(b) Bar code scanners read the bright-to-dark-to-bright light level changes, and how long they last (which depends on the code line width) as an information signal.

SECTION 3.8 QUESTIONS

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Understanding Concepts

1. Laser light is *monochromatic* (one colour/wavelength/frequency), *coherent* (acts like one long continuous wave), and *collimated* (rays are quite precisely parallel).
2. Lasers work on a principle of raising many electrons to a higher energy level, and then stimulating them to drop to a lower level all at once, producing an output of a very large number of photons.
3. Applications of the principles of quantum mechanics in medical diagnosis include the use of infrared spectroscopes to detect traces of substances in body tissues and fluids; and the use of MRI machines to scan the inside of the body by causing tissues to emit microwave radiation.

Making Connections

4. (Student reports will vary, but should include a basic description and diagrams of X-ray diffraction due to interference of the very short electromagnetic wavelengths with the similarly sized spacings between entities in solid crystals—which provides information about the sizes, shapes, charges, and arrangements of these entities in condensed phases. A simple parallel phenomenon is the diffraction pattern created when a pocket laser pointer beam is reflected from the surface of a CD. The angular displacement of the secondary images is proportional to the line spacing on the CD. Students with physics background in calculations of the diffraction of light from diffraction gratings can easily calculate the CD line spacing using the same technique.)

CAREERS IN CHEMISTRY

PRACTICE

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Making Connections

1. (A typical report would include information such as:)
   In the field of Biochemistry, a gene medicine scientist may do precise mass determinations of purified peptides, proteins, and oligosaccharides, using MALDI (Matrix Assisted Laser Desorption/Ionization time of flight) mass spectroscopic analysis. A scientist in charge of this area for a company would also prepare complex biological samples and determine atomic sequencing in organic molecules, in order to identify and develop new therapeutic materials. Such a position would require a Ph.D. in biochemistry or chemistry, preferably with a few years postdoctoral experience, or an M.Sc. in biochemistry with 10+ years of related experience. People in this area are in demand worldwide, and annual salaries on the order of $100 000 are not uncommon in industrial areas.

CHAPTER 3 LAB ACTIVITIES

INVESTIGATION 3.1.1 THE NATURE OF CATHODE RAYS

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Evidence/Analysis

(a)

Observations of a Cathode Ray and Laser Light		
	Cathode ray	**Laser light**
Effect of bar magnet	ray moves perpendicular to the long axis of bar magnet	no effect
Effect of charged plates	ray moves toward positive plate and away from negative plate	no effect

(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

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- 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

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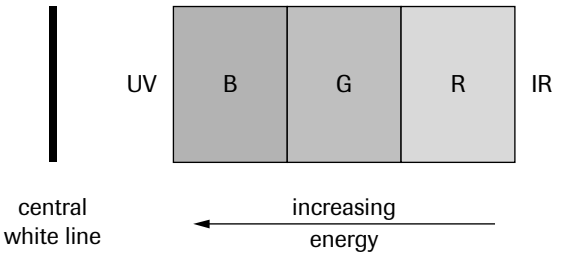
(a) The filament starts with a dim, orange-red colour that becomes brighter and more orange, and then brighter and more yellow, and then brighter still and white.

(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.