

Chapter 2 Study Guide and Case Studies: Energy Sources of Earth Processes and Disasters

Key Concepts

- The four principal types of energy relevant to natural disasters are kinetic, potential, rotational and thermal energy. Potential energy occurs in various forms, such as gravitational potential energy and elastic potential energy.
- Newton's three laws of motion explain how forces act on bodies. Work is done on an object by exerting a force. A body initially at rest is accelerated by the acting force.
- A type of energy can be transformed into another type of energy.
- Energies, forces and deformation along an earthquake fault can be likened to those of a coil spring. Protrusions (asperities) on a fault increase friction that lead to the locking of a fault.
- Stress across or along an earthquake fault causes strain.
- Earth and the Moon attract each other through the same gravitational force, but with opposite sign, according to Newton's Law of Universal Gravitation.
- Rotating motion causes acceleration and rotation bodies experience a (fictitious) centrifugal force.
- As a result of Earth's daily rotation around its spin axis, the Coriolis Effect deflects moving objects to the right in the Northern Hemisphere and to the left in the Southern Hemisphere.
- Earth's internal heat is a result of energy from impacts during early formation, initial gravitational compression, early differentiation and the decay of radioactive elements (fission).
- Earth's external heat is mainly the result of solar radiation. The Sun's energy is generated through fusion of hydrogen into helium.
- Heat can be transferred by ways of radiation, conduction, diffusion and convection, whereby the latter also involved mass transport and is the most effective transport mechanisms.
- H₂O exists in three phases: ice is solid, water is liquid and water vapor is gaseous. A phase change either takes up energy (endothermic) or releases energy (exothermic).
- Heat is taken up by water vapor during evaporation (endothermic phase change) and released during condensation (exothermic phase change). This energy is stored in the water vapor as latent heat.
- A calorie is defined as the amount of heat energy necessary to raise the temperature of 1 g of water by 1°C.

- Water has a high heat capacity implying that it takes up a large amount of heat before its temperature rises.
- The barycenter, the center of mass of the Earth-Moon system is about $\frac{3}{4}$ from Earth's center. The Moon and, to a lesser degree the Sun, exert tidal forces on Earth. Earth deforms in response and has two bulges (the locations of high tides) and two depressions (the locations of low tides).
- The time for a tidal bulge to return to the same geographic location is about 24 h 50 min, i.e. high and low tides occur about 50 min later each day. Most locations on Earth experience semi-diurnal tides (two high tides and two low tides a day), while relatively few locations experience diurnal tides (one high and low tide each day). Some locations, including the U.S. West Coast experience mixed tides. The tidal range at a location is the daily difference between the highest high tides and the lowest low tide.
- The sidereal month of 27.3 days is the time it takes for the Moon to orbit Earth, relative to the stars. The synodic month of about 29.5 days is the time it takes for the Moon to orbit Earth with respect to the Sun-Earth line, e.g. the time between two Full Moons.
- Spring tides occur twice a month: during Full Moon (Moon-Earth-Sun in a line as viewed from above the Sun's north pole) and New Moon (Earth-Moon-Sun in a line as viewed from above the Sun's north pole). Neap tides occur twice a month when Earth, the Sun and the Moon make a right angle (First Quarter Moon, Last Quarter Moon). The tidal range is largest during spring tide and smallest during neap tide.
- Along Moon's slightly elliptical orbit around Earth, the perigee is at the shortest distance to Earth, while the apogee is at the greatest distance. Spring tides are particularly large when Earth, the Moon and the Sun align at perigee and perihelion (Earth's shortest distance to the Sun). This occurs twice a year, in June and December.

Key Terms

- kinetic energy
- potential energy
- rotational energy
- thermal energy (heat)
- force, acceleration
- Newton's laws of motion
- gravitational potential energy
- elastic potential energy
- spring constant, elastic and plastic deformation
- brittle failure
- asperities
- stress
- strain
- centrifugal force
- Coriolis Effect
- gravitational compression
- differentiation
- fission
- fusion
- conduction
- radiation
- diffusion
- convection
- phase changes
- latent heat of fusion
- latent heat of vaporization
- evaporation and condensation
- heat capacity
- climate moderator
- barycenter
- Earth tides
- high and low tides
- tidal range
- spring and neap tides
- Moon phases
- sidereal and synodic month

Questions for Review

1. What are the four principal types of energy relevant to natural disasters?
2. Explain the concept of the normal force acting on a body on a horizontal surface and a slope.
3. What is the name of the energy of motion?
4. What happens to the potential energy of a falling object?
5. How does a coil spring store energy? On what parameter(s) does the amount of energy it can store depend?
6. Discuss the analogies between forces acting on a coil spring and forces acting along an earthquake fault.
7. What is the relationship between stress and strain?
8. Explain the concept of the centrifugal force.
9. What happens to an object that is initially on the edge of a spinning disk and moving straight toward the center? Which effect explains this movement? How does this compare to an object on Earth that moves northward from the equator?
10. How does the Coriolis Effect deflect moving objects in the Southern Hemisphere?
11. What are Earth's principal types of energy? Discuss an example for each type.
12. What are the principal ways to transfer heat?
13. Define latent heat.
14. What is an endothermic process? What is an exothermic process?
15. Relate the terms endothermic and exothermic to the processes of condensation and evaporation.
16. Explain the concept of heat capacity.
17. Which forces cause tides on Earth?
18. How often do high and low tides occur?

19. Define the tidal range.
20. What is the difference between a high tide and a spring tide?
21. Define a neap tide.
22. Relate spring tides and neap tides to the phases of the Moon.
23. What is the difference between the synodic month and the sidereal month of the Moon?
24. What is an example of a ductile material?