Camera lenses explained

30mm · 50mm · f/1.8 · f/3.5

A detailed visual guide to focal length, aperture, depth of field and the physics behind the photograph.

> **Two different controls:** 30mm and 50mm describe focal length - how wide or tight the view is. f/1.8 and f/3.5 describe aperture - the relative opening that controls image illumination and influences depth of field.

A lens can be **30mm f/1.8**, **50mm f/1.8**, or another combination. Focal length and aperture are separate properties.

Inside this guide

How to read the examples

Unless stated otherwise, examples use a **36 × 24mm full-frame sensor**. Comparisons that keep camera position fixed are different from comparisons that keep the subject the same size in the frame.

The three generated image plates are qualitative teaching illustrations. Their framing and blur are not calibrated optical simulations. Use the equations and numerical tables for quantitative comparisons. A label correction is explicitly noted on the physics plate.

Read across: longer focal length gives tighter framing from the same position. **Read down:** stopping from f/1.8 to f/3.5 increases depth of field. Brightness is matched to isolate appearance; generated scene geometry and blur are illustrative.

What 30mm and 50mm mean

Focal length describes the optical system's focusing geometry. For a distant subject, it is the distance from the lens system's **rear principal plane** to the focused image. That plane is an optical reference and need not lie at the physical centre of the lens. A 50mm lens therefore does not have to be 50mm long. [1, 5]

On the same sensor, a shorter focal length captures a wider angle. A longer focal length captures a narrower angle and makes a distant subject larger in the image. On full frame, 30mm is moderately wide and 50mm is generally considered standard; category boundaries are approximate. [1]

Calculate the angle of view

For a conventional rectilinear lens focused at infinity, the horizontal angle of view is approximately:

$$\theta = 2 \operatorname{atan}(\text{sensor width} / (2f))$$

Focal length	Full-frame horizontal angle	Practical view
30mm	61.9°	Wider surroundings; smaller subject
50mm	39.6°	Tighter surroundings; larger subject

For distant subjects, image size increases approximately in proportion to focal length: **50 / 30 = 1.67**. A subject is therefore about 1.67 times larger in width and height with 50mm from the same position. Close focusing and lens design can modify this comparison.

Perspective comes from viewpoint

Photograph a face with 30mm, then switch to 50mm without moving. Framing tightens while perspective remains essentially the same. But if you move closer with 30mm to fill the frame with the face, the nose becomes proportionally larger relative to the ears.

Moving farther away with a longer lens reduces those relative distance differences. The familiar **telephoto compression** appearance therefore comes from the more distant viewpoint commonly used with a longer lens. Curved straight lines caused by lens distortion are a separate effect.

> Keep the comparison conditions explicit: **same position** tests framing; **same subject size** usually requires changing distance and therefore perspective.

Why f/1.8 is a larger opening

The f-number is a ratio between focal length and entrance-pupil diameter. The **entrance pupil** is the apparent aperture opening seen through the front optics. It is not necessarily the physical iris diameter and is unrelated to the filter-thread diameter. [2]

$$N = f / D \rightarrow D = f / N$$

N = f-number; f = focal length; D = entrance-pupil diameter. A smaller denominator gives a larger opening.

Setting	Calculation	Entrance pupil
30mm at f/1.8	30 / 1.8	16.7mm
30mm at f/3.5	30 / 3.5	8.6mm
50mm at f/1.8	50 / 1.8	27.8mm
50mm at f/3.5	50 / 3.5	14.3mm

Almost two stops more light

For the same scene and shutter speed, ideal illumination per unit sensor area is proportional to $1/N^2$. Real lenses lose some light through absorption and reflection.

$$\text{Light ratio} = (3.5 / 1.8)^2 = 3.78$$

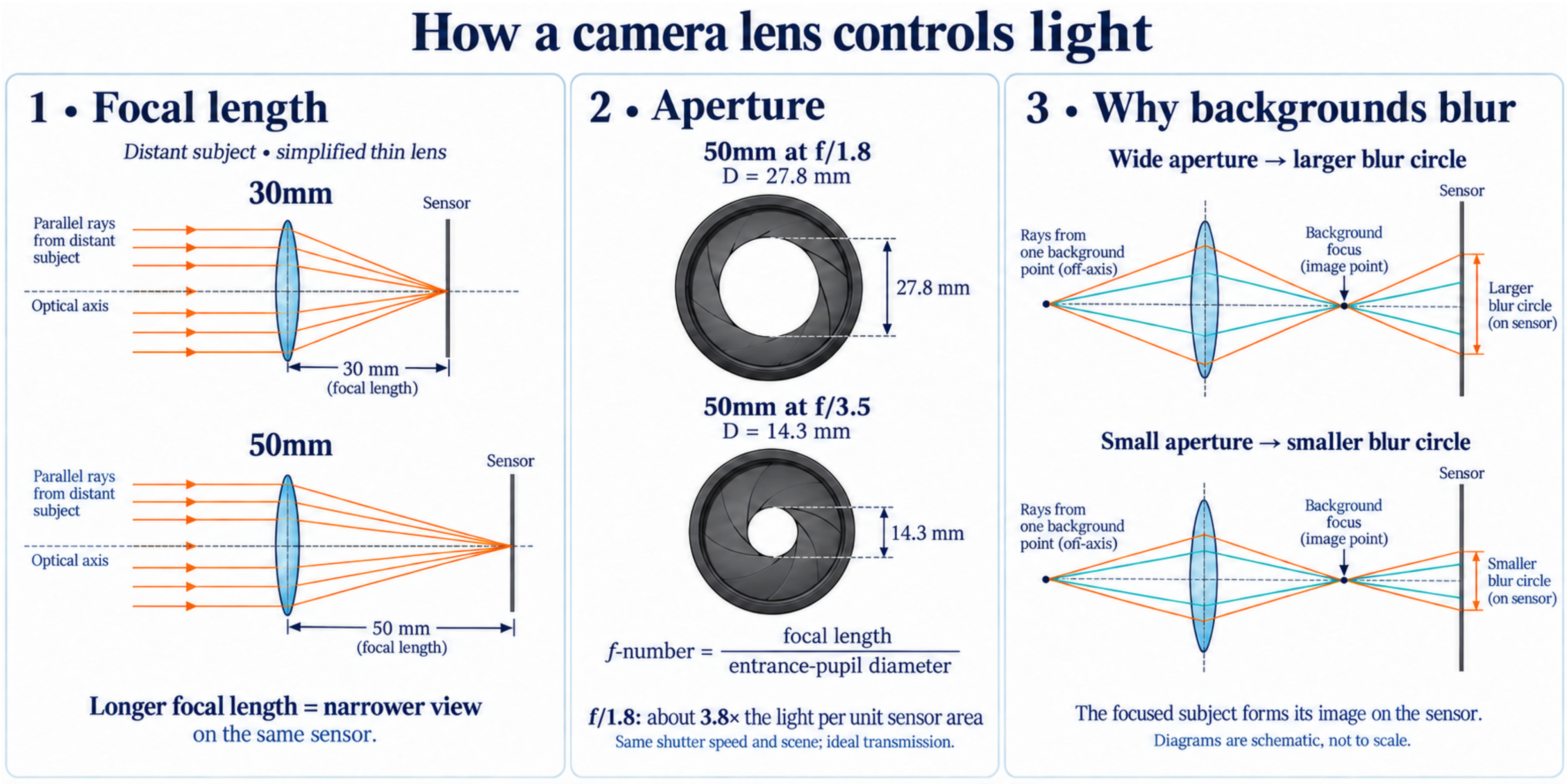
Thus f/1.8 admits about **3.8 times as much light**, or **1.92 stops more**, than f/3.5. If a scene needs f/3.5, 1/125 second and ISO 800, f/1.8 allows approximately **1/500 second at ISO 800** to help freeze movement, or **1/125 second at ISO 200**. These are rounded equivalents.

The full-stop sequence

f/1.4 → f/2 → f/2.8 → f/4 → f/5.6 → f/8 → f/11 → f/16

Each step right approximately halves the light. Numbers increase by $\sqrt{2}$ because aperture area depends on diameter squared. [2, 3]

> **Same f-number, similar exposure:** 30mm f/1.8 and 50mm f/1.8 give approximately the same exposure at the same shutter speed and ISO. Their different entrance-pupil diameters are accounted for by the focal-length ratio.



Correction to the generated label: the upper-right source point marked "off-axis" is actually **on-axis**. Both source points lie on the dashed optical axis. The diagrams illustrate a background image forming before the sensor, producing defocus at the sensor.

The thin-lens distance drawings and aperture illustrations are schematic, not to scale. In the right panel, a wider cone produces a larger blur circle for the same image-plane mismatch.

How glass forms a sharp image

A lens focuses light through **refraction**. Light changes speed when it passes between air and glass. At an angled boundary, its direction changes according to Snell's law. The angles below are measured from the surface normal. [4]

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

The refractive indices n_1 and n_2 describe the materials. Curved surfaces bend rays passing through different parts of the lens so they converge. A photographic lens uses multiple elements to form an image while reducing optical errors.

