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PROPER LIGHTING TO SUPPORT AVIAN VISION

The Importance of Avian Lighting

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Birds may be the most visually-oriented animals in nature. They have one of the most sophisticated visual systems, the largest eyes of any animal (relative to body size) and the highest proportion of brain power devoted to vision. They have often been described as "a pair of eyes with wings".

Birds' ability to see color far surpasses that of humans, as does their visual acuity and the speed with which they process images. In almost all aspects of the visual experience, birds see a world that we can scarcely imagine. Yet our companion birds often exist in an environment that is unable to support this spectacular visual machinery. Our human homes are lit for our comparatively unsophisticated eyes, and they often leave our feathered companions, if not "in the dark", then something relatively close to it.



Birds need proper light to find and analyze food; to identify flock mates; to detect predators and other dangers; to regulate daily cycles (sleep, feeding); and to regulate seasonal cycles (migration, reproduction). Yet standard home lighting is inadequate for several reasons. It is far too dim, has poor color spectrum, is often too red, has little-to-no ultraviolet, and is usually placed too low to effectively illuminate a bird's environment. These deficiencies can lead to health and behavior problems such as lethargy (inadequate brightness to fully trigger wakefulness), poor appetite (food may not "look right"), phobias (difficulty identifying objects and detecting dangers), and aggression (cannot recognizing flock mates), stress (from color imbalance), and reproductive behavior (too much red light indicating breeding season).

Moreover, birds actually have extraocular photoreception, meaning that they are affected by light in ways other than through their eyes (vision). Birds have two glands: the harderian gland and the pineal gland, which respond to light and are, thereby, thought to control things like migration/molting, reproduction, and sleep cycles. And, their visual acuity is superior; avian photoreceptors are 8 times denser than the human eye, allowing them to focus on the entire field of view, all at once.

To address the shortcomings of home lighting for birds, we need to consider the lighting equipment that our birds evolved under: the sun. While most of us can't realistically offer our birds full access to natural, unfiltered sunlight, many options exist to bring some of the key qualities of the sun into our living areas. We simply need to understand which characteristics of sunlight are most important to our birds' visual experience.

Brightness

The most important aspect of avian lighting is adequate brightness. The lighting that humans use in their homes is often hundreds—or thousands—of times dimmer than the tropical sun that our companion birds are used to. Recent studies have shown that birds require five-to-twenty times the light humans do in order to see in color. In general, this means that birds have severely limited color vision in lighting conditions dimmer than those of a clear sunrise or sunset.

Most human homes are not lit to nearly this brightness level. Standard living room lighting is about eight times dimmer than sunrise or sunset. Even the most brightly-lit rooms in our homes—the kitchen and bathroom—are rarely bright enough to fully support avian vision. To make matters worse, humans are generally poor at noticing differences in brightness. Our eyes quickly adjust to low light conditions, giving us the impression that our indoor lighting is much brighter than it actually is.



When buying bulbs, know that the brightness of a light source is measured in lumens and the brightness of light over an area, as perceived by humans, is measured in lux. To give you some perspective: the brightness of the sun at sunrise is 400 lux; the brightest room in your house, your kitchen, is about 300 lux; the brightness of the sun in the tropics at mid-day is about 130,000 lux.

Currently, fluorescent tubes offer the best solution for providing adequate brightness. They can greatly increase the brightness of a room with a minimum of cost or electricity use. They also provide a diffuse light source that mimics the general diffuse, bright lighting of a tropical forest.

Spectrum (CRI, Color Rendering Index)

Bird's visual ability exceeds ours in many ways, and nowhere is this truer than in the area of color vision. Birds' eyes have four different color receptors compared to our three, giving them an extra dimension of color perception. Each color receptor is also much more precise than ours, and tests have shown that birds are able to distinguish between colors that look identical to humans.

These visual "superpowers" give birds the potential to see billions of colors, whereas human color perception maxes out at around seven million. This makes birds much more sensitive to differences in the color spectrum of light. Lights that seem adequate for human purposes will likely be seen by our avian friends as quite different from natural sunlight.

The accuracy of a light's color spectrum is often expressed in Color Rendering Index (CRI). A perfect CRI is 100, reflecting the color of midday sunlight. Most indoor lighting has CRIs in the 60s and 70s. Even so-called full-spectrum lights can be rated as low as 85 CRI.

