HW2 Solutions
Computational Physics
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1.4 - rk4debug

The output of rk4debug:

```
T,S,RK:      2  -1.08268226589290, -1.44357635452387, -1.44357635452387
T,S,RK:     20  -0.99916646582534, -1.00001769724284, -1.00001769724284
T,S,RK:    200  -0.99999166666667, -0.99999999999999, -0.99999999999999
T,S,RK:   2000  -0.99999991666667, -1.00000000000000, -1.00000000000000
T,S,RK:  20000  -0.99999999916666, -1.00000000000000, -1.00000000000000
T,S,RK: 200000  -0.99999999999165, -0.99999999999997, -1.00000000000000
T,S,RK:2000000  -0.99999999999978, -0.99999999999984, -0.99999999999997
```

It looks as though the rk4 method is less susceptible to roundoff errors.

2.4 - poisson

The output of poisson:

```
N, phi[0], rms error:      2  -0.8044704431548360   0.8044704431548360
N, phi[0], rms error:     20  -0.0002031045234736   0.0002113343589213
N, phi[0], rms error:    200  -0.0000000511670959   0.0000000471860743
N, phi[0], rms error:   2000  -0.0000000000054820   0.0000000000050309
N, phi[0], rms error:  20000   0.0000000000000033   0.0000000000000016
N, phi[0], rms error: 200000   0.0000000000000001   0.0000000000000054
```

The most common bugs (and symptoms) are: using the wrong array index[1]for the rms calculation (linear scaling in rms error), improper initial conditions and/or endpoints (poor convergence of solution to zero, and poor rms error scaling), and setting the appropriate sign of both h and dk (poor solution/rms error scaling).

The error scaling is not quite as good as fourth-order. This can be explained by considering the shooting process: we make a fourth order error in the first

step, which we use to shoot to the next step, and so on; including our previous errors in our shooting steps to the end.

3.1 - quicksch

Output of quicksch:

```
E: -.5
N=200; E, Psi[0]:  -0.5000000000000000 -2.100003e-03
E: -.4
N=200; E, Psi[0]:  -0.4000000000000000 5.449880e+02
E: -.6
N=200; E, Psi[0]:  -0.6000000000000000 -8.181156e+05
```

The most common bugs are similar to the previous part; endpoints, initial conditions, and signs of h, dk. The initial condition for Φ' determines the normalization; if changed, the answers will scale appropriately but should behave similarly.

[1] Thanks to Shannon for pointing out the index bug!