

Practice Final Exam / Review Sheet

Some useful constants and Formulas:

Useful constants

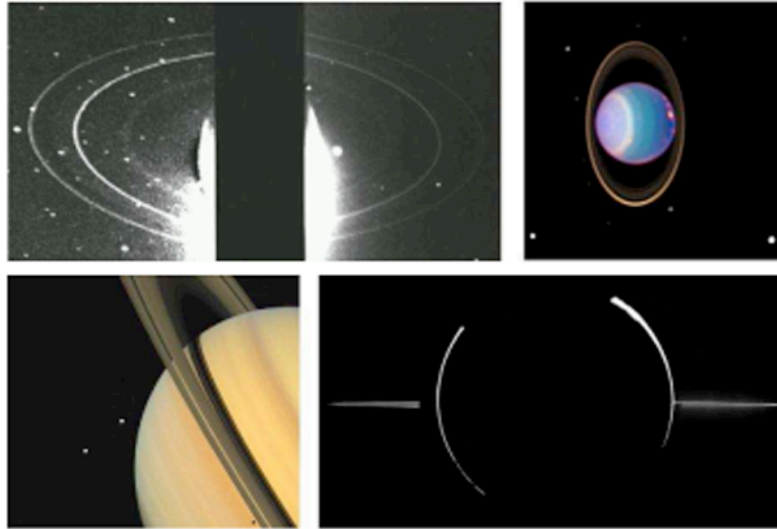
- $G = 6.67 \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}$
- $1 \text{ AU} = 1.5 \times 10^8 \text{ km}$
- $M_{\odot} = 2 \times 10^{30} \text{ kg}$, $L_{\odot} = 4 \times 10^{26} \text{ watt}$
- $M_{Earth} = 5.9 \times 10^{24} \text{ kg}$
- $\sigma = 5.7 \times 10^{-8} \text{ W / m}^2 \text{ K}^{-4}$

Useful formulas

- $p^2 = \frac{4\pi^2}{G(M_1 + M_2)} a^3$ (Kepler's 3rd law)
- $\lambda f = c$ (wavelength-frequency relation)
- $j = \sigma T^4$ (Stephan-Boltzmann law; j is the power emitted per unit area)
- $\lambda \text{ (nm)} = \frac{2.9 \times 10^6 \text{ (nm K)}}{T}$ (Wien's law)
- $F \text{ (flux)} = \frac{L}{4\pi d^2}$ (energy flux at a distance d)
- $\rho \text{ (density)} = \frac{M}{V}$ (density of a sphere)
- $V \text{ (sphere)} = \frac{4}{3}\pi R^3$ (volume of a sphere)
- Diffraction limit (arcsec) = $2 \times 10^5 \frac{\lambda}{D}$ (D diameter of the telescope) where λ and D are in the same units
- $d_{roche} = 2R \left(\frac{\rho_{planet}}{\rho_{moon}} \right)^{1/3}$ (Roche radius)

Final exam - Review

1.



All four giant planets are surrounded by a ring system, which are believed to originate from tidal disruption inside the Roche radius (the distance a satellite can get close from the center of its parent planet before breaking up because of tidal forces).

The ring system of Saturn (diameter = 120,000 km, density = 690 kg / m^3) extends to about 120,700 km from the surface of the planet. Assume that the rings formed from tidal disruption of a big moon made of ice (density = 917 kg / meter^3)

- The total mass of the rings is about $3 \times 10^{22} \text{ kg}$. How big was the radius of that moon?
- Calculate the Roche radius of Saturn, and compare it to the extension of the ring system. Do you expect them to be similar?
- What other cosmic collisions/disruptions have obviously happened in the Solar System? List as many as you can.

2.