At first glance, large windows seem like a great solution to the problem of accurate spectrum. Windows certainly provide the high CRI of minimally-filtered sunlight, but they also present some problems. Large windows can leave birds feeling exposed, adding to their stress levels. Windows may also lead to overheating if a cage is left in direct sun for too long.

Again, fluorescent tube lighting comes to our rescue. Many manufacturers produce specialty fluorescent bulbs that have a rating of 95 CRI or above. These bulbs tend to produce the most accurate and longest-lived color output.

Color Temperature

The temperature rating follows the color progression that hot objects exhibit as they start to glow from heat. As an object heats up, it first gives off dull red and then orange. These are examples of lower-temperature colors (note that this is the opposite of the cool/warm ratings that artists use). As an object grows hotter, its light becomes orange, then yellow and finally white and blue. (The flame on a gas stove is a great example of a very hot color spectrum.) Thus, "cooler" light is red (long wavelength), "hotter" light is blue (short wavelength).

For lighting, color temperature is measured on the Kelvin (K) temperature scale. You'll find ratings of "4700 K" or "6000 K", where the "K" stands for "Kelvin." This does NOT mean that the bulb gives off 6000 K of heat! It is simply a convenient way to refer to the hot/cold balance of colors in a light's spectrum.

Our companion birds do best under the color temperature of the sun (as experienced on earth), which is 5000 K in the tropical latitudes. Color temperatures lower than this (more red) can lead to breeding behavior, while higher color temperatures (more blue) have been shown to produce more stress and feather destruction. For tropical birds, look for a light that has a temperature of at least 5000 K and not more than 5700 K.

Specialty fluorescent tubes, like the Philips TL-950, give the best color temperature (5000 K) and have a of 98 CRI rating, offering a great option for basic supplemental lighting for your birds.

Ultraviolet Support

In addition to seeing more color detail, birds are also capable of seeing ultraviolet light. Birds likely perceive UV as an additional set of colors, which combine with the other colors in their visual spectrum. These extra color combinations are what allow birds to see around 200 times the number of colors that humans perceive.

Human vision stops around wavelengths of 380 nm, or just below ultraviolet. Birds can see wavelengths as low as 315 nm, thus into the near UV-A. UV-A is the closest to human visible light, and occurs in wavelengths of 315 to 400 nm, or approximately the limit of bird vision at the low end of the spectrum. UV-A is further divided into:

- Near UV-A (345-400 nm), which enhances bird vision of food, feathers, and so on.
- Far UV-A (315-345 nm), which produces suntan and vitamin D production in humans.

Birds' ultraviolet vision is likely useful in recognizing their flock mates. Most parrots have feathers that reflect UV light, meaning that parrot eyes are likely tuned to notice those reflections. Some parrots may even display sexual dimorphism in their UV coloration.

Birds can also use their UV vision to see the nutrients in their food. Flowers, berries, and fruits reflect UV light, as do many key nutrients and toxins. This is not unlike humans' ability to detect sugar content simply by looking at the amount of green or yellow in a banana's skin. For birds, their UV-sensitive eyes allow them to see oils, sugars, vitamins, minerals and amino acids that are invisible to us. Without UV light, birds cannot identify whether food looks nutritious and enticing, or rancid, moldy, and toxic. Thus, food may simply not "look right" to birds and may lead to problems with appetite.

Most of our household lighting is well-shielded against UV output. In addition, modern window glass blocks practically all UV. Mix in UV-absorbing interior paint and our living rooms are very UV-poor environments indeed.

Luckily, birds do not need much UV light to support their full vision. Natural sunlight has no more than 5% total UV content, of which only .1%—that is, 1/10 of 1 percent—is UV-B. Also, birds are not capable of seeing the powerful ultraviolet-B light, which is a high-energy, short wavelength of 280-315 nm. This light produces sunburn, skin cancer, and cataracts in humans and animals. Fortunately, in nature we are shielded from most UV-B, which is largely absorbed by the atmosphere. Thus, the UV-B that most reptile bulbs put out—and which have been repackaged as Avian lights—are not unnecessary to support your bird's vision and, in fact, can be dangerous.



(There's also little evidence that UV-B is useful for generating vitamin D, but that's a topic for another day.) A small fluorescent tube labeled "black light" should provide enough UV to support your birds' vision. Make sure that it only outputs the lower-energy ultraviolet-A, and try to find a bulb that also puts out some visible light. The Philips 13036 model is a good choice for UV supplementation.

While humans and other land vertebrates require some ultraviolet to produce vitamin D in the skin, birds produce vitamin D in oils secreted onto their feathers while preening. Birds can manufacture vitamin D with UV-A. UV-B is not required for birds and should only be used under explicit directions from your avian vet.

Placement

Proper positioning of a light source is often an afterthought, but it is a critical consideration when setting up your bird's lights. Placing a light directly over the cage (or on the cage) can lead to stress as a bird adjusts to a large new object looming over them. Also, placing a light too close to the cage can lead to big differences in light levels in different parts of the cage. That's because brightness is the measure of the amount of light at a certain location; and drops off as the square of the distance from the light source. Thus, if you move your light 2 feet further away from your bird cage, the brightness decreases 4 times. Conversely, if you move the light 3 feet closer, the brightness increases 9 times! So, do not place the light too close or too far from the cage.

Placing a light too low will also negate many benefits of proper lighting. Food dishes will still be in shadow, as will many toys and cage mates. Also, light coming from below or from the side may defeat a bird's natural eye shading, reducing visual acuity and causing stress. For best results, place your bird's lights well above the cage and offset from the top. This will give good, consistent illumination without adding a potential new stressor to your bird's environment.

Summary

As with most parrot-related topics, there is more to learn and new information constantly being discovered. But, at present, you can give your birds a decent indoor visual experience using a combination of windows and fluorescent tubes with the proper specifications, installed in electronic ballast fixtures, and supplemented with blacklights for near UV-A visual support. For additional focused light, you can use carefully placed halogen bulbs.

If mounting or hanging fluorescent tubes is not an option, using compact fluorescents is still better than using standard incandescents found in most homes.

Mickaboo offers a free class that covers these topics in detail. You'll learn about light, avian vision, the properties of sunlight, and how to select and set up proper lighting for your bird. Check our website under Advanced Classes for the next time this class will be offered.

LIGHTING REFERENCE

What do birds need to best simulate their natural experience in nature under the sun?

ADEQUATE BRIGHTNESS

Try to provide 400 lux as a minimum, 1000 lux or more is preferable. It is highly unlikely that your setup will be too bright. 10,000 lux, which would be nearly impossible to simulate, is acceptable. However, also provide an area that is shielded from light, by hanging a towel over a corner of the cage or placing a large (bird-safe) floor-plant behind it.

PROPER COLOR SPECTRUM

The ideal CRI (Color Rendering Index) is 100, which is the spectrum of the midday sun. Since humans cannot detect CRI over about 85, bulbs labeled full-spectrum are often no better than 85 CRI. For birds, the CRI should ideally be 93 or above, if possible.

APPROPRIATE COLOR TEMPERATURE

5000 K (Kelvin) is perfect, up to 5700 K is acceptable. Avoid bulbs that are 5900 K! The temperature will be too actinic and could lead to molting problems and feather destructive behavior. Avoid temperature below 5000 K, which is too red and can lead to egg laying and aggression.

MOUNTING LOCATION AND DISTANCE

To mimic sunlight, place the brightest lights above the cage and to the side, not directly overhead. Placement is critical to proper lighting. Mount or hang lights several feet from the cage, preferably mounted on the ceiling, wall, or at the juncture of the ceiling and wall.

Compact fluorescents should be installed a little closer to the cage, since they have a much lower output than fluorescent tubes. Remember the inverse square law.

PROPER FLICKER RATE

Flicker perception is the speed at which a flickering light appears continuous. Human flicker rate maxes out at about 50 flashes per second. So, for humans, a light with more than 50 flashes per second looks continuous. However, birds can detect flicker rates exceeding 100 flashes per second. A light with a low flicker rate, in which your bird can see the flashes, will be annoying, if not seriously stressful. To avoid this, use proper fixtures with electronic ballasts and **NEVER** put fluorescent lights of any kind on a dimmer. They dim by changing the flicker rate!

CONCENTRATION

Use mostly diffuse light, accented by a few brightly-lit areas. Create variable lighted areas. In nature, birds fly in and out of direct sunlight and spend much of their day in the filtered light of trees. Provide areas (in or out of the cage) where your bird can get away from light.

ULTRAVIOLET SUPPORT

Provide UV-A only, supplemental light (not UV-B) and remember, you don't need much. Our atmosphere filters most of the UV from the sun.

SPECIFIC RECOMMENDATIONS

Make sure that ALL bulbs are placed in open fixtures! Glass or plastic enclosures for tube lights, or lampshades on floor lamps for compact fluorescents, will ruin the full-spectrum and UV output.

Avoid Avian specialty bulbs for now. These are largely repackaged, reptile bulbs with a dangerously high UV-B content for birds. The CRI is far too low, the temperature is far too blue, they degrade quickly, and the placement instructions are ridiculous and dangerous. Some brands to **avoid** are the Avian Sun compacts and the ReptiSun tubes. **NEVER USE THESE!**

Our recommendations are listed below.

WINDOWS

Use natural windows to raise illumination (brightness) and improve CRI (color spectrum). Windows, however, will block UV light. Also, **DO NOT** leave your bird in front of a window in direct sun!

FLUORESCENT TUBES

Use fluorescent tubes for the best source of diffuse light. These bulbs are not expensive, can be put on a timer, and take very little wattage relative to standard incandescent lights. However, because they contain mercury, be careful to mount them well so that they do not fall in an earthquake. Use proper, electronic ballast fixtures with these bulbs. For the T8 tubes, see the section on fixtures. For the T5 tubes, many off-the-shelf fixtures are available.

NEVER put fluorescent lights on a dimmer. They dim by changing the flicker rate. See the PROPER FLICKER RATE section above for details.

There are two models of fluorescent tubes that we recommend: the T8 and the T5.

T8 Tubes

The 5000 K model T8 tubes (Philips TL-950) are the perfect temperature and the CRI, at 98, is excellent (the best we have found).

Philips TL-950 bulbs can be purchased in lengths of 2 feet, 3 feet, or 4 feet. Currently the 2 and 3 foot bulbs can be purchased singly; the 4 foot bulbs must be purchased in packs of 25. Match the tube length with the recommended fixtures. Below are the item numbers and links to purchase these fluorescent tube bulbs. The item number differences signify the wattage.

The item number on the 4-foot bulbs is F32T8/TL950 and the link to purchase them is:
http://www.topbulb.com/find/Product_Description.asp?intProductID=44259

The item number on the 3-foot bulbs is F25T8/TL950 and the link to purchase them is:
http://www.topbulb.com/find/Product_Description.asp?intProductID=50961

The item number on the 2-foot bulbs is F17T8/TL950 and the link to purchase them is:
http://www.topbulb.com/find/Product_Description.asp?intProductID=44126

Note: When you receive the tubes, check to see that you got the correct bulbs. Occasionally they have sent a Sylvania, which does not have the same specifications.

T5 Tubes

An alternative fluorescent tube is the Blue Max T5. The disadvantage of these tubes is that the CRI is much lower, at only 91. However, they do have several advantages:

- they have a much higher luminescence per watt
- they are more readily available as individual bulbs, in all lengths
- they can use easily available, nice-looking off-the-shelf electronic fixtures
- they have a lower mercury content than the T8 tubes

Be sure that you get the T5 tubes with the 5000 K temperature. Others are available with an inappropriately high spectral temperature of 5900 K.

We recommend the Maxum™ 5000 47" F54T5HO, which has the following specifications:

- CRI: 91+
- Kelvin: 5000
- Lumens: 5200

The T5 tubes can be purchased here:

http://www.fullspectrum solutions.com/bluemax_f54t5ho_612_prd1.htm

PROPER FIXTURES

Always use fixtures with *electronic* ballasts. Older, cheaper fixtures use magnetic ballasts, causing an annoying flicker that may lead to stress and feather destruction.

And, make sure that the tubes are not covered, therefore, the fixtures *must* be open.

Fixtures for T5 Tubes

For the T5 tubes, you can find many off-the-shelf fixtures; again, make sure that they are open.

Fixtures for T8 Tubes

For the T8 you can also find some off-the-shelf electronic ballast fixtures (shop lights) at Home Depot and hardware stores. These fixtures usually come prewired. You can hang these or put them on a high bookshelf, but they should be high above the cage and preferably off-set a little.

