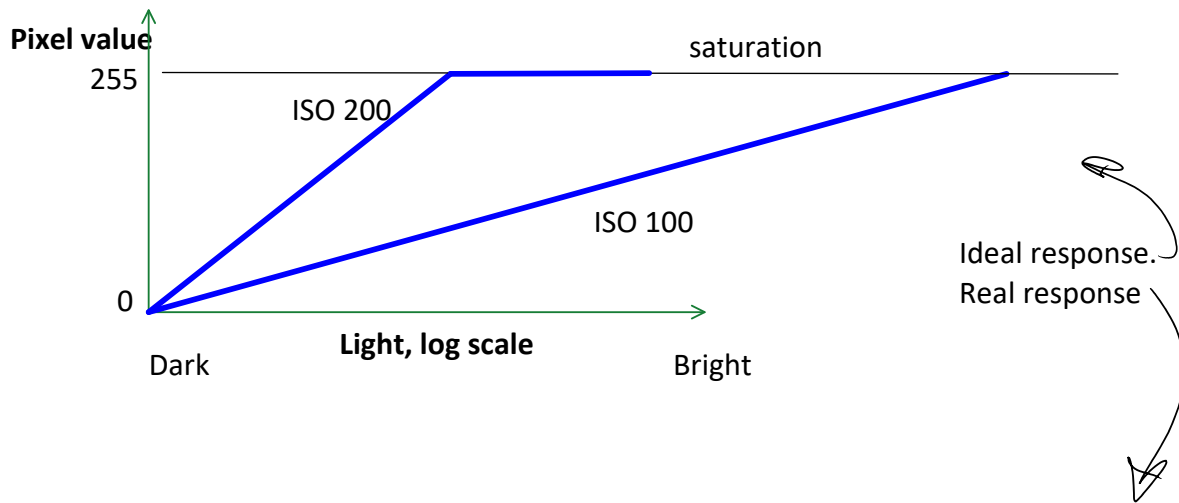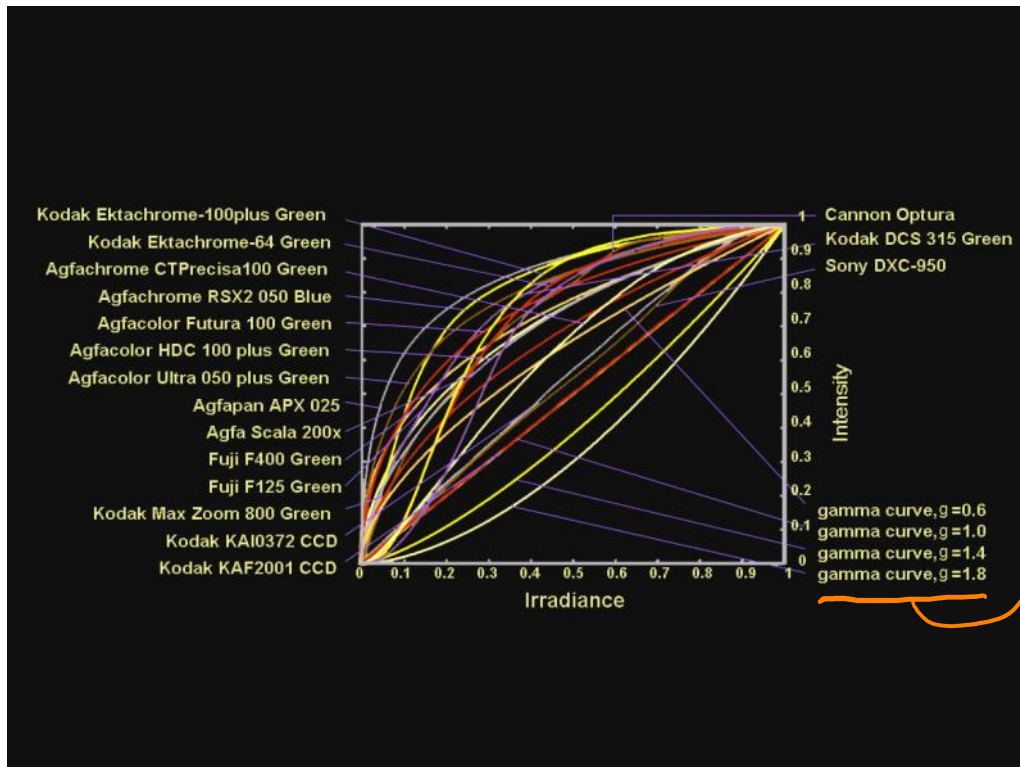Irradiance ⟶