Lens elements and complete lenses

Common element shapes include **biconvex, plano-convex, biconcave, plano-concave and meniscus**. In air, ordinary positive elements converge light and negative elements diverge it. A photographic lens combines these elements into an overall image-forming optical system. [5]

The thin-lens equation

$$1/f = 1/u + 1/v$$

Here u is object distance and v is image distance. Distances use consistent units. This simplified model treats the lens as thin; real camera lenses require a more complete optical model. [5]

For a 50mm thin lens focused on an object 2,000mm away:

$$v = fu / (u - f)$$

$$v = (50 \times 2{,}000) / (2{,}000 - 50) = 51.28\text{mm}$$

At infinity, image distance approaches 50mm. At closer distances, the required image position changes. Camera focusing mechanisms move lens elements or groups to place the focused image on the sensor.

Why the background does not share that focus

When you focus on a person, light from that person forms its sharp image at the sensor. Light from a distant background would form its sharp image at a different position. At the actual sensor, it occupies a patch instead of an ideal point - a **blur circle**.

> The sensor stays at its image plane. Focusing changes the optics so the chosen subject's image coincides with that plane. Other object distances generally remain defocused.

Understanding depth of field

Depth of field is the range of object distances that appears acceptably sharp. It does not mean that all points within that range have identical optical focus. [3, 6]

A wide aperture creates a broad cone of rays. Away from its focus, the cone's cross-section grows quickly. A smaller aperture narrows the cone, so the same image-plane mismatch creates a smaller blur circle. This is the geometric reason stopping down increases depth of field. [6]

Change	Typical result with other conditions fixed
Open f/3.5 to f/1.8	Shallower depth of field
Move closer to the subject	Shallower depth of field
Increase focal length at fixed distance	Shallower depth of field
Move the background farther away	More background defocus, approaching a limit

A calculated example: focus at 2 metres

These approximate values use full frame, a conventional 0.03mm circle-of-confusion criterion and standard geometric depth-of-field equations. The camera-to-subject distance remains fixed.

Setting	Acceptable-sharpness range	Total depth
30mm, f/1.8	1.79-2.27m	48cm
30mm, f/3.5	1.63-2.59m	97cm
50mm, f/1.8	1.92-2.09m	17cm
50mm, f/3.5	1.85-2.18m	33cm

The transition is gradual. Large prints, close viewing and pixel-level inspection require stricter sharpness criteria, giving a smaller apparent acceptable range.

> **Distance matters:** if you move back with 50mm to match the subject size obtained with 30mm, the comparison changes. Depth of field around the subject can become much closer. Greater depth of field also does not mean the whole background becomes sharp.

Diffraction and crop factor

Light also behaves as a wave. Every finite aperture produces diffraction, even with perfect optics. For a circular aperture, the central Airy-disc diameter at the image plane is approximately **$d = 2.44\lambda N$**, where λ is wavelength and N is f-number. [7]

Aperture	Airy-disc diameter at 550nm
f/1.8	2.4µm
f/3.5	4.7µm
f/8	10.7µm
f/16	21.5µm

Stopping down increases geometric depth of field while eventually reducing fine-detail contrast through diffraction. Wide-open performance can instead be limited by aberrations. The best aperture depends on the lens, sensor and required depth of field.

A smaller sensor records a smaller part of the image

Equivalent focal length describes which full-frame lens gives a similar angle of view. It does not change the lens's actual focal length. [8, 9]

Equivalent focal length = actual focal length × crop factor

Sensor format	Crop	30mm looks like	50mm looks like
Full frame	1×	30mm	50mm
APS-C, 1.5× systems	1.5×	45mm on full frame	75mm on full frame
Canon APS-C	Approx. 1.6×	48mm on full frame	80mm on full frame

Thus 30mm on APS-C gives roughly a standard view, while 50mm on APS-C gives a tighter, short-telephoto view. The actual focal length remains 30mm or 50mm.

> **Exposure and equivalence differ:** f/1.8 remains f/1.8 for exposure. For similar depth of field at the same viewpoint, framing and output size, multiply the f-number by crop factor too. Thus 30mm f/1.8 on 1.5× APS-C roughly matches 45mm f/2.7 on full frame for framing and depth of field.

The images demonstrate category characteristics, not exact focal-length scaling. Categories overlap: one lens can be a prime, a telephoto and a macro lens. Tilt changes the focus plane; how much of a three-dimensional scene stays sharp still depends on aperture and scene geometry.