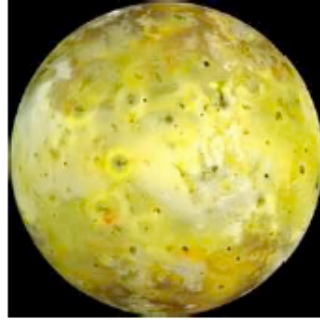
Demonstrate that smaller planets tend to cool quicker, and that larger planets have hotter internals.

3.

What are the possible causes of global warming? List as many as you can.

4.

- Calculate how much energy is received from sunlight on Io, which is at about 5 AU from the Sun and has a radius of 1821 km.
- How much energy is received per unit area?
- What would be the temperature on Io? (remember the no-greenhouse calculation?). The albedo is 0.62.
- The actual temperature on Io can be as high as 1800 K. What's going on?



5.

- Calculate the mass of the Sun knowing the Earth's mass and semi-major axis.

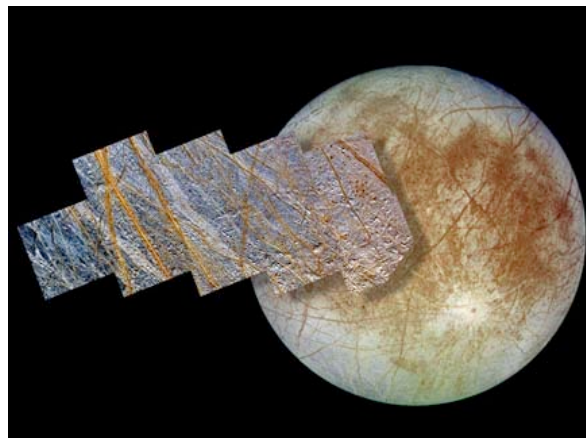
6.

Each of the four VLT Telescopes run by the European Southern Observatory (ESO) has a diameter of 8 meters. The Shane Telescope at Lick Observatory on Mount Hamilton CA is from an older generation, and has a diameter of 3 meters.

- 1) By what factor is light collection ability improved with one VLT telescope, compared with the Shane Telescope?
- 2) By what factor is the diffraction limit improved?
- 3) Calculate the diffraction limit for a VLT Telescope at a wavelength of 0.5 microns (1 micron is one millionth of a meter).
- 4) In practice, what effect limits the spatial resolution of a VLT Telescope? What technology addresses this issue?

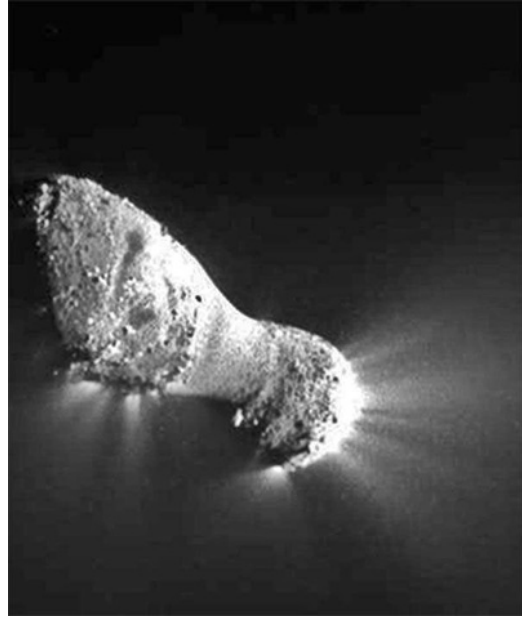
7.

What surface is shown in the image on the right? What features are visible? What do they imply?



8.

What type of object is shown in the image on the right? What features are visible? What do they imply (and/or how did they form)? Where do objects like this one spend most of their time?