http://www.sapiens.itgo.com/documents/foto/
photographic_terms8.htm

1. Have you been taught to count in binary or base 8 or 16? When?
2. What is a pixel? What is it made of (for software purposes)?

2019   18 in college
       7 in K-12
       3 never

Pixel value
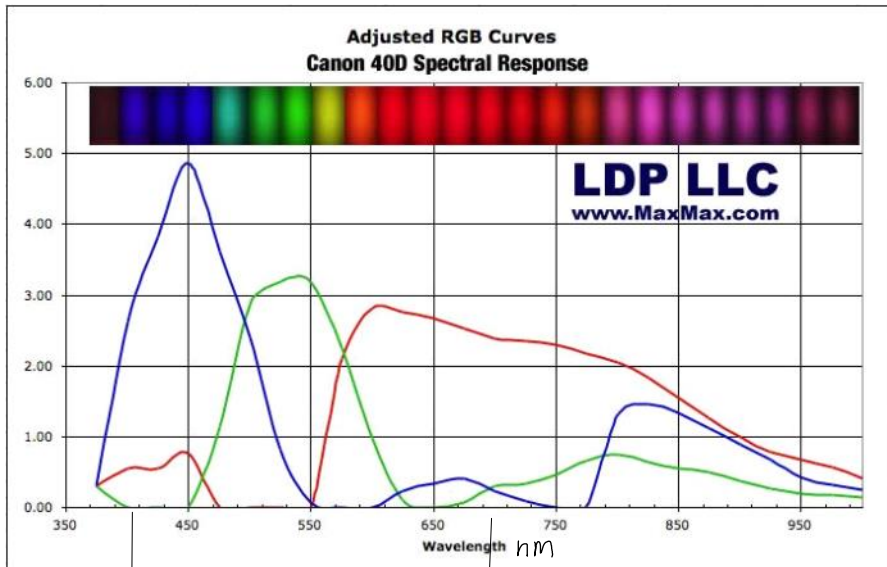255 ─────────────────────── saturation ───────────
        ISO 200
                          ISO 100
                                          Ideal response.
                                          Real response
0
  Dark   **Light, log scale**   Bright

Digital camera response database

http://www.cs.columbia.edu/CAVE/projects/rad_cal/

Kodak Ektachrome-100plus Green
Kodak Ektachrome-64 Green
Agfachrome CTPrecisa100 Green
Agfachrome RSX2 050 Blue
Agfacolor Futura 100 Green
Agfacolor HDC 100 plus Green
Agfacolor Ultra 050 plus Green
Agfapan APX 025
Agfa Scala 200x
Fuji F400 Green
Fuji F125 Green
Kodak Max Zoom 800 Green
Kodak KAI0372 CCD
Kodak KAF2001 CCD

Cannon Optura
Kodak DCS 315 Green
Sony DXC-950

Intensity

Irradiance

gamma curve, g = 0.6
gamma curve, g = 1.0
gamma curve, g = 1.4
gamma curve, g = 1.8

On other end, brightness of screen for a given pixel value

Adjusted RGB Curves
Canon 40D Spectral Response

http://www.maxmax.com/spe

Adjusted RGB Curves
Canon 40D Spectral Response

LDP LLC
www.MaxMax.com

Wavelength *nm*

FLIR in ITLL

TIC

Human spectral sensitivity to color
Three cone types (ρ, γ, β) correspond *roughly* to R, G, B.

