between the bills.

The last and most difficult compromise was whether the EPA administrator required a court injunction to halt or limit manufacture of new chemicals. The final bill states that the administrator can either get an injunction or put an administrative order into effect. Even with the order, EPA must go to court if the manufacturer objects to the ruling.

Another compromise makes allowances for small businesses. They are partially exempted from the reporting requirements and will pay only $100, rather than $2,500, for registering each new chemical.

The final bill had the support of the Manufacturing Chemists Association and some labor and environmental groups.

The toxic substances law leaves much to the discretion of the EPA administrator. The question now is: How much preventive action will he take? □

Quantized light-emitting diode

It was a relationship among light, solids and electricity, the photoelectric effect, that introduced the concept of the quantum of energy into physics. Light falling on certain solids will eject a stream of electrons, an electric current, from their surfaces. But for each substance there is a threshold frequency, below which the light does nothing; above the threshold electrons come off. This led to the notion that light contains discrete quanta of energy, and that to get loose an electron had to swallow a whole quantum of appropriate size or nothing at all. The energy of the quantum is porportional to the frequency of the light, and the relevant equation is the famous $E = h\nu$.

At the research laboratories of the Ford Motor Co. in Dearborn, Mich., John Lambe and S. L. McCarthy have developed a species of solid-state sandwich that emits light in a kind of converse to the photoelectric effect. Diodes that emit light are not new, but a class that shows a quantum relationship between the frequency of the emitted light and the voltage applied to the diode is unusual, Lambe says.

The diodes are a form of tunneling junction, a device in which electric current "tunnels" its way through a thin insulating layer between two conductors. In each case that Lambe and McCarthy experimented with, one electrode was aluminum. The insulating layer was aluminum oxide formed on the surface of the aluminum. Against this were placed various electrodes of silver, gold, lead or indium. When a voltage was applied, light was emitted from the entire junction area.

These junctions radiate a broad spectrum of light up to a certain cut-off frequency. The cut-off frequency bears a quantum relation to the applied voltage. The energy of the cut-off quantum is equal to the energy of the electron in the current driven by the given voltage, or Planck's constant times the cut-off frequency equals the absolute value of the voltage times the electron's charge. The absolute value comes in because the polarity of the voltage does not matter.

The effect of variation of the cut-off frequency with voltage was plainly visible: "One could observe the emission color change from deep red at low voltage to orange to blue white as the voltage was increased," Lambe and McCarthy report in the Oct. 4 PHYSICAL REVIEW LETTERS. "This showed the effect of the change in [cut-off frequency] in a very striking way."

Lambe and McCarthy attribute the phenomenon to a relationship between the current electrons driven by the applied voltage and plasmons in the surface of one of the electrodes. Plasmons are collective oscillations of electrons within a solid. They have been a little difficult to study, but Lambe and McCarthy were able to make them react with the passing current by roughening the surface of the electrode slightly. So this phenomenon should provide a means for the study of plasmons.

Lambe also expects that devices of this sort, because they introduce a calculable quantum relation between voltage and light frequency, will be useful as secondary voltage standards for calibration and comparison. They will also be useful in a new kind of spectrometer, and in fact one such spectrometer was built as part of the present experimental program. Applications could also extend to places where other forms of light-emitting diodes are also used. □

Mars soil similar at two Viking sites

The two Viking spacecraft on the Martian surface are some 7,400 kilometers apart, on opposite sides of the planet. Lander 2 is more than 1,400 kilometers closer to the north pole than is its predecessor, and the more northerly atmosphere seems to contain at least three times as much water vapor. Yet despite these seeming grounds for difference, and despite the widely divergent appearance of the two sites in Viking orbiter photographs, the first analysis of a surface sample by lander 2 has revealed an uncanny similarity with the soil studied in the Chryse basin by lander 1.

If one selected two earth rocks for the same kind of analysis, says a member of Viking's inorganic chemistry team, he would be hard-pressed to find a pair that matched as closely as the Martian samples. Both are rich in iron, with near-carbon-copy amounts of calcium, silicon, potassium and other elements. The lander 2 sample was taken from an area topped with a crusty layer possibly due to evaporites formed by water-soluble salts. Yet sulfur and chlorine, two elements cited as candidates in such processes, are present in amounts almost indistinguishable in the first few days of study from those in the lander 1 sample.

The Martian samples involved, however, are not whole rocks, but "fines" or dust. In fact, says team leader Priestley Toulmin III of the U.S. Geological Survey, the likeliest implication of the data is that the material must represent the well-mixed products of weathering rather than simply broken up primary rock fragments. Such mixing, he says, would seem to take place on a planetwide scale, and very rapidly compared with the rate at which the weathering products are produced in the first place. "Indeed," he adds, "that inference might lead further to speculate that the entire weathering process is an ancient one, and that what we are now seeing is only a redistribution—mixing and homogenization—of those very ancient weathering products around the planet."

The team's X-ray fluorescence spectrometer, however, measures only elemental abundances; it does not tell how they are combined. That is the job of the human end of the experiment back on earth. "The best agreement that we can find in attempting to model the mineralogy to the chemistry," Toulmin says, "seems to include . . . a very large proportion of iron-rich . . . clays of the montmorillonite group. These are clays which on earth are generally the product of alteration or weathering of mafic, igneous rocks, such as basalts especially. They form either by weathering at the surface or by hydrothermal alteration connected with mineralization." Though they also have been found in deep-sea oozes, he says, their best known source is in the Red Sea, in an area where submarine hot springs have apparently altered the chemistry of the bottom sediments.

The weathering products suggest that, as with the lander 1 samples, the material came from basaltic rather than granitic parent rocks. "The implication would be that if the weathering products are widespread on a planetary scale, their source region must be similarly wide," Toulmin says. "That in turn implies that there must not be a large amount of granitic-type rock exposed at the surface and available for weathering which would go along with the idea that the planet is by no means so highly differentiated as the earth."

The lander 1 samples, meanwhile, under study for a longer time, are starting to reveal their more detailed secrets, notably including trace elements such as rubidium, strontium, yttrium and zirconium. All four have now been detected, but at extremely low levels compared with most terrestrial igneous rocks. Ultramafic