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How to choose a camera lens

Understanding the technology

SUMMARY

When you buy a camera, make sure the lens is suited for the intended purpose. With the right lens, you can greatly enhance the results you achieve in a particular type of photography and, by having a variety of lenses, you can greatly extend the usefulness of your camera.

This paper provides a basic introduction to the principles of camera lenses. It explains the terminology: what is meant by focal length and f/number?

Choose the right lens and taking good photographs becomes so much easier!

The Basics

The most important component of your camera is the lens. It's no good having a camera with an impressively large number of megapixels if the lens is not up to the job. A lens has two basic properties:

- **Focal length** — This determines the field of view of the lens. To match human vision, you'd need a lens with a focal length of about 35mm (in photography, focal length is always measured in millimetres). The **normal**, or **standard**, focal length for a camera lens is 50mm - anything smaller is called **wide-angle**, anything greater is called **telephoto**. A camera lens offering a range of focal lengths is called a **zoom** lens; one of fixed focal length is called a **prime** lens.
- **f/number** — The ratio of the focal length of the lens (f) to its effective diameter: the size of its 'window' on the outside world , or **aperture**. The f/number is a measure of the light gathering power of the lens (called its **speed**). For example, in low light conditions, a prime lens with a variable aperture will produce a brighter photo at f/2.8 than at f/5.6 (at the same shutter speed).

Understanding lens specifications

We can now understand a lens specification!

A lens specification is generally written as *focal length, f/number*. So, **24mm. f/3.5** means that the lens has a focal length of 24mm and a maximum aperture of 1/3.5 of that, i.e. 6.9mm. Here are some more examples:

- 17-55mm, f/2.8 — A Zoom lens with a variable focal length range from 17 to 55mm and a maximum aperture of f/2.8.
- 15-85mm, f/3.5-5.6 — A Zoom lens with a variable focal length range from 15 to 85mm and a variable maximum aperture f/3.5 to f/5.6
- 65mm, f/2.8, 1-5x — A prime lens with a fixed focal length of 65mm, a maximum aperture of f/2.8 offering magnifications from 1:1 to 5:1.

Now, how do you choose the right lens for the job?

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Where and what is your subject?

You want to fill a substantial proportion of your photograph with your chosen subject. So, the combination of the size of your subject and your proximity to it will determine the width of the arc you need to capture. It is by choosing a lens of the right focal length that you will get the appropriate angle of view.

- Wide-angle lenses capture a wide arc because they have a have a short focal length, usually less than 28mm, and they are typically used for landscapes and for interiors. For example, if you back into the corner of a room or a working space and use a wide-angle lens you can often capture most of the four walls, the floor and the ceiling. The drawback of wide-angle lenses is that they cause some distortion of subjects close to the camera.

- At the other extreme, you may want to capture a relatively small subject a long way off. For this you need a the long focal length of a telephoto lens, which is in the range of 100-300mm, or over 300mm for 'super telephoto'. Although this is probably not your task, the principle is well illustrated by the paparazzo taking shots of a celebrity from hundreds of metres away!

- If your requirement does not involve either of these extremes, you need a standard lens. Standard lenses, typically with a focal length 35-85mm, are used in the majority of everyday photography.

Zoom or Fixed?

Do you need flexibility from your equipment? Flexibility is of course one of the reasons for using detachable lenses in the first place, but if you need your lens to be versatile in terms of focal length, you should get a lens with a variable focal length: a **zoom lens**.

A 'normal' zoom lens typically has a focal length varying from 28mm (wide-angle) to 300mm (telephoto), and the power of the zoom is the ratio of its longest to its shortest focal length. So, with a range of 28-300mm, the power is 10.7x. There are also zoom lenses with ranges covering just wide-angle or just telephoto focal lengths.

So why not use a zoom lens all the time? As you may guess, they are expensive, and pound for pound you get higher optical quality from a lens with a fixed focal length: a **prime lens**. If you don't need the flexibility of a zoom lens, for example, if the camera is to be used for a single task, use a prime lens selected for the job.

There are two more subtle points to bear in mind, regarding usability:

- Zoom lenses are simply heavier and bulkier than prime lenses. In environments where protective clothing is required, a zoom lens could be too fiddly to use effectively.

