

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

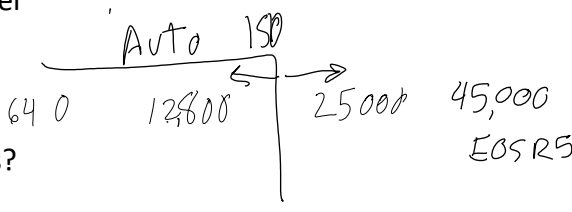
ISO = sensor sensitivity, gain

1 EV = 1 stop = factor of 2 in ISO

25 (100) 200 400 800 1600 3200

What is the highest ISO your camera has?

H



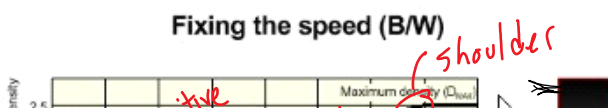
The ISO sensitivity of a digital sensor works in a slightly different way to film. A film rated at 200 ISO is physically different to a film rated at 800 ISO, whereas a digital sensor is the same regardless of the ISO setting used in the camera. All digital sensors have a base ISO setting but to achieve higher ISO settings the sensitivity of the sensor is increased.  
 The sensitivity of a camera sensor is increased in steps which correspond to ISO settings i.e. ISO 100, ISO 200, ISO 400, ISO 800 etc. The difference between ISO 100 and ISO 200 is that ISO 200 is twice as sensitive as ISO 100 (or 1 stop difference). This is also the same between ISO 200 and ISO 400 (1 stop difference).  
 When increasing a digital camera's ISO sensitivity by a large amount the sensor may perform slightly differently to the ISO standard for that ISO speed. Due to this we rename these settings as Hi 1, Hi 2 or Hi 3 instead of actually naming the sensors ISO setting. Whilst the camera is often performing at levels far past available film speeds, the performance of the sensor, in relation to how much light is needed to expose correctly, may differ by a very small amount to the level expected at that ISO setting.

From <[https://www.nikonimgsupport.com/na/NSG\\_article?articleNo=000027508&configured=1&lang=en\\_SG](https://www.nikonimgsupport.com/na/NSG_article?articleNo=000027508&configured=1&lang=en_SG)>

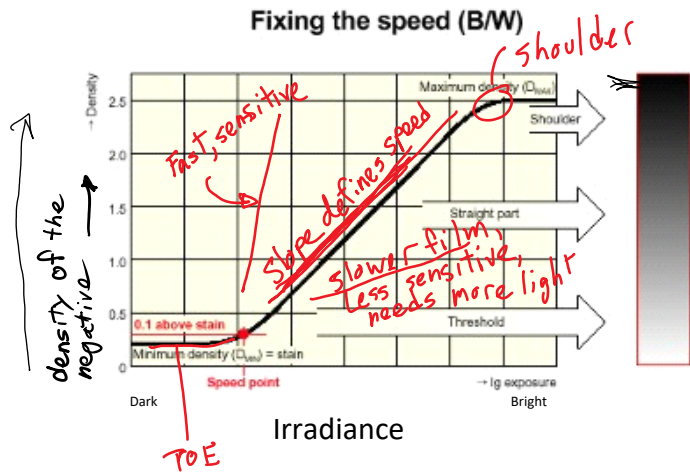
Used to be called ASA for film.

From [American Standards Association](http://www.ansi.org/) (now named [ANSI](http://www.ansi.org/))

ISO = International Organization for Standardization



[http://www.sapiens.itgo.com/documents/foto/photographic\\_terms.htm](http://www.sapiens.itgo.com/documents/foto/photographic_terms.htm)



[http://www.sapiens.itgo.com/documents/foto/photographic\\_terms8.htm](http://www.sapiens.itgo.com/documents/foto/photographic_terms8.htm)

