Camerass

1. Why does a camera need a lens?
2. Why do most camera lenses need focusing?
3. Why are lenses telephoto or wide-angle?
4. Why do fancy lens's have internal apertures?
5. Why is a good camera lens so complex inside?

Question 1
Q: Why does a camera need a lens?
A: Lens bends rays from one point to one point.

An illuminated object reflects or scatters light
- The object's light produces diffuse illumination
- A converging lens bends light rays via refraction
  - Light rays spreading from a point converge to a point

Real Images
An image forms in space on far side of the lens
- The image is a pattern of light in space that exactly resembles the object, except for size and orientation
- The image is “real” – you can put your hand in it

Question 2
Q: Why do most camera lenses need focusing?
A: So that the real image forms on the image sensor.

The sensor records the pattern of light it receives
When focused, the real image forms on the sensor
**Focusing**

Distant object’s light diverges slowly
- Real image forms near to the lens

Nearby object’s light diverges quickly
- Real image forms far from the lens

A lens focuses light coming from one object distance at a time

If the object distance changes, the image distance also changes.

**Question 3**

Q: Why are lenses telephoto or wide-angle?
A: Lenses’ focal length (FL) determines image size

Focal length measures lens’s converging strength
- Long FL: long image distance, large dim image
- Short FL: short image distance, small bright image

**Question 4**

Q: Why do fancy lenses have internal apertures?
A: To vary image brightness and depth of focus

f-number is focal length divided by lens diameter
- f-number determines brightness of the image, regardless of focal length
- Small f-number: bright image, small depth of focus
- Large f-number: dim image, large depth of focus

Sophisticated lenses have adjustable f-numbers
- For low light, fast exposure, or small depth of focus: small f-number
- For bright light, long exposure, or large depth of focus: large f-number

**Question 5**

Q: Why is a good camera lens so complicated inside?
A: To allow zooming and to correct image flaws

Adjustable focal length allows for zooming
Different glasses fix dispersion-based color focus problems
Anti-reflection coatings reduce reflection-based fogging
Aspherical lens surfaces fix imperfections due to spherical surfaces
Coma correction fixes poor focusing off the central axis
Astigmatic correction fixes spherical focus on flat image sensor

**Zoom Lenses**

A zoom lens typically forms three images overall
- Its first lens group produces a real image
- Its second lens group projects a resized image
- Its third lens group projects an image onto the image sensor
Summary about Cameras

They use converging lenses to form real images
Lens focal length sets image size
Lens f-number sets image brightness
The image sensor records the pattern of light