Spencer Museum of Art
Vaseline Glass Collection

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The demonstration of a healthy safety culture was apparent in your time with Alice and me on Wednesday. Identifying the hazards, and thus evaluating and managing the risks for both employees and members of the public, and showcasing a great collection go hand in hand.

Uranium is naturally occurring, but in any form, it is radioactive. This just means that the atom is unstable, and like a tin cup that is left out in the sun and then taken inside, it gives off heat or energy, until it achieves the temperature of the materials around it. Such is true of a radiochemical. The energy is not felt by the human hand just as an x-ray cannot be felt, but the energy can be measured by a detector. We use the term decay to describe the process whereby a uranium atom gives off this energy as radiation to achieve a lower energy state. Here, uranium oxide was used to color the art piece to transparent yellow or yellow-green. Transparent Vaseline pieces rarely have more than 2% uranium by weight. Uranium glass (opaque) can have up to 25% uranium. Darker green pieces may combine uranium with iron or other metals.

Ultraviolet Light

You quickly identified uranium in these pieces by exposing each to the Spectroline, Model Q-22, ultraviolet (UV) light source. Not all yellow or yellow green pieces have uranium; some have been colored with cerium oxide, etc.

The brilliant green color from a piece composed of uranium comes about because the incoming UV light is absorbed by the uranium atoms giving energy to the orbital electrons, and the excited orbital electrons in returning to the ground state or natural energy state of the atom, give off the wavelength (energy) of green light (510 nm). The UV light has a shorter wavelength (365 nm) and can't be seen. The green light is of a longer wavelength and can be seen.

The Q-Series combines a powerful UV lamp with a high-resolution magnifier lens that measures 2" x 4" with the power of 3X that has a focal length of 8 inches. The Model Q-22 has four lights - two longwave 4-Watt integrally filtered tubes, and two 4-Watt white light tubes. Typical peak intensity at 6 inches is 650 uW/cm^2.

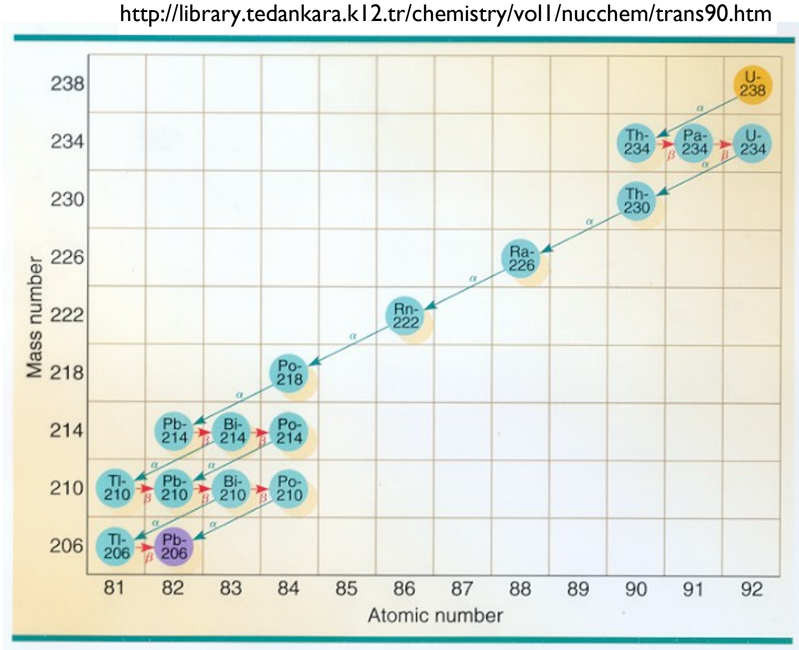
The long wave lamps, and thus UV tubes, give off wavelengths of light at 365 nm. This is invisible radiation and can't, of course, be seen with the eye. The white light tubes are a spectrum of energies from 700 nm (red) to 400 nm (violet). The 365 nm is the ultra-violet region. This is similar to the UVA contribution of the sunlight and the higher energy UVB of the sun that is shielded by sunscreen. The shorter the wavelength, the higher the energy.

You will be careful not to look directly into nor point the light source towards someone.

Radiation Field

The radiation dose is determined by making an assessment of the radiation or energy that is given off by the uranium. It is somewhat more difficult to make an easy determination of dose for uranium.

http://library.tedankara.k12.tr/chemistry/vol1/nucchem/trans90.htm



The parent uranium includes 18 daughters before stable lead is formed. Each of these daughters decays by alpha, beta, or gamma emission. Thus, uranium decays to a daughter which decays to a daughter which decays again to a daughter.

Alphas and some betas would not be able to penetrate a sheet of paper or a pair of gloves. Other betas and most gammas would penetrate that thickness.

Thus, a surface exposure or handling a piece would tend to give a greater dose since the dose would include alpha, beta, and gamma contributions. However, as one moves away from the piece just a centimeter, only the beta and gamma emitters would contribute to the total dose.

Alice showed you that increasing the distance from a source of radiation also greatly reduces the observed count rate or dose rate in the same way that moving away from an oven decreases the heat.

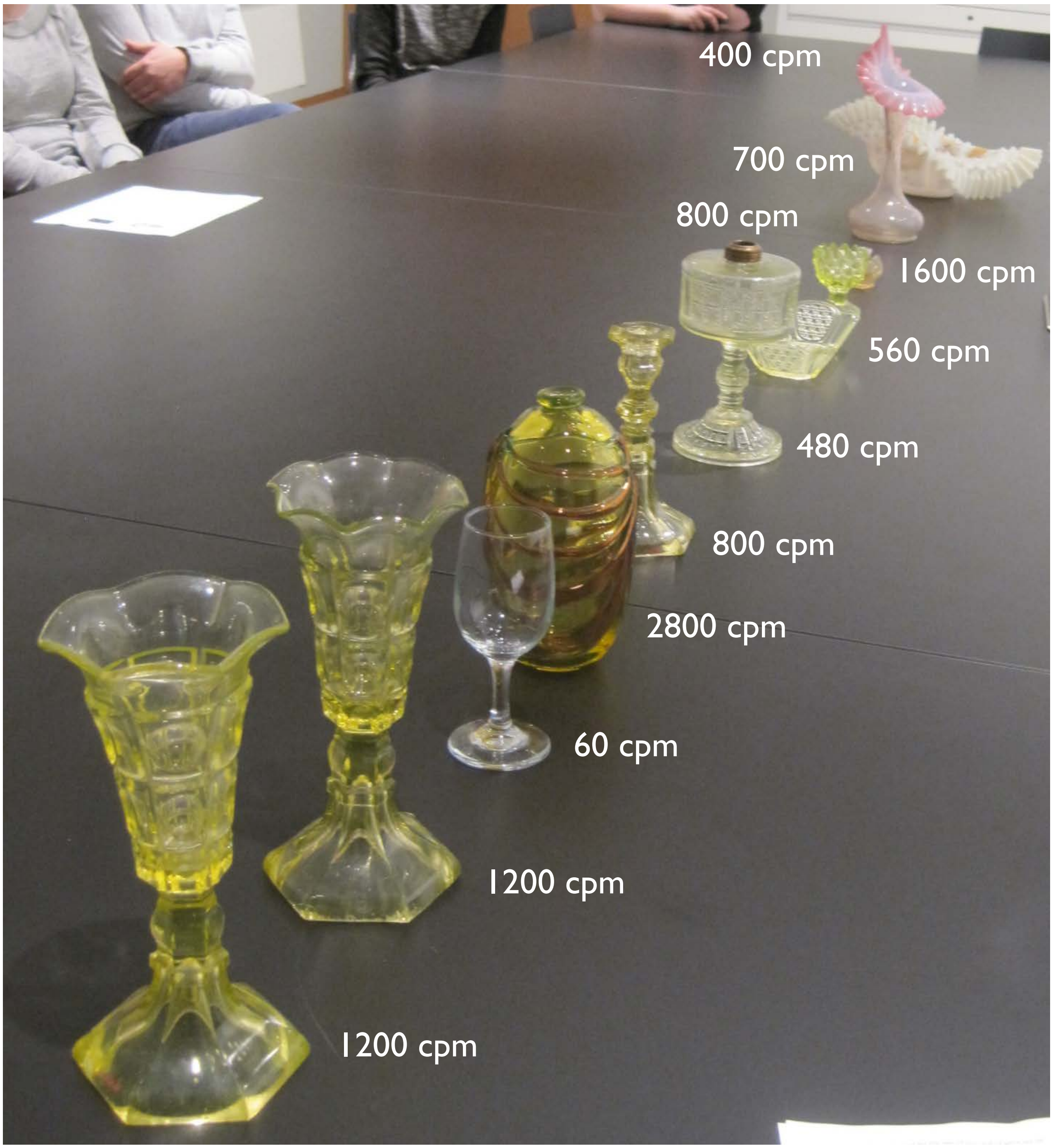
Each decay has a different energy associated with it and the dose is determined by the energy per mass. Thus, there are more than 30 different energies given off during the decay.

Let me begin with the dose assessment by documenting that there was no measurable dose at ten inches from any of the collection pieces. And there will certainly be no dose to any member of the public when the pieces are placed behind a glass window.

The average Geiger Counter pancake probe background is about 60 counts per minute (cpm). CPM is a measure of the decays per minute that the Geiger Counter is actually 'seeing.' This background is about 5 microrem per hour. The surface doses ranged from about 30 microrem per hour to about 200 microrem per hour. Handling the pieces will be performed in a few minutes and so the dose to the hands then becomes one microrem to about 8 microrem for two minutes. A chest x-ray gives 8000 microrem. There is no body dose for any of these pieces.

The count rate for each of the pieces is documented below.

Geiger-Muller Counter with Pancake Probe (Calibrated April 17, 2017)
    Ludlum Model 3, SN 148723
    Ludlum Model 44-9 SN PR 150460



Radon Gas

You will most likely know or will be informed that uranium produces radon gas. Radon is formed by the natural radioactive decay of uranium in rock, soil, and water. Naturally existing, low levels of uranium occur widely in the earth's crust. Thus, U-238 decays to Th-234 to Pa-234 to U-234 to Th-230 to **Ra-226 (solid) to Rn-222 (gas) to Po-218 (solid)**. Radon has a half-life of about four days - half of a given quantity of it breaks down every four days.

There are very few atoms in these pieces that are being formed both to Radon and finally to the stable Lead. The recorded cpm's in the picture show that there are about 2800 decays per minute or 2800 atoms per minute that are being changed (area of detector) or about 50 atoms per second. You may know that chemists talk about Avogadro's number, or the molecular weight in grams of a substance, that is equal to $6.022140857 \times 10^{23}$ atoms. One could not find these 50 atoms. The normal building ventilation will prevent any buildup of radon in the space.

Contamination or Breakage

The uranium is integrated into the glass and so contamination is not a concern. The greatest concern would be shattering the glass across a floor. The cleanup would involve the use of instruments that are able to measure the energy.

These pieces make up a wonderful collection.

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