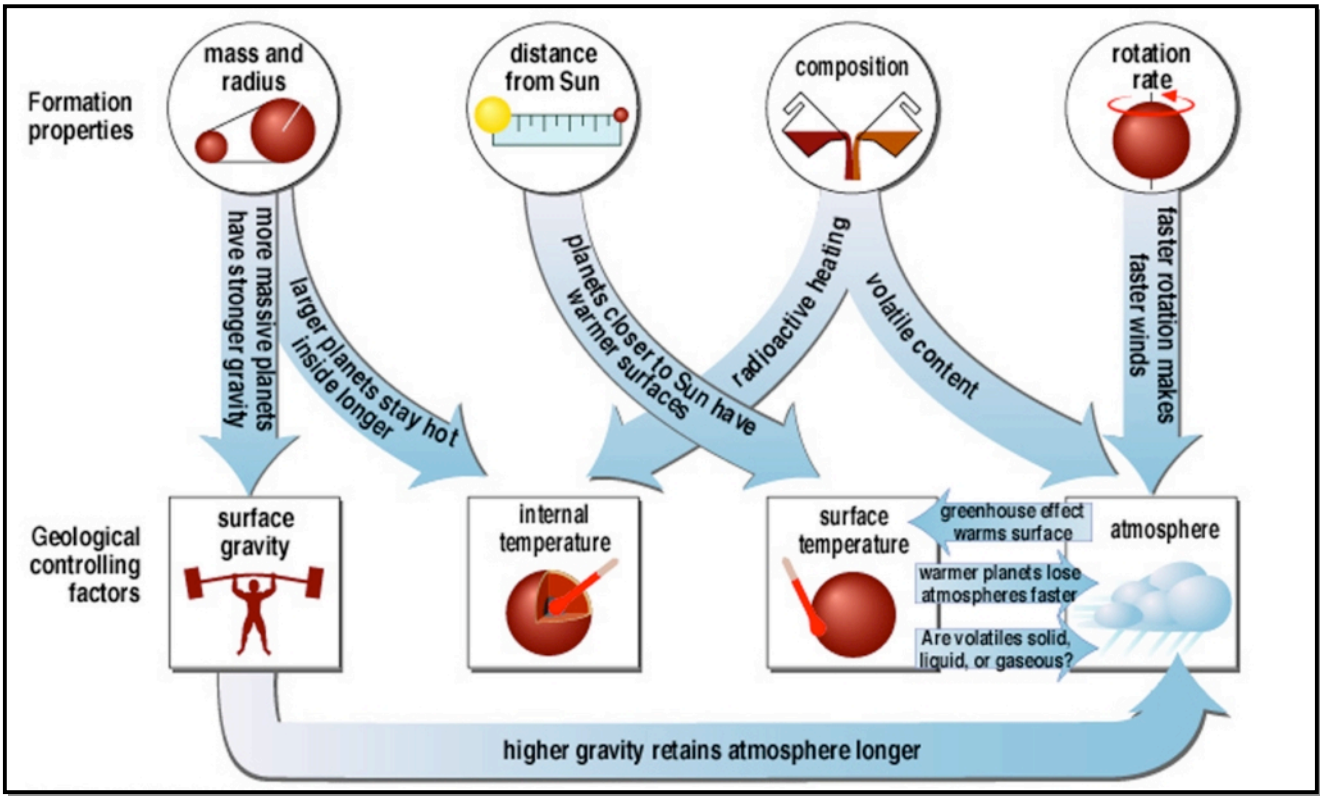
9.

Attached to this practice exam are some concept maps related to planetary characteristics. Think carefully about each of them, and then draw your own full-page concept map to describe the factors affecting atmospheres of the terrestrial planets. You will hand this in at the "real" final exam, so be sure to bring it with you then.