Blue Cyan Green Red
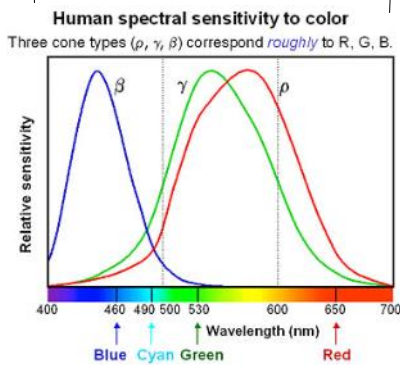
Don't worry, images come from camera with
compensation done automatically (mostly);
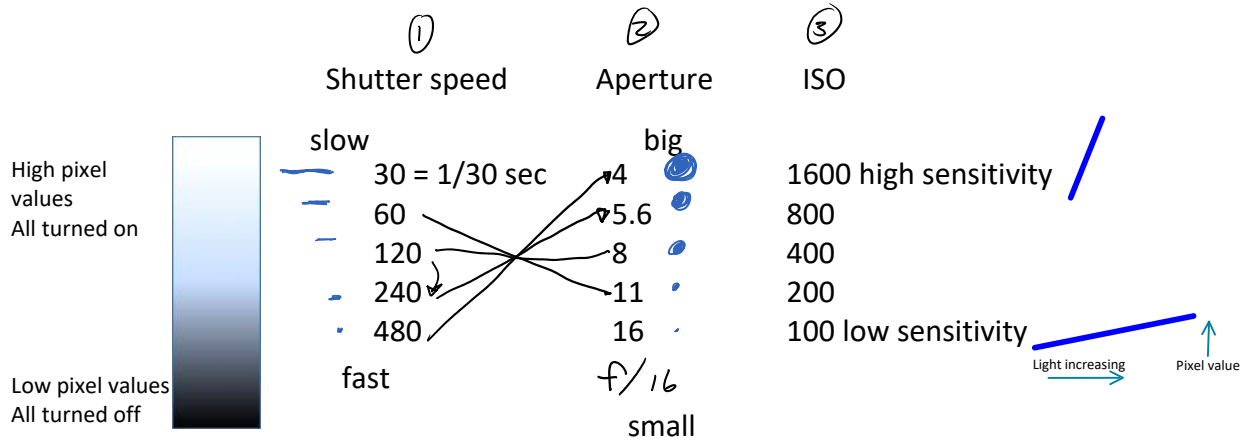color management again.

Same image density f/5.6, 1/100 sec, ISO 200
f/8, 1/100 sec, ISO 400
f/4, 1/200 sec, ISO 400

Used to be hard to change sensitivity , ISO: change film or go into menus.
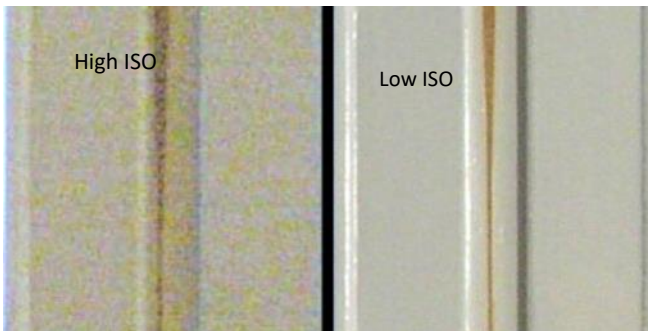Now is becoming easier; single button or thumbwheel select.

Check your camera ISO settings. How easy to change?

Proper exposure = middle value on an average pixel

3 ways to control pixel values so far

① Shutter speed ② Aperture ③ ISO

High pixel values All turned on	slow 30 = 1/30 sec 60 120 240 480 fast	big 4 5.6 8 11 16 f/16 small

1600 high sensitivity
800
400
200
100 low sensitivity

Light increasing → ↑ Pixel value

Low pixel values
All turned off

Other implication of ISO: Noise

High ISO   Low ISO

http://en.wikipedia.org/wiki/Image_noise#Low_and_high-ISO_noise_examples

$$$$ in camera buys less noise at high ISO

Autoexposure programs (AE)

Wide variety. Stay away if you can.

Semi -automatic programs are better.

Av = aperture priority. You choose the aperture, camera will choose shutter speed. ISO might be automatic too.

Tv = Time priority; you set the shutter speed and ISO, camera AE will choose the aperture.