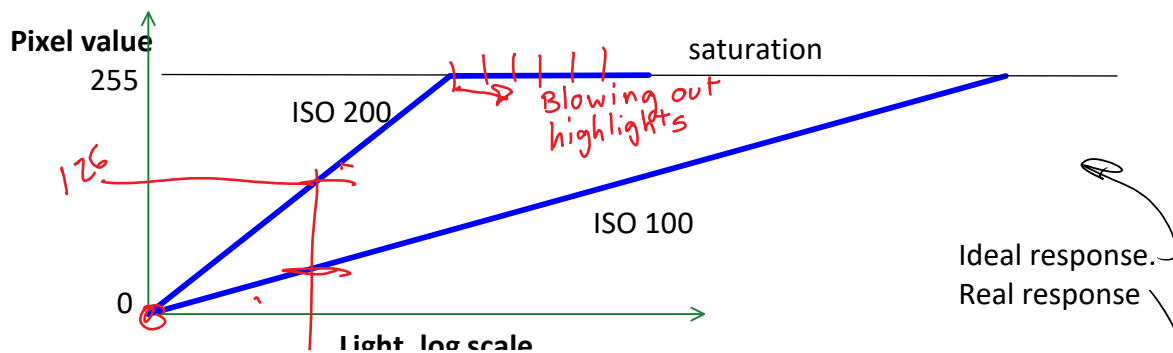
Have you been taught to count in binary or base 8 or 16? When?

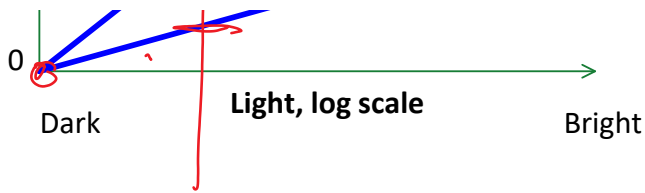
- 2 a) College math class
- 11 b) College computer science class
- 3 c) Other college class
- 6 d) K-12 school
- 2 e) never

What color does a pixel value of FF FF FF correspond to?