For much nicer looking fixtures, **Brodwax Lighting** sells appropriate fixtures for the fluorescent tube bulbs. You want the open channel strips, available on this page:

<http://www.brodwax.com/strips.html>

Be aware that while the off-the-shelf shop lights are prewired, the **Brodwax** fixtures are not prewired. These fixtures come without an electric outlet cord, since they were designed to attach to a wall switch. So either you or a contractor must wire them and attach an electrical cord (of any desired length) or a premade cord (that is usually sold in a specified length). You can mount the fixture on the ceiling or wall and run electrical cords down to an outlet, or you can have a contractor wire them to a wall switch. You can also connect several fixtures together and run a single electrical cord to a switch or outlet.

We recommend either the **SF** (right-angle mount) or the **SP** (flat mount) **Series**. Both versions are available in 2 feet, 3 feet, and 4 feet lengths. Note that the item numbers, like the Philips tube bulbs, indicate the wattage and the number of bulbs. Thus, SP 132 means the flat mount for a fixture that takes one 32 bulb; and, SF 217 means the right-angle mount for a fixture that takes two 17-watt bulbs.

The **SP Series** is a flat mount and offers fixtures in 1 or 2 light strips (meaning, for use with 1 or 2 bulbs). We recommend that you get the ones that take 2 bulbs to provide more light in a single mounted area.

Flat-mount:

- SP 117 (flat mount, 1 bulb, 17 watts)
- SP 125 (flat mount, 1 bulb, 25 watts)
- SP 132 (flat mount, 1 bulb, 32 watts)
- SP 217 (flat mount, 2 bulbs, 17 watts)
- SP 225 (flat mount, 2 bulbs, 25 watts)
- SP 232 (flat mount, 2 bulbs, 32 watts)

The **SF Series** is a right-angle mount and offers a 2 light strip (meaning, for use with 2 bulbs). These fixtures are especially nice for mounting where the wall meets the ceiling, and are our personal favorite! You can also mount them on the wall over a cage, since they will still not sit directly overhead (over the cage) but to the side of it (or behind it).

Right-angle mount:

- SF 217 (right-angle mount, 2 bulbs, 17 watts)
- SF 225 (right-angle mount, 2 bulbs, 25 watts)
- SF 232 (right-angle mount, 2 bulbs, 32 watts)

FLUORESCENT TUBE BLACKLIGHTS

Home-use fluorescents are shielded against UV. To remedy this, you can use fluorescent tubes labeled "blacklight." These lights have UV-A output that peaks at about 370 nm (near UV-A). Remember, you don't need much UV. Use an open fixture and, if possible, use one with a reflective surface or painted white, like the **Brodwax** fixtures that we recommend.

When including a blacklight with fluorescent tubes, use the correct ratio of regular (full-spectrum) light to UV light. We measured the output for these particular tubes and, to accomplish a correct balance of UV that simulates sunlight, use one foot of blacklight tube for every four feet of fluorescent full-spectrum tubes (whether T5 or T8 tubes). If you are using compact fluorescents, see the compact fluorescent full-spectrum and compact fluorescent blacklight sections for a proper ratios.

T8 Blacklights

The F30T8/BLB blacklight peaks at 368nm which, of all the available blacklights, is nearest to where avian vision peaks. It has a total UV output of 6.0 watts.

You can purchase the two-foot blacklight tube at one of the following places:

<http://www.blacklight.com/items/F17T8BLB>

You can purchase the three-foot blacklight tube at one of the following places:

http://www.topbulb.com/find/Product_Description.asp_Q_intProductID_E_44237

<http://www.amazon.com/F30T8-BLB-Fluorescent-Black-Higuchi/dp/B003YNYU2O>

<http://www.blacklight.com/items/F30T8BLB>

You can purchase the four-foot blacklight tube here:
<http://www.blacklight.com/items/F32T8BLB>

We recommend against using this high-output version of the four-foot blacklight, which not only REQUIRES A DIFFERENT BALLAST than the ones suggested in this article, but would require a different ratio (much lower) of blacklight to visible light ratio.
<http://www.blacklight.com/items/WFF32T8BLB>

T5 Blacklights

The only T5 blacklights we've found are 12" bulbs. So you would need to use a separate fixtures for the blacklight bulbs if you're using T5s. You can purchase one here:
<http://1000bulbs.com/product/322/F-08T5BLB.html>

HALOGEN SOLUX

For focused, bright light, use high-CRI, 5000 K, halogen bulbs (Solux makes them). These bulbs do not provide the base, overall lighting solution, but supplement it by providing concentrated light on a few areas. Mount these lights high, as on the ceiling, so that people and birds are not looking directly into them. Shine them on a playstand or play area where birds can get away from the light if they want to. This particular light can be put on a timer and also on a dimmer; and you can use a diffuser to minimize the intensity.