The main types of camera lens

Focal-length ranges below are approximate full-frame conventions. Prime and zoom describe adjustment, while macro, tilt-shift and anamorphic describe capabilities or optical construction. [10-13]

Category	Meaning	Typical application
Ultra-wide	Roughly below 24mm; very wide view	Interiors, expansive landscapes
Wide-angle	Roughly 24-35mm	Street scenes, environmental portraits
Standard	Roughly 40-60mm	Everyday photography
Short telephoto	Roughly 70-135mm	Portraits, selective details
Telephoto	Roughly 135-300mm	Sports, distant subjects
Super-telephoto	Roughly 300mm and longer	Wildlife, distant action
Prime	One focal length, such as 30mm or 50mm	A consistent angle of view
Zoom	Adjustable focal length, such as 24-70mm	Reframe without changing lenses
Macro	Close focusing and high reproduction ratios	Insects, jewellery, small details
Fisheye	Extremely wide, deliberately curved projection	Immersive, exaggerated scenes
Tilt-shift	Tilt adjusts focus plane; shift adjusts framing	Architecture, products
Anamorphic	Horizontal squeeze during capture; de-squeeze afterward	Cinematic widescreen imagery

For macro, **1:1 magnification** means a 10mm subject produces a 10mm image on the sensor, independent of its later size on a monitor. [11]

Tilt can align the focus plane with an inclined surface. Shift permits reframing while keeping the camera level. Anamorphic optics can produce oval bokeh and characteristic effects depending on design. Prime or zoom alone does not establish image quality. [12, 13]

From lens markings to photographs

Marking	What it means
50mm f/1.8	Fixed 50mm focal length; widest available aperture is f/1.8.
18-55mm f/3.5-5.6	Zoom range; maximum aperture changes from f/3.5 at the wide end to f/5.6 at the long end.
24-70mm f/2.8	Zoom range with f/2.8 available throughout.
Ø58mm	Filter-thread diameter, not focal length or aperture.
1:1 macro	Life-size maximum reproduction on the sensor.

An f/1.8 lens can normally be stopped down to f/3.5, f/5.6 and smaller apertures. Its exact minimum aperture depends on the model. A variable-aperture zoom's f/3.5-5.6 marking describes maximum aperture across the zoom range. [3, 14]

Try two controlled photo sequences

1. Arrange the scene. Place a small object in front of a distant background. Keep the object and background stationary. Focus on the same part of the object throughout.

2. Keep the camera position fixed. Photograph at 30mm f/1.8, 30mm f/3.5, 50mm f/1.8 and 50mm f/3.5, if your lenses support these settings. Match brightness using shutter speed or ISO. Compare framing and background blur.

3. Match the subject size. Repeat while moving the camera so the object occupies the same proportion of the frame at 30mm and 50mm. Compare foreground-background proportions and perspective.

4. Inspect the differences. Compare sharpness around the focus point, background blur, field of view and any motion blur. Avoid mistaking a brighter exposure for a shallower depth of field.

> **Choose deliberately:** focal length and camera position determine composition; aperture balances light with depth of field; shutter speed controls exposure time and motion rendering. ISO affects how the captured signal is rendered - raising ISO does not admit more light through the lens.

For the four-setting example, 30mm f/3.5 provides the widest view and greatest depth of field; 50mm f/1.8 provides the tightest view and shallowest depth of field at the same focus distance.

Sources and calculation notes

[1] Sony - Lens basics

[2] Edmund Optics - System throughput, f-number and numerical aperture

[3] Nikon - Understanding maximum aperture

[4] OpenStax - Refraction - Physics, section 16.2

[5] OpenStax - Thin lenses - University Physics, section 2.4

[6] Edmund Optics - Depth of field and depth of focus

[7] Edmund Optics - The Airy disk and diffraction limit

[8] Nikon - DX NIKKOR lenses and crop factor

[9] Canon Academy - Full frame and sensor-size crop factor

[10] Nikon - Understanding focal length

[11] Nikon - Experimenting with macro photography at home

[12] Canon - TS-E 135mm: tilt and focus-plane control

[13] ZEISS - Anamorphic optics and image characteristics

[14] Nikon - 18-55mm f/3.5-5.6: a variable-aperture zoom example

Numerical assumptions

Angle-of-view examples use a 36mm sensor width and infinity-focus rectilinear geometry. Aperture and light-ratio examples assume ideal transmission and ordinary, non-macro distances. Airy-disc values use a circular pupil and 550nm light. Values are rounded.

Depth-of-field calculations use f in millimetres, focus distance s = 2,000mm and circle-of-confusion criterion c = 0.03mm: $H = f^2/(Nc) + f$; near = $Hs/(H + s - f)$; far = $Hs/(H - s + f)$. These are conventional geometric approximations; they do not predict actual lens aberrations or a fixed perceptual sharpness threshold.

Illustration and edition notes

Prepared from the detailed explanation in this conversation, 22 September 2026. Three raster teaching illustrations were created using the built-in image-generation tool. Source links support the underlying optics; the images are not photographs from controlled lens tests. The physics-plate label correction appears directly beneath that plate.