M = Manual (maybe). You choose both aperture and shutter speed. Meter will tell you if exposure is OK.
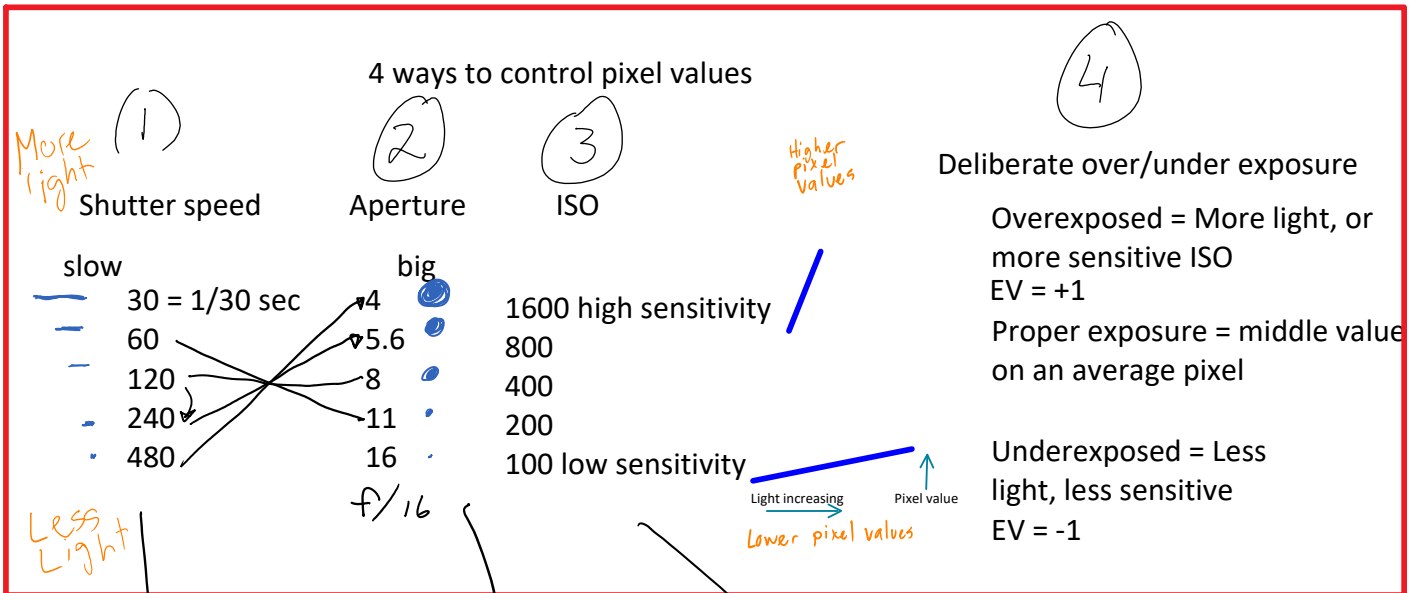
±   to set over/under exposure

Lighten image, overexpose compared to AE suggestion +++
Darken, underexpose compared to AE, -----

⭐ Does your camera have a +/- button?

4 ways to control pixel values

More light ①
Shutter speed ② **Aperture** ③ **ISO** ④

④ **Deliberate over/under exposure**

Higher pixel values

slow   big

──	30 = 1/30 sec	4
──	60	5.6
──	120	8
╴	240	11
·	480	16

f/16

1600 high sensitivity
800
400
200
100 low sensitivity

Overexposed = More light, or more sensitive ISO
EV = +1
Proper exposure = middle value on an average pixel

Underexposed = Less light, less sensitive
EV = -1

Light increasing   Pixel value
Lower pixel values

Less Light

Minute paper, in groups: List the side effects of each method, beyond the effect on exposure. Set a goal, want high pixel value for dim fluorescence:

Motion Blur   **DOF**   **NOISE**

Shutter speed: motion blur at slow speeds
Aperture: low depth of field at large aperture. Diffraction will reduce sharpness at small apertures
ISO: Noise at high ISO
Deliberate under/over: Camera will change one or more of the other three settings, with attendant side effects. With underexposures, get loss of detail in shadows. Worse, at high overexposure, lose detail in highlights.