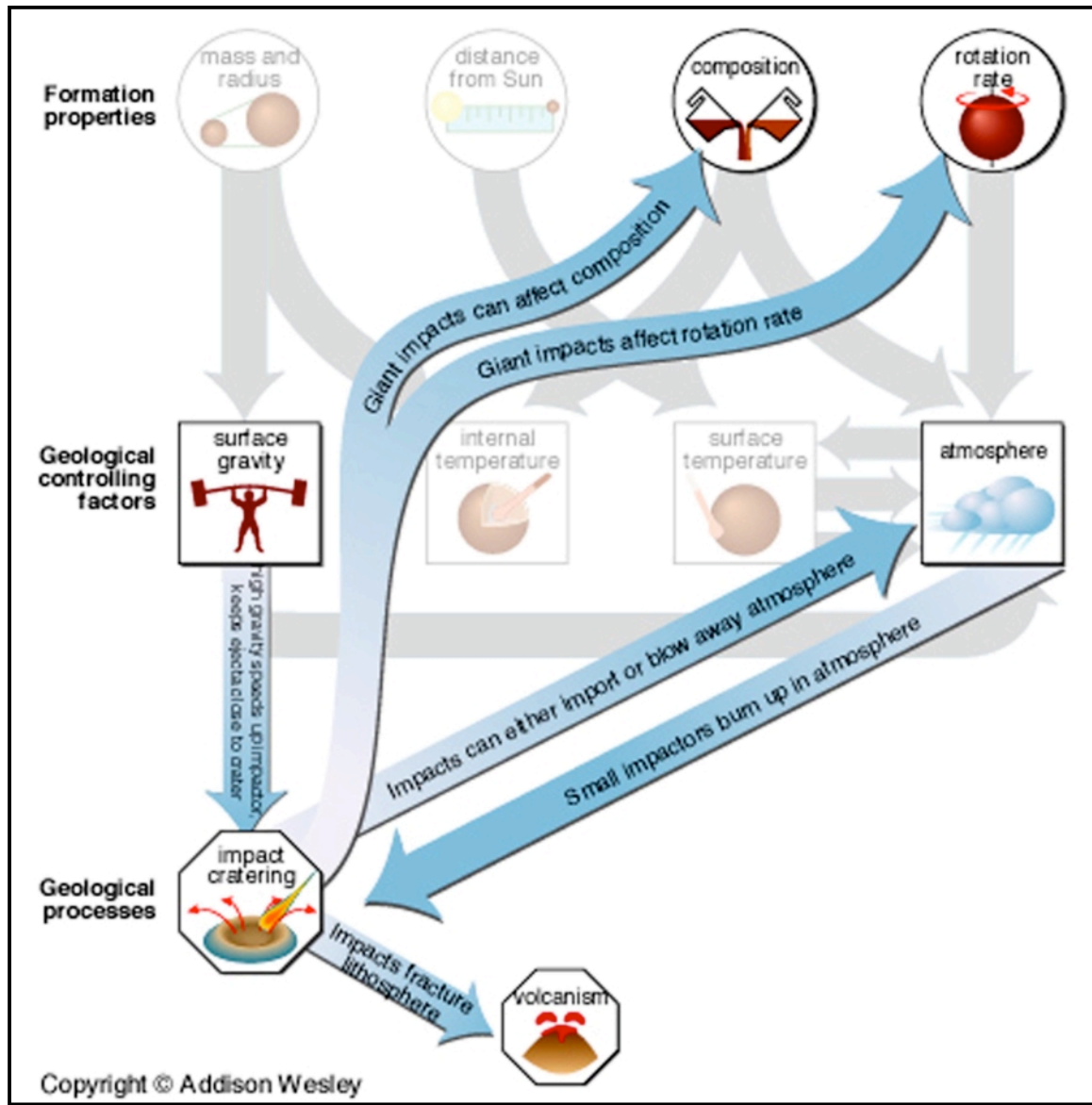
Flow Charts from The Cosmic Perspective, 2nd Edition
Bennett, Donahue, Schneider, and Voit
Pearson Addison Wesley

