[CONTRIBUTION FROM THE DEPARTMENT OF CHEMISTRY, COLUMBIA UNIVERSITY]

A Revision of Some Normal Electrode Potentials

BY JOSEPH SHRAWDER, JR., I. A. COWPERTHWAITE AND V. K. LA MER

In a previous paper,[1] E^0 values from 0 to 50° have been presented for the cell

Pb-Hg (two phase), $PbSO_4$(s), H_2SO(m), H_2 (1)

Since the potential of the hydrogen electrode is, by definition, zero at all temperatures, the E^0 values of the above cell constitute the normal potentials of the lead two phase amalgam–lead sulfate electrode at the temperatures investigated. By combining these data with published values for other cell combinations, several revised normal electrode potentials have been obtained.

The mercury–mercurous sulfate normal electrode potential may be obtained by combining the E^0 for the above cell with the potential of the cell

Pb-Hg (two phase), $PbSO_4$(s), Na_2SO_4(m), Hg_2SO_4(s),Hg(l) (2)

measured by Henderson and Stegeman,[2] and Carpenter.[3]

The normal potential of **zinc two phase amalgam** and of **zinc** may be obtained with the aid of the E^0 value given by Cowperthwaite and La Mer,[4] for the cell

Zn-Hg (two phase), $ZnSO_4$(m), $PbSO_4$(s), Pb-Hg (two phase) (3)

and the potential of zinc against zinc amalgam as given by Cohen.[5]

The normal potential of **cadmium two-phase amalgam** and of **cadmium** may be found by taking the E^0 value for the cell

Cd-Hg (two phase), $CdSO_4$(m), $PbSO_4$(s), Pb-Hg (two phase) (4)

given by La Mer and W. G. Parks,[6] and also the value of the potential of cadmium against cadmium amalgam as given by the same authors.[7]

From the indicated combinations, the following table of revised normal potentials has been constructed.

TABLE I

NORMAL ELECTRODE POTENTIALS AT 25°

	E^0_{298}	$-\Delta F^0_{298}$ per equivalent
Pb-Hg (two phase), $PbSO_4$(s), SO_4^{--}	+0.3505	8088
Hg, Hg_2SO_4(s), SO_4^{--}	− .6141	−14170
Zn-Hg (two phase), Zn^{++}	+ .7614	17569
Zn, Zn^{++}	+ .7620	17583
Cd-Hg (two phase), Cd^{++}	+ .3519	8120
Cd, Cd^{++}	+ .4024	9285

(1) Shrawder and Cowperthwaite, THIS JOURNAL, **56**, 2340 (1934).
(2) Henderson and Stegeman, *ibid.*, **40**, 84 (1918).
(3) Carpenter, Thesis, Columbia University, 1934.
(4) Cowperthwaite and La Mer, THIS JOURNAL, **53**, 4333 (1931).
(5) Cohen, *Z. physik. Chem.*, **34**, 612 (1900).
(6) La Mer and Parks, THIS JOURNAL, **53**, 2040 (1931).
(7) Parks and La Mer, *ibid.*, **56**, 90 (1934).

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Behavior of the Hydronitrogens and their Derivatives in Liquid Ammonia. X. Equilibria in the System Hydrazine Trinitride–Ammonia[1,2]

BY D. H. HOWARD, JR., AND A. W. BROWNE

Investigation of the ternary system hydrazine–hydrogen trinitride–ammonia and of the three related binary systems, from the viewpoint of the phase rule, was projected many years ago in this Laboratory.[3] The system hydrazine–ammonia has been studied[4] throughout the entire range of composition, while the systems hydrazine–hydrogen trinitride,[5] and hydrogen trinitride–ammonia[1d,1i] have been investigated over ranges covering percentages of hydrogen trinitride from 0% to the percentage of that component present in the respective compounds hydrazine trinitride and ammonium trinitride.[6]

(1) For the earlier articles of this series see THIS JOURNAL, (a) **33**, 1728, (b) 1734, (c) 1742 (1911); (d) **35**, 649, (e) 672 (1913); (f) **41**, 1769 (1919); (g) **55**, 1968, (h) 3211 (1933); (i) **56**, 2332 (1934).
(2) The current article is based chiefly upon a part of the thesis presented to the Faculty of the Graduate School of Cornell University by David H. Howard, Jr., in partial fulfilment of the requirements for the degree of Doctor of Philosophy.
(3) Ref. 1a, p. 1728.
(4) Friedrichs, *Z. anorg. allgem. Chem.*, **127**, 221 (1923).
(5) (a) Thesis, "Hydronitric Acid and Hydrazine Trinitride," by Harold Eaton Riegger, 1910. A typed copy is on file in the Library of Cornell University, Ithaca, N. Y. (b) Dresser and Browne, THIS JOURNAL, **55**, 1963 (1933).
(6) Work is still to be done upon these two systems over ranges covering higher percentages of hydrogen trinitride; *i. e.*, upon the binary systems hydrazine trinitride–hydrogen trinitride, and ammonium trinitride–hydrogen trinitride.