- Most zoom lenses change their overall external length as they change focal length, thereby changing the balance of the camera, and they may possibly slide out of adjustment if pointed upwards or downwards. Hence the further refinement of internal zoom lenses, which stay unaltered in their external dimensions as the focal length changes.

What are your lighting conditions?

To get a good picture, you must achieve the correct exposure by allowing the correct amount of light to reach the sensor. Two factors control this: the length of time the shutter is open (the **shutter speed**), and the aperture of the lens. As we have seen, the aperture is specified using an 'f/number', which gets smaller as the aperture gets wider. There is a standard scale of f/numbers:

32 22 16 11 8.0 5.6 4. 0 2.8 2.0 1.4

Each step on this scale (going from left to right) represents a doubling of the aperture area. Some lenses also show intermediate values such as 3.5 and 3.2.

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All lenses can be **stopped** to f/16 (smaller aperture), but the maximum aperture will vary considerably, and the greater the maximum, the larger and more expensive the lens. In particular, if you are looking for a lens with a wide aperture for a reasonable price, you are more likely to find a suitable prime lens rather than a zoom.

So how do you choose? A camera with automatic exposure control will arrive at the optimum combination of shutter speed and aperture but it is limited by the maximum aperture of the lens. The question is, if it reaches that limit, will it slow down the shutter speed too much and cause blurring of the image? The answer will depend on movement of the subject and/or the camera, and the lighting conditions.

The other important effect of widening the lens aperture is to reduce the **depth of field**. This is the range of distance which is in focus in the picture. In some situations this may be a problem, but in many cases it will not matter. It is sometimes an advantage to reduce the visual impact of a background by letting it be fuzzy.

One final point about apertures: a prime lens has a constant maximum aperture, but the maximum aperture of a zoom lens may change as the focal length changes. If that is the case, the exposure setting changes as you zoom in and out, which is not a problem in automatic exposure mode, but is regarded as a nuisance by photographers who like to control exposure manually.

Do you need to get really close?

If you have to get right up close to your subject, and produce images the same size as the subject or larger, you are entering the world of **macro photography**. You need a **macro lens**.

So why not just use the '**macro mode**' setting on your camera? There are several reasons:

- This will probably not get you a 1:1 image:subject magnification let alone the higher magnifications of a dedicated macro lens. The macro mode limits the focusing range of the lens to minimise interference from objects farther away – it does not give you optical magnification.
- The camera may rely on electronic processing (**digital zoom**), which uses only the central area of the sensor (i.e. fewer pixels) and therefore yields intrinsically poorer resolution than optical magnification.
- The quality is simply poorer, with potentially more geometric distortion, chromatic aberration (colour defects) and 'vignetting' (darkening around the edge).

Bear in mind that macro photography demands good illumination, made more difficult because the space between camera and subject is very limited. Also, your depth of field will be extremely small, so to maintain focus on your chosen subject, the camera must be held very still, preferably on a tripod. So, how do you choose a macro lens?

Macro Lens Type	Use
Short focal lengths (50-60mm)	Really close work – subject possibly almost touching the camera
Medium focal lengths (90-105mm)	General work, such as portraits
'Telephoto macro' (150-200mm)	Close ups from a distance – when you don't want to cast a shadow on the subject from you or the camera.

Some zoom lenses provide a macro option, but (like the macro mode on a camera) the best magnification will be less than 1:1.

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Conclusions

Prime, zoom or macro?

Type of work	Lens type
Close-ups	Macro lens Important factors: allows life size or magnified images
Repeated, similar, tasks	Prime lens, e.g. 50mm Important factors: best image quality, light weight, compact, low cost, must be matched to the task
Various tasks	Zoom lens, e.g. 30-200mm Important factors: versatile, heavy, bulky, expensive

Focal length?

Type of work	Lens aperture
Indoor work without using flash	Maximum aperture f/2.8 to f/1.4 This allows fast enough shutter speeds to give sharp images with a hand-held camera in most cases. Flash, of course, has a very limited range.
In overcast conditions outdoors	f/3.5 to f/2.8
In the shade on a sunny day	f/5.6 to f/3.5
In full daylight	A lens of any f/number will perform well.

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