Lesson 4 Test Bank – Atmosphere Energy, Radiation, and Temperatures

Multiple Choice Questions

1. What is the definition of heat in atmospheric science?
   1. Motion of gases
   2. Average molecular velocity
   3. Total energy from molecular motion
   4. Change in pressure

Correct Answer: C

1. What is the primary form of energy emitted by Earth back into space?
2. Gamma rays and X-rays
3. Ultraviolet and visible radiation
4. Microwaves and radio waves
5. Thermal infrared radiation

Correct Answer: D

1. Latent heat is transferred into the air by
   1. conduction
   2. convection
   3. radiation
   4. none of the above

Correct Answer: B

1. \_\_\_\_ heat is used in the evaporation process.
   1. Sensible
   2. Latent
   3. Ground
   4. Potential

Correct Answer: B

1. \_\_\_\_\_ heat is released from water molecules and converted to \_\_\_\_\_ heat during condensation:
2. Sensible; latent
3. Latent; sensible
4. Potential; kinetic
5. Kinetic; radiant

Correct Answer: B

1. What is specific heat?
   1. Energy needed to break molecular bonds
   2. Energy required to raise 1g of substance by 1°C
   3. Maximum heat a body can store
   4. The heat emitted by a specific surface

Correct Answer: B

1. Which of the following best represents the primary forms of energy received by Earth from the Sun?
2. Longwave radiation and ultraviolet light
3. Ultraviolet, visible, and near-infrared radiation
4. Gamma rays and X-rays
5. Microwaves and radio waves

Correct Answer: B

1. The temperature of a substance is related to:
   1. Its albedo
   2. The speed of its molecules
   3. Cloud height
   4. Air pressure

Correct Answer: B

1. What is the difference between elevation and altