Post-lecture quiz, Elaine Christman & Evan Lewis

1. **What physically limits the minimum period neutron stars can have?**

   If a rotating body spins too fast, gravity can no longer keep the body together. Balancing centripetal force and gravitational force leads to the conclusion that the mass and radius mainly control the minimum spin period (note: any mix of answers along these lines were marked correct).

2. **Identify one simplifying assumption used during this lecture, and the context in which the assumption was relevant (or rather, why it was important). (note: your answer should reflect an understanding of the use or impact of the assumption).**

   A few examples (there are more in lecture)...
   - Assumption: pulsar is a uniform-density sphere. Leads to a few outcomes, e.g. allows us to estimate the moment of inertia as $\frac{2}{5} MR^2$.
   - Assumption: pulsar's initial period is much less than its current period. Allows us to derive characteristic age, and it is a generally correct assumption though particularly true for older pulsars that have had more time to lose rotational inertia.
   - Assumption: B-field stays nearly constant over lifetime of pulsar. That allowed us to keep PPdot constant and determine simplified values for pulsar (age).

3. **Estimate the moment of inertia of an average pulsar (note how you got to your answer; use OOM estimation).**

   $I = \frac{2}{5} MR^2$ for a uniform-density sphere; using $\sim 1.4 \text{ Msun}$ and $R \sim 10 \text{ km}$, we get for a canonical pulsar that $I \simeq 10^{38} \text{ kg/m}^2$.

4. **Explain conceptually what physical change the “braking index” quantifies.**

   It describes the evolution of the pulsar’s spin over time (generally but the standard $n=3$ value encompasses torque applied to the pulsar spin from magnetic dipole radiation). If the braking index is not this value, it means that the pulsar is not existing in a vacuum; that is, other processes are effecting the power radiated and hence pulsar spin-down.