(f) A fluorescence indicates the presence of invisible ultraviolet light. (Note that this is not likely visible if the light passes through the lenses of an overhead projector. Evidence for UV is more easily obtained using a diffraction grating and a simple screen without a projector.)
(g) Being exposed to a red lamp is much more dangerous, because UV photons have much more energy than red photons.
(h) (on diagram)

INVESTIGATION 3.3.1 THE PHOTOELECTRIC EFFECT

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Evidence

(a)
- When charged, the vane of the electroscope moved to about 45° from the vertical.
- When the charged electroscope was touched, the vane returned to the vertical position.
- The 100-W light bulb did not produce any noticeable change in the angle of the vane of the charged electroscope.
- The UV light source caused the vane of the charged electroscope to immediately return to its vertical position. This was a permanent change because the vane did not return to its charged position when the light was removed.

Analysis

(b) The bright white light shining on the charged electroscope did not produce any effect, just like the control test. There was no difference if the bright light was near or not.
(c) Compared to the control, the UV light had the immediate and obvious effect of neutralizing the charged electroscope.
(d) If the intensity of the light was a factor, the 100-W bulb should have produced the more noticeable effect. The 100-W light bulb is much brighter than the UV light. The results seem quite certain because the white light did not produce any effect and the effect of the UV light was immediate.
(e) The zinc plate was initially neutral with equal numbers of protons and electrons. When the negatively charged vinyl strip contacts the zinc on the electroscope, some electrons are transferred from the vinyl strip to the zinc and electroscope. The zinc and electroscope now have an excess of electrons compared with protons and hence a negative charge.
(f) The electroscope became less charged based on the evidence that the vane returned toward its electrically neutral vertical position.
(g) The evidence suggests that most of the excess electrons on the zinc plate were removed as a result of the action of the UV light. Because the vane of the electroscope did not return to its charged position after the UV light was removed, the electrons must have escaped from the electroscope.

Evaluation

(h) Another neutral electroscope or some other device with a meter could be placed near the zinc plate to see if any escaping electrons could be detected.
(i) The vane or leaf electroscope could be replaced by a electrostatic meter attached to the zinc plate. The meter could give a measurement of the charge before, during, and after shining light onto the zinc plate.
(j) I am not very certain because it is not possible to see or directly detect the electrons leaving the electroscope. It seems logical that electrons are leaving but where are they going?

Synthesis

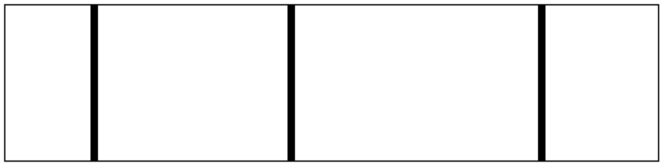
(k) If a glass plate is placed between the UV light and the zinc plate, the electroscope should not lose its negative charge and the vane should remain at the original angle.
(l) Only if the window is open and the sunlight shines directly onto the electroscope should it discharge. Otherwise, the glass in the window would absorb the UV part of the sunlight.

ACTIVITY 3.4.1 LINE SPECTRA

(Page 212)

(a) Neither glass nor water change the colours in the visible spectrum, so these substances do not absorb visible light.
(b) The aqueous potassium permanganate absorbs the green light from the visible spectrum. The region of the spectrum that initially showed green is now black, flanked on either side by the blue and red bands.
(c) The spectrum after passing through the iodine vapour showed the original blue and red but the green region was quite a bit darker with most of the green colour removed. The effect was about the same as the potassium permanganate but not as complete. Based on the disappearance of most of the green, gases such as iodine vapour can also absorb electromagnetic radiation.

(d) The evidence that some light is being absorbed is the dark lines across the spectrum. Possible gases that might be responsible would include the hydrogen and helium in the Sun and gases such as oxygen in Earth's atmosphere. (Almost all the dark lines in the visible region originate from elements in the Sun.)



(e) Gases produce visible light when they are very hot (or when electricity is passed through them).
(f) In this case (hot gases), the spectrum produced is a bright-line spectrum.
(g) Line spectra are used in chemical analysis to identify substances by the colours (wavelengths or frequencies) of light that they emit or absorb.

ACTIVITY 3.4.2 THE HYDROGEN LINE SPECTRUM AND THE BOHR THEORY

(Page 213)

(a) The wavelengths (shortest to longest) are about 410 nm, 434 nm, 486 nm, and 655 nm.
(b) The wavelength is 656 nm.
(c) A photon is released in this transition.
(d) This transition ($3 \rightarrow 2$) corresponds to the first line in the Balmer series.

- For hydrogen energy-level transition: $n_i = 4$, $n_f = 2$:
  The wavelength is 486 nm.
  A photon is released.
  This transition corresponds to the blue-green line in the spectrum.
- For hydrogen energy-level transition: $n_i = 5$, $n_f = 2$:
  The wavelength is 434 nm.
  A photon is released.
  This transition corresponds to the blue line in the spectrum.
- For hydrogen energy-level transition: $n_i = 6$, $n_f = 2$:
  The wavelength is 410 nm.
  A photon is released.
  This transition corresponds to the violet (very deep blue) line in the spectrum.

(e) Answers from Figure 3 are essentially the same as those from the computer simulation. It seems logical to assume the simulation would be programmed with the correct (accepted) values for these wavelengths.
(f) An electron that absorbs a photon jumps to a higher energy level.
(g) The wavelength of light emitted corresponding to the transition from $n_i = 3$ to $n_f = 2$ is identical to that for the light absorbed in the transition from $n_i = 2$ to $n_f = 3$. The Bohr theory requires that the energy of the levels be fixed, so the energy change, and hence the wavelength of the photons of light involved, must be fixed.
(h) In the Bohr theory, only certain fixed orbits and energies are allowed. These orbits are numbered 1, 2, 3, etc. There are no other orbits in between.

INVESTIGATION 3.5.1 PARAMAGNETISM

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Experimental Design

(a) The independent variable is the metal ion in the compound. The dependent variable is the effect of the strong magnet. A controlled variable is the sulfate anion in each compound.

