Half-lives of some Radioactive Isotopes

In the course of investigations with radioactive isotopes in this Department, anomalous rates of decay have been observed with some isotopes in particular chemical forms. The escape of iodine-131 from evaporated samples of sodium iodide has already been reported by one of us[1], and Hevesy[2] has reported the escape of carbon-14 from exposed samples of barium carbonate. Anomalies have also been observed in the decay of phosphorus-32 as disodium hydrogen phosphate in solution. In this case, the solution sometimes appears to form a mould (often very rapidly even in sterile solution) on to which the activity appears to concentrate. The activity of the solution over a period of time usually appears to decay more rapidly than the normal half-life of phosphorus-32 would indicate, although it does not appear to decrease regularly. Also phosphorus-32 incorporated as red phosphorus in polythene plastic, which has uses as a superficial applicator in radiotherapy, appears to exude phosphoric acid when prepared by calendering. Particularly in warm weather, apparent half-lives as short as eight days have been observed for phosphorus-32 in this form.

Measurements of the half-life of a number of isotopes in particular types of source in use in this Department were made to determine whether other anomalies existed. No further peculiarities were observed in the sources tested, but the values of the half-lives found for nine different isotopes may be of interest to others working in this field, particularly those of iridium-192 and tantalum-182.

Isotope	Source	Method of measurement	Period of observation	Half-life
*K-42	Solution K_2CO_3	Liquid counter	4 half-lives	12·5±0·2 hr.
*Na-24	Solution Na_2CO_3	,,	3·5 ,,	15·0±0·1 ,,
*Br-82	Solution $CaBr_2$	,,	5 ,,	35·7±0·3 ,,
Au-198	Gold colloid	,,	4 ,,	2·72±0·01 days
	Solid	β-Electroscope	3 ,,	2·74±0·015 ,,
†I-131	Solution NaI	Liquid counter	3 ,,	8·04±0·04 ,,
P-32	Solid Na_2HPO_4	β-Electroscope	3 ,,	14·60±0·05 ,,
	Solid Na_2HPO_4	,,	3 ,,	14·59±0·03 ,,
Ir-192	Solid Ir metal	γ-Ionization chamber	4 ,,	74·5 ±0·7 ,,
Ta-182	Solid Ta metal	,,	3·5 ,,	111 ±1 ,,
Co-60	Liquid $CoCl_2$	,,	1·7 years (0·32 half-life)	5·25±0·21 yr.

* Measurements also made with solid samples of the same chemical form with no apparent anomaly in the decay-rate.
† Reported previously (see ref. 1).

The values obtained for the nine isotopes investigated are listed in the accompanying table. In each case the type of source, method of measurement and period of observation are included. The measurements were made at intervals of about one-tenth of a half-life, and before each measurement the performance of the measuring equipment used was checked with standard cobalt-60 or radium-226 sources. The observation period extended over about three to five half-lives. It is quite difficult to extend this period if the constancy of the geometrical conditions of measurement is to be maintained. The values given in the table were calculated using the method of least squares, and the probable errors assigned to each value were calculated on the basis of this method[3]. It will be observed that in the case of gold-198 and phosphorus-32, the two values given for separate sources agree to within the limits of the errors assigned.

Most of the values given do not differ greatly from those in Seaborg and Perlman's table[4]. It will be noted, however, that a higher value (15·0 hr.) is found for the half-life of sodium-24, in agreement with a recent report by Solomon[5]. The value, 14·60 days, obtained for phosphorus-32 is significantly higher than the accepted value, 14·3 days, which is outside the range of error stated for these measurements. There was, however, no evidence of contamination with a longer-lived isotope (sulphur-35, for example), and further independent measurements of this important value are therefore desirable. An interim value for the half-life of cobalt-60 has been included, although the observation period is too short to obtain an accurate value.

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W. K. Sinclair
A. F. Holloway

Physics Department,
Royal Cancer Hospital,
London, S.W.3.
Dec. 4.

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Sigma-Phase in Transitional Metal Alloys

The existence of a phase isomorphous with the sigma-phase of the iron–chromium system has now been proved in a number of other alloys containing transitional elements. It has been observed in the following systems:

System	Observers
Iron-chromium	Cook and Jones (ref. 1).
Cobalt–chromium	Sully and Heal (ref. 2).
Iron–vanadium	Andrews (ref. 3); Wever and Jellinghaus (ref. 10).
Nickel–vanadium	Pietrokowsky and Duwez (ref. 4).
Cobalt–vanadium	Pearson, Christian and Hume-Rothery (ref. 5).
Chromium–manganese	Pearson, Christian and Hume-Rothery (ref. 5).
Vanadium–manganese	
Iron–molybdenum	Goldschmidt (ref. 6).

In the iron–chromium system this phase occurs at compositions close to the 50 : 50 atomic ratio. In some of the other systems, however, the range of homogeneity does not include the 50 : 50 ratio, and Sully and Heal[2] have already suggested that its occurrence may be determined by a critical electron : atom ratio, that is, that it is an 'electron compound'. Raynor and his co-workers[7] have shown that in the alloys of aluminium with transitional metals, phases of the composition X_2Al_9 (where X is one or more transitional elements) occur at an electron : atom ratio which varies from one alloy system to another in the range of 2·06–2·28. In calculating this ratio, the assumption is made that a proportion of the