(b) According to the evidence collected, both electric charges and magnets change the direction of cathode rays but not laser light. Therefore, cathode rays are different in nature from electromagnetic radiation like visible light.

Evaluation

(c) There are no obvious flaws in the design. The materials and procedure could be improved by including several different sources of cathode rays and different types of light. This would produce more evidence to make the answer to the question more certain.
(Other effects could also be tested.)

(d) The hypothesis that cathode rays are a form of electromagnetic radiation has been shown to be false because the evidence clearly shows significant differences between cathode rays and light.

Synthesis

(e) The bending of cathode rays when passing near electrically charged plates suggests that cathode rays contain charged particles.

(f) Opposite electric charges attract each other and like charges repel. The evidence that cathode rays are attracted to the positively charged plate and repelled from the negative plate suggests that cathode rays contain negatively charged particles.

ACTIVITY 3.1.1 RUTHERFORD'S GOLD FOIL EXPERIMENT

(Page 210)

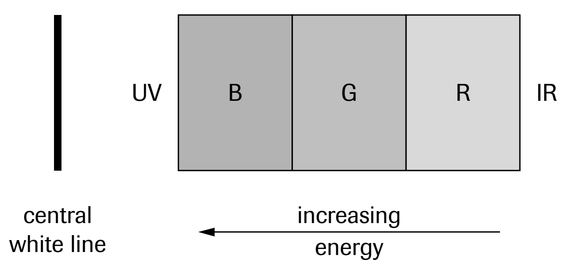
- animation mode; activity of source = average; scintillations set to remain; time = 5 min
- Most alpha particles are deflected within 20° of the straight-line path; a few alpha particles are deflected up to 40°, occasionally up to 60°, and very rarely beyond 90° (only 2 in this simulation).

(a) According to the Thomson atom model, a stream of alpha particles should pass more or less straight through a gold foil, perhaps deflecting a little.
(b) Rutherford's results showed that the majority of alpha particles deflected little but some alpha particles deflected significantly and few appeared to "bounce back."
(c) Almost all of the alpha particles were relatively undeflected, suggesting that the nucleus is very much smaller than the atom, because most alpha particles miss it completely.
(d) The evidence conflicts strongly with the Thomson model, which therefore must be replaced with a new model.
(e) The general pattern of the results with aluminum foil should be similar to that with the gold foil. With aluminum foil, fewer alpha particles should deflect through significant angles because an aluminum nucleus (13 p^+) is not as positive as a gold nucleus (79 p^+).

ACTIVITY 3.3.1 HOT SOLIDS

(Page 210)

(a) The filament starts with a dim, orange-red colour that becomes brighter and more orange, and then brighter and more yellow, and then brighter still and white.
(b) "White hot" objects are much hotter than "red hot" ones.
(c) Objects in a home that may be red hot at certain times include electric stove elements and wires in electric toasters.
(d)



The main colours in the visible spectrum to the right of the central white line are blue, green, and red.
(e) The region beyond the blue is called ultraviolet; and the region beyond the red is called infrared.

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(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

(Page 211)

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.

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