- 6 a) Black
- 9 b) White
- 1 c) Neutral gray
- d) Pure red
- 8 e) No idea

Y Y Y  
R G B  
ALL pixels on

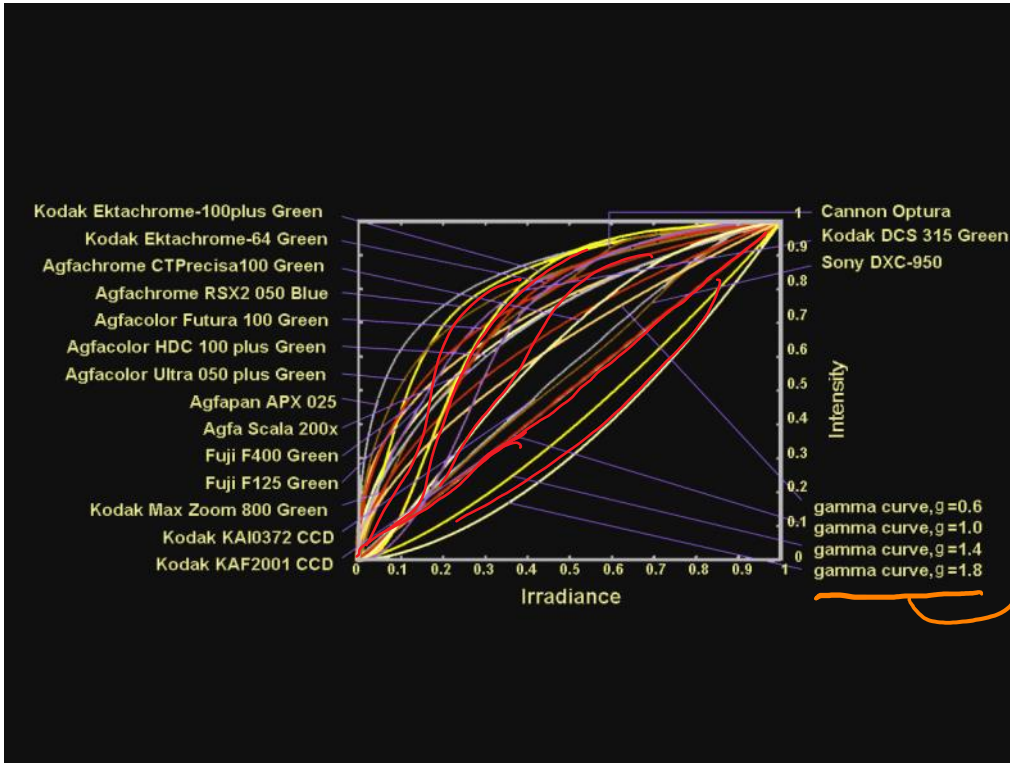




ideal response.  
Real response

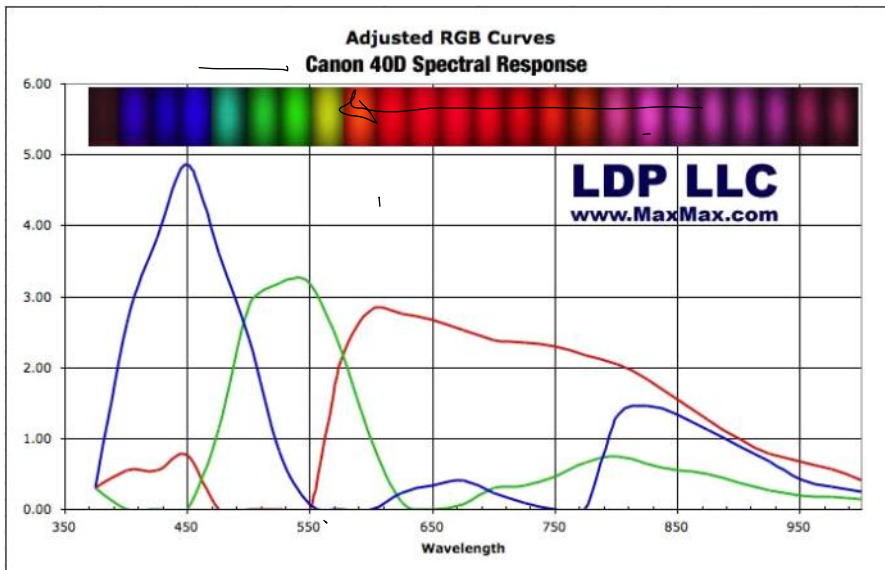


Digital camera response database




[http://www.cs.columbia.edu/CAVE/projects/rad\\_cal/](http://www.cs.columbia.edu/CAVE/projects/rad_cal/)

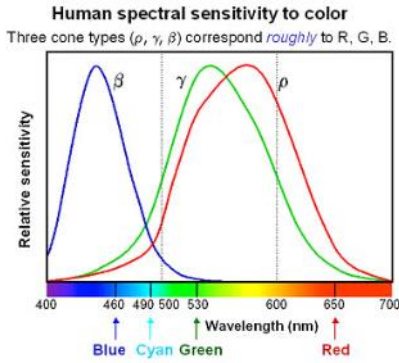
On other end, brightness of screen for a given pixel value



[http://www.maxmax.com/spectral\\_response.htm](http://www.maxmax.com/spectral_response.htm)

0-255 in each color channel  
  
 1 px

Px value  
 ↑



<http://pixinsight.com/forum/index.php?topic=2542.0>

Excellent book on how human eyes work, for nonspecialists: Livingstone, Margaret S. *Vision and Art: The Biology of Seeing*. Abrams, 2008.

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

or brightness  
 f/8, 1/100 sec, ISO 400  
 f/4, 1/200 sec, ISO 400

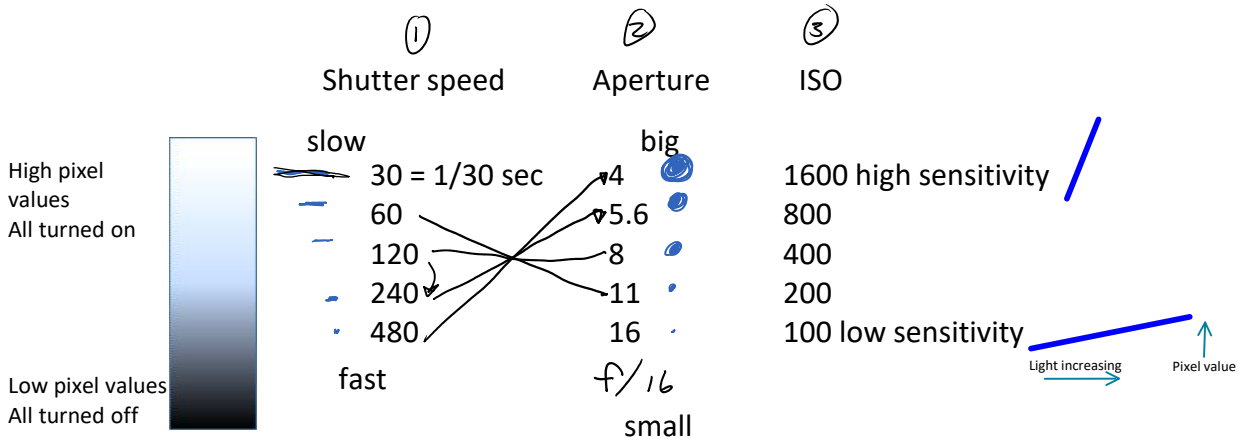
73% A - ISO BUTTON  
 25% B - Menu  
 5% C - Mysterious

