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Michael J Griffin* (mjgrif3@emory.edu), Dept. of Math and CS, Emory University, 400 Dowman Dr., W401, Atlanta, GA 30322, and **Claudia Alfes, Ken Ono** and **Larry Rolen**.

Weierstrass mock modular forms and elliptic curves.

Mock modular forms, which give the theoretical framework for Ramanujan's enigmatic mock theta functions, play many roles in mathematics. We study their role in the context of modular parameterizations of elliptic curves E/\mathbb{Q} . We show that mock modular forms which arise from Weierstrass ζ -functions encode the central L -values and L -derivatives which occur in the Birch and Swinnerton-Dyer Conjecture. By defining a theta lift using a kernel recently studied by Hövel, we obtain canonical weight $1/2$ harmonic Maass forms whose Fourier coefficients encode the vanishing of these values for the quadratic twists of E . We employ results of Bruinier and the third author, which builds on seminal work of Gross, Kohnen, Shimura, Waldspurger, and Zagier. We also obtain p -adic formulas for the corresponding weight 2 newform using the action of the Hecke algebra on the Weierstrass mock modular form. (Received September 08, 2014)