Astro 18
UCSC
Claire E. Max, Professor

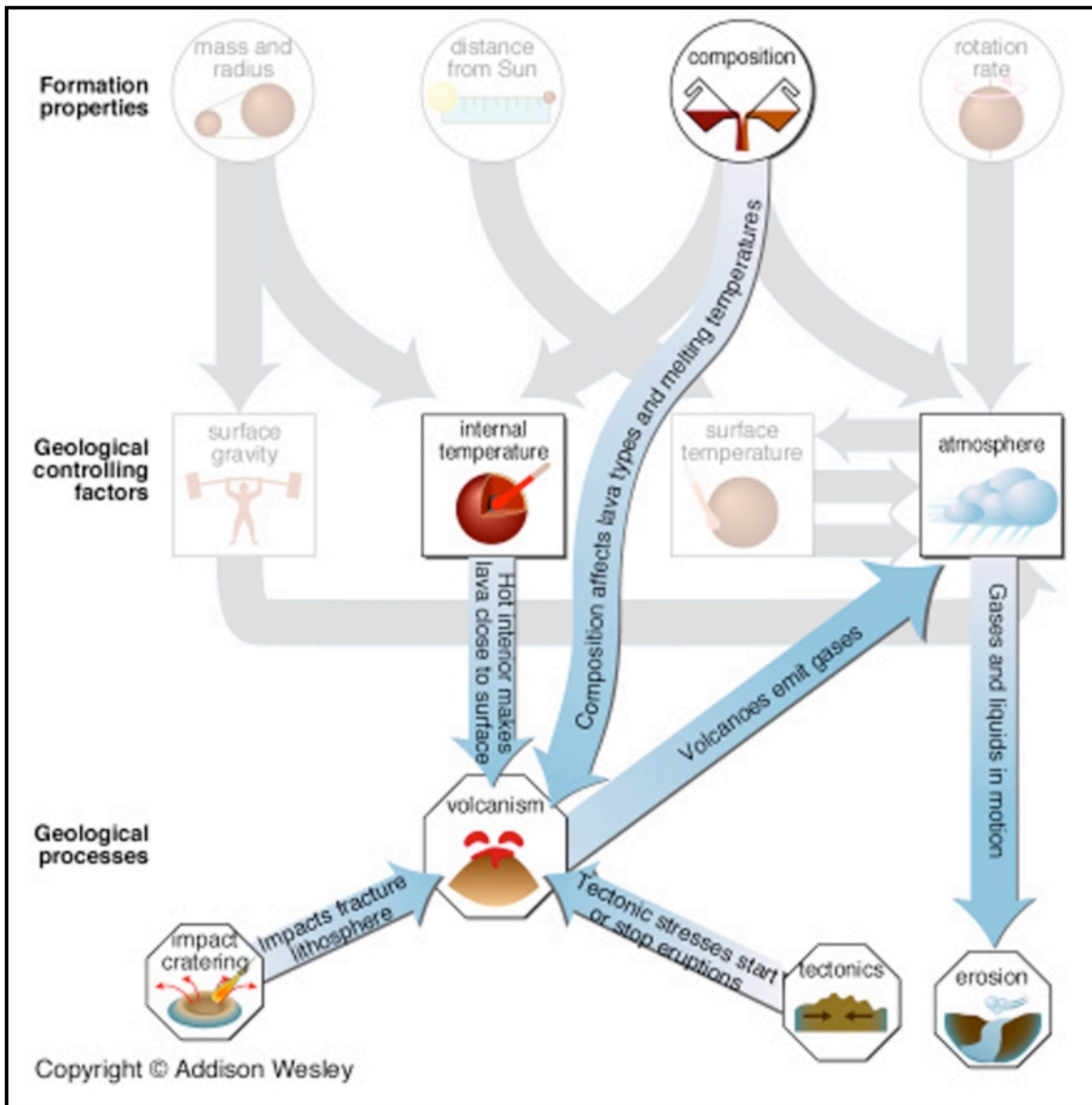
Flow Chart 1:
Formation properties of planets influence geological processes