The Solux bulbs come in 5000K versions, which is what you want. You can purchase them at:
<https://www.solux.net/cgi-bin/tlistore/soluxbulbs.html>
For fixtures, use any 35watt, two-pin halogen fixture.

The diffuser is called a Plano-Convex diffuser, and can be purchased at:
<https://www.solux.net/cgi-bin/tlistore/filterclip.html>

COMPACT FLUORESCENT FULL-SPECTRUM

If you cannot mount fluorescent tubes, Blue Max and FeatherBrite make compact fluorescents that are acceptable, but not perfect. Because compact fluorescents are a bent tube, they will develop hot spots causing the CRI to degrade, so you need to replace them *OFTEN*. In addition, the lumination from these bulbs is notably inferior to the fluorescent tubes. While compact fluorescent bulbs are an inferior solution, they are still preferable to standard incandescent lighting.

NEVER put fluorescent lights on a dimmer. They dim by changing the flicker rate. See the PROPER FLICKER RATE section above for details.

Of the two compact fluorescents we've researched, our primary recommendation, because of brightness, is the 2300 lumens Blue Max, supplemented with a compact fluorescent blacklight.

Blue Max

The Blue Max Full-Spectrum Compact Fluorescent bulbs closely approximate many of the Avian requirements with a 93+ CRI and a temperature of 5500k. Blue Max makes these bulbs in many different specifications. **BE SURE** that you buy the ones that are **NOT MORE THAN** 5500k. Some of the Blue Max bulbs are 5900k, which is too high (too blue) for parrots.

You can purchase the Blue Max bulbs at:
http://www.fullspectrum solutions.com/compact_fluorescent_32_ctg.htm

The BlueMax 50w Umbrella CFL has the most lumens and is our recommended compact fluorescent:
http://www.fullspectrum solutions.com/50w_umbrella_688_prd1.htm

- CRI: 93+
- Kelvin: 5500
- Lumens: 2300

FeatherBrite

The only SAFE single bulb that that we know of that includes both UV and regular full-spectrum lighting is the FeatherBrite 15w Full Spectrum Bulb:

<http://www.featherbrite.com/featherbrite-15w-full-spectrum-bu15.html>

The temperature (5500k) and the UV ratios (UV-A 4%, UV-B .05%) are perfect. However, the CRI, is only 91, which is just below the 93 CRI minimum that we recommend, and it is only available in 15 watts, making it only about 1/3 as bright as the BlueMax 50w Umbrella CFL.

COMPACT FLUORESCENT BLACKLIGHTS

If you are using a compact fluorescent without UV (such as the Blue Max), you can use a compact fluorescent blacklight for UV-A supplementation. For the correct ratio, match compact fluorescent blacklights and full-spectrum by wattage. You want to use 4 watts of the compact fluorescent bulb with every 1 watt of the compact fluorescent blacklight.

Here is a compact fluorescent blacklight that we recommend:

http://www.amazon.com/Sunlite-SL20-BLB-Spiral-Blacklight/dp/B002P4TYVK/ref=pd_sim_hi_6

TIMERS

All of our recommended bulbs can be put on a timer. Generally you can set the full-spectrum and blacklights to come on for about 9 or 10 hours a day. Ideally, set incandescent lights to come on for about one hour before, and then again for one hour after, the fluorescents. This helps to simulate sunrise and sunset. A good timer is the Aube TI032-3W/U 7-Day Programmable Timer Switch, White, available here:

http://www.amazon.com/Aube-TI032-3W-7-Day-Programmable-Switch/dp/B000E3BUCK/ref=sr_1_26?ie=UTF8&qid=1369590355&sr=8-26&keywords=light+timer