Define: N_0 = the number of ^{210}Po atoms at time zero;
N = the number of atoms left after 1 second.
Then, N_0-N is the number of atoms that decay in 1 second. Incorporating the rate law for decay, we have

$$N_0 - N = N_0 - N_0(e^{-kt}) = N_0(1 - e^{-kt})$$
$$= N_0(1 - e^{-5.80\times10^{-8}\,s^{-1}\times 1s}) = N_0 \times 5.80 \times 10^{-8}$$

Since we are considering 1 g,

$$N_0 = \frac{1\,g}{210\,g\,mol^{-1}} \times 6.02 \times 10^{23}\ atoms\,mol^{-1}$$
$$= 2.87 \times 10^{21} atoms$$

Therefore, $N_0 - N = 2.87 \times 10^{21} atoms \times 5.80 \times 10^{-8}\,s^{-1}$
$$= 1.66 \times 10^{14} atoms\ s^{-1}$$

So, 1.66 x 10^{14} atoms decay in the first second in a sample that initially weighs 1 g.

You need a 10-digit calculator for the preceding calculation because N_0-N is the small difference between two very large and nearly equal numbers. A different approach, which avoids this problem, is to evaluate the initial rate by taking the first derivative of the integrated rate law.

$$-\left(\frac{dN}{dt}\right)_{t=0} = -\left[\frac{d}{dt}\left(N_0 e^{-kt}\right)\right]_{t=0} = -\left(N_0(-k)e^{-kt}\right)_{t=0} = +kN_0$$
$$= 5.80 \times 10^{-8}\,s^{-1} \times 2.87 \times 10^{21} atoms$$
$$= 1.66 \times 10^{14} atoms/s \text{ (same as before)}$$

6. The energy released by a decay rate of 1.66 x 10^{14} atoms per second, which is the decay rate in 1 g of ^{210}Po, is given by

$$E = 1.66 \times 10^{14} \frac{decays}{s\ g} \times 5.3 \frac{MeV}{decay} \times \frac{1.60 \times 10^{-13} J}{MeV}$$
$$= 141\ J\ s^{-1}\ g^{-1}$$

But, one watt (W) is, by definition, one joule per second. Therefore, ^{210}Po releases energy at the rate of about 140 W/g, as stated in the article. ■

Answers to *An intuitive crostic*

The winner of the book prize for solving the December crostic *An intuitive crostic,* is Dinie Steunenberg, Kelowna Secondary School, Kelowna BC. Dinie would also like to thank fellow teacher, David Lovering, for his crostic help. The quotation is taken from *The Natural Mind*, by Andrew Weil.

The history of science makes clear that the greatest advancements in man's understanding of the universe are made by intuitive leaps at the frontiers of knowledge not by intellectual walks along well-traveled paths.

A, Archimedes
B, neon
C, databanks
D, resistivity
E, eureka
F, wetting
G, work-up
H, emerald
I, idempotent
J, level off
K, that's that
L, hydrogen
M, elevenths
N, nucleons
O, agents
P, tantalate
Q, utterances
R, Rayleigh
S, affront
T, leans
U, microwaves
V, ill
W, nth
X, decibels ■

Su-chem-du with message

Another su-chem-du to keep your mind warm through the winter months. There is a message in the first row. Here is your clue: "what everyone is on March 17".

Everything else is the same as our usual su-chem-du. Each of the nine chemical symbols is to appear once in each row, column and each 3x3 square. At the bottom of the puzzle is the list of elements to be used. We'll draw the winner of a periodic table from the correct entries on May 7, 2007. Send your entry to *Chem 13 News,* March su-chem-du, Department of Chemistry, University of Waterloo, Waterloo ON N2L 3G1. Fax: 519-888-9168. E-mail: kjackson@uwaterloo.ca.

		Re			**Ir**			**H**
Ir			**I**		**S**		**O**	
	Er			**F**		**Ir**		
		Er			**O**			**S**
	V						**F**	
S			**H**			**Re**		
		F		**O**			**V**	
	Re		**S**		**Er**			**Ir**
V			**Re**			**S**		

Er	F	H	I	Ir	O	Re	S	V

Colleen Keaney wins su-chem-du

Colleen Keaney from Megan Murphy's class at Marymount Academy in Sudbury, Ontario was the winner of December's "su-chem-du with a message", page 6. Megan will receive a small version of the "most beautiful periodic table poster in the world". The answer to the clue "what one does while doing a su-chem-du in the winter" was "SiP HOT cHoCoLaTe" and can be found in the first row of the puzzle's solution, below.

Si	**P**	**H**	**O**	**Tc**	**Ho**	**Co**	**La**	**Te**
Co	**Te**	**Ho**	**La**	**H**	**Si**	**Tc**	**O**	**P**
La	**Tc**	**O**	**Te**	**P**	**Co**	**Ho**	**H**	**Si**
P	**Ho**	**Co**	**Si**	**O**	**Te**	**H**	**Tc**	**La**
Tc	**O**	**Te**	**Co**	**La**	**H**	**Si**	**P**	**Ho**
H	**Si**	**La**	**Tc**	**Ho**	**P**	**O**	**Te**	**Co**
Te	**Co**	**Tc**	**P**	**Si**	**O**	**La**	**Ho**	**H**
O	**H**	**P**	**Ho**	**Co**	**La**	**Te**	**Si**	**Tc**
Ho	**La**	**Si**	**H**	**Te**	**Tc**	**P**	**Co**	**O**