Calculating Your Yearly Exposure to Ionizing Radiation

An especially damaging form of radiation is "ionizing radiation," which can create electrically-charged ions in the material it strikes. This ionization process can break apart atoms and molecules, causing severe damage in living organisms, either by affecting living tissue directly (e.g., causing radiation sickness and possibly cancers), or by prompting changes in the DNA (i.e., causing mutations—hereditary mutations are extremely rare, however). There are several forms of ionizing radiation:

- X-rays and gamma rays: High-energy parts of the electromagnetic spectrum.
- Alpha particles: Atomic nuclei consisting of two protons and two neutrons.
- Beta particles: Fast-moving electrons ejected from the nuclei of atoms.
- Cosmic radiation: Energetic particles arriving at Earth from outer space.
- Neutrons: Produced mainly in nuclear power plants.

Calculate your exposure to ionizing radiation over the past year. Take your time to think about each of the types of exposure you may have had, and how many times you were exposed. The calculation is done in units called Sieverts, which approximately describes the biological effect a dose of radiation has on living beings. The exposure rates are given in millisieverts—one thousandth of a Sievert—and per one year.

Note that the chart does not include ultraviolet radiation from the Sun, low-energy radiation from cell phones, etc. While their potential health effects are being investigated—and ultraviolet radiation from the Sun is known to be able to cause skin cancer with repeated exposure over time—they are not thought to be as dangerous as the ionizing radiation listed here.

Have someone check your math before you turn in your work.

For your information:

(1) Sample one-way distances (as the crow flies) in the United States:

New York City – Los Angeles	2462 miles (3961 km)
Oklahoma City – Washington, DC	1153 miles (1855 km)
Oklahoma City – San Francisco	1387 miles (2248 km)
Seattle – San Diego	1058 miles (1702 km)
Chicago – Houston	937 miles (1508 km)
Boston – Miami	1255 miles (2020 km)

Sample distances from the United States:

New York City – Paris, France	3635 miles (5850 km)
New York City – New Delhi, India	7301 miles (11750 km)
New York City – Cairo, Egypt	5621 miles (9046 km)
Los Angeles – Sydney, Australia	7487 miles (12049 km)
Los Angeles – Tokyo, Japan	5478 miles (8815 km)
Houston – Mexico City, Mexico	747 miles (1203 km)
Miami – Buenos Aires, Argentina	4372 miles (7037 km)

Remember to double your one-way distance for round-trip travel. If you want to know the exact distance for your city and target, search for distance calculators on the Internet.

(2) Remember to multiply the numbers given by how many times during the last year you had the procedure (e.g., if you had dental X-rays done twice, multiply 0.2 by 2).

BE PREPARED TO DISCUSS THE FOLLOWING QUESTIONS:

1) Identify three sources of radiation that have virtually no effect on your own total yearly exposure. How could you protect yourself against these sources? Would it be worthwhile?

2) Identify three sources of radiation that have a significant effect on your own total exposure. How could you protect yourself against these sources? Would it be worthwhile?

To read more about radiation, you can visit the U.S. Environmental Protection Agency's Radiation Web Pages at http://www.epa.gov/radiation/students/

CHART OF YEARLY RADIATION EXPOSURE FOR _____

TYPE OF IONIZING RADIATION	AMOUNT OF RADIATION IN MSV
From space	
Cosmic radiation at sea level, add 0.26 mSv.	
Cosmic radiation adjusted for the elevation of where you live	
Less than 300 m (1,000 feet), add 0.02 mSv.	
300 - 600 m (1,000-2,000 feet), add 0.05 mSv.	
600 - 900 m (2,000-3,000 feet), add 0.09 mSv.	
900 - 1,200 m (3,000-4,000 feet), add 0.15 mSv.	
1,200 - 1,500 m (4,000-5,000 feet), add 0.21 mSv.	
1,500 - 1,800 m (5,000-6,000 feet), add 0.29 mSv.	
1,800 - 2,100 m (6,000-7,000 feet), add 0.40 mSv.	
2,100 - 2,400 m (7,000-8,000 feet), add 0.53 mSv.	
More than 2,400 m (8,000 feet), add 0.70 mSv.	
From the ground (rocks, soil)	
If you live on the Atlantic Coast, add 0.23 mSv.	
If you live on the Gulf Coast, add 0.23 mSv.	
If you live in the Colorado Plateau, add 0.90 mSv.	
If you live elsewhere in the U.S, add 0.46 mSv.	
From the air	
Radon (natural radioactive gas seeping from underground), add 2 mSv.	
Radiation in the living body	
Food and water (e.g., potassium), add 0.4 mSv.	
From building materials	
If you live in a wooden structure, add 0.05 mSv.	
If you live in a brick structure, add 0.07 mSv.	
If you live in a concrete structure, add 0.07 mSv.	
From jet plane travel	
For each 1,000 miles, add 0.01 mSv. (see page 2)	
If your luggage was X-rayed, add 0.00002 mSv.	
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Type of ionizing radiation	Amount of radiation in mSv
From power plants	
If you live within 50 miles of a nuclear power plant operating normally, add 0.00009 mSv.	
If you live within 50 miles of a coal fire plant operating normally, add 0.0003 mSv.	
From radioactive waste disposal	
Average U.S. dose is 0.01, so add 0.01 mSv.	
From weapons test fallout	
Average U.S. dose is 0.01, so add 0.01 mSv.	
From medical procedures (see page 2)	
If you have had X-rays of the chest, add 0.06 mSv.	
If you have had X-rays of the pelvis and hips, add 0.65 mSv.	
If you have had X-rays of the arms, hands, legs, or feet, add 0.01 mSv.	
If you have had X-rays of the skull, head, or neck (including dental X-rays), add 0.2 mSv.	
If you have had a Barium procedure, add 2 mSv.	
If you have had CT scan (head or body), add 4 mSv.	
If you have had a nuclear medicine procedure (such as ^{99m}Tc bone scan), add 5 mSv.	
If any of your teeth have porcelain crowns or you have false teeth, add 0.0007 mSv.	
If you have a plutonium-powered pacemaker, add 1 mSv.	
Lifestyle	
If you watch TV, add 0.01 mSv.	
If you use a computer, add 0.001 mSv.	
If you wear a luminous (LCD) wristwatch, add 0.0006 mSv.	
If you use gas lantern mantles when camping, add 0.00003 mSv.	
If you have a smoke detector at home, add 0.00008 mSv.	
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ADD SUBTOTAL FROM LAST PAGE	
TOTAL	