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

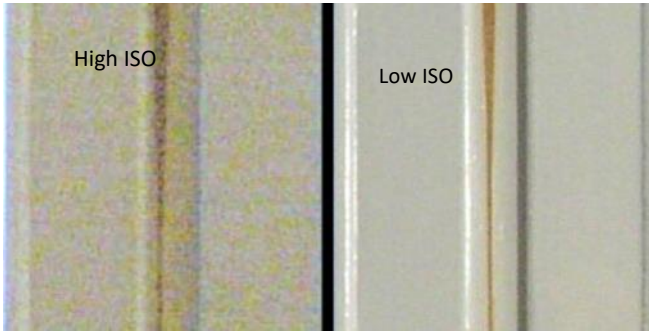
Check your camera ISO settings. How easy to change?

Proper exposure = middle value on an average pixel

3 ways to control pixel values so far



## Other implication of ISO: Noise



[http://en.wikipedia.org/wiki/Image\\_noise#Low\\_and\\_high-ISO\\_noise\\_examples](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.

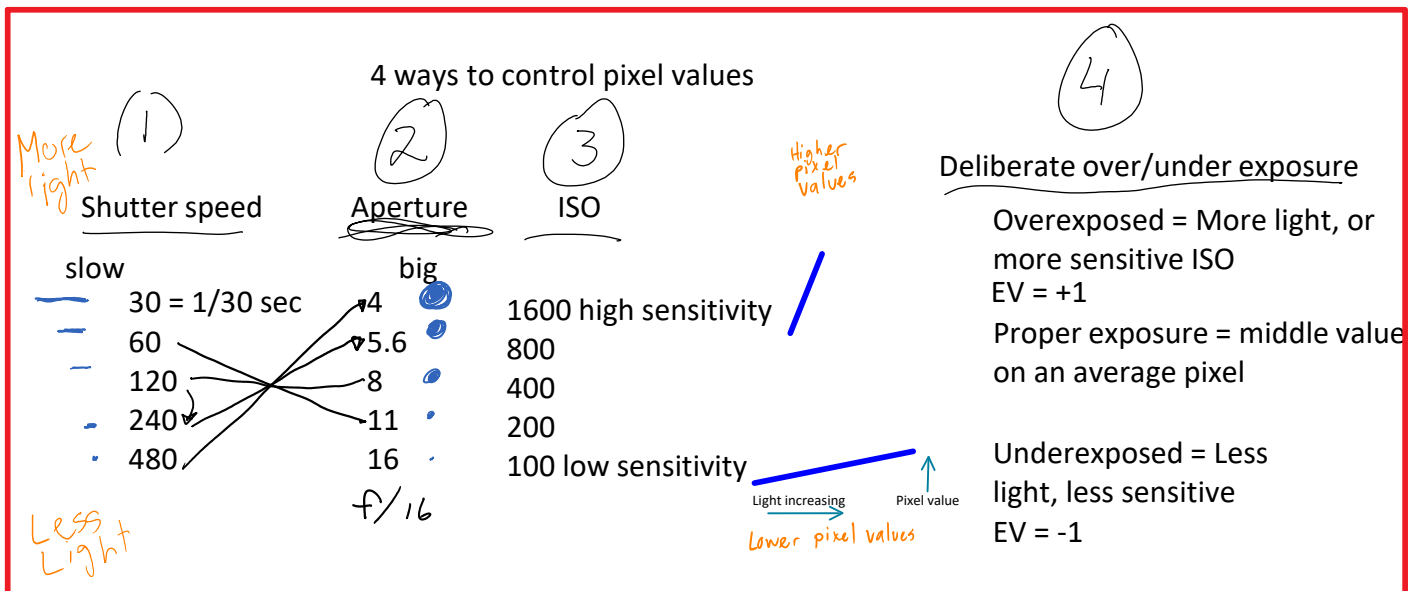


to set over/under exposure

Lighten image, overexpose compared to AE suggestion +++

Därken, underexpose compared to AE, ----

★ Does your camera have a +/- button?



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:

Side effects:

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.