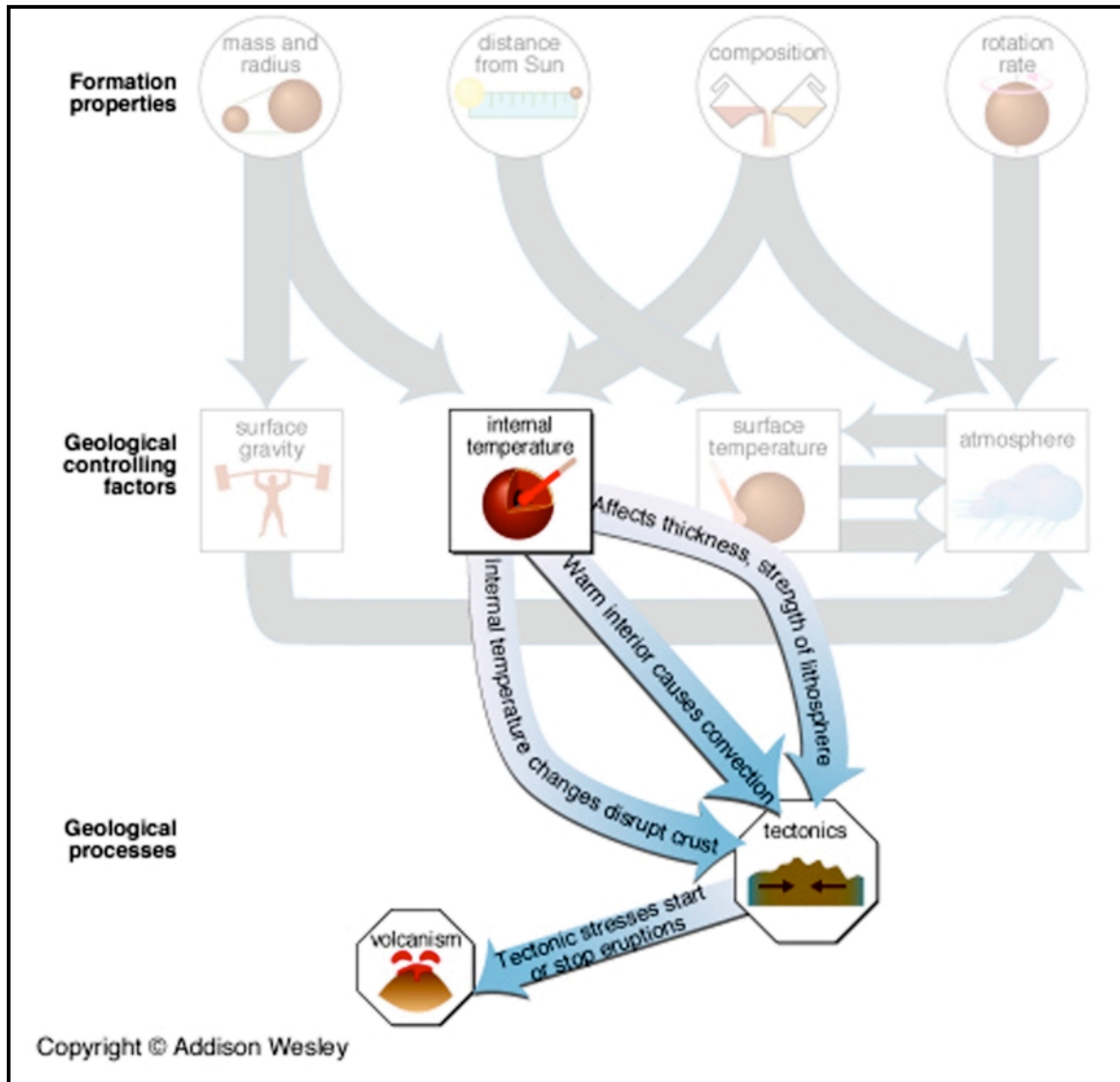
Flow Chart 2: Cratering



Flow Chart 3: Volcanism



Flow Chart 4: Tectonics



Flow Chart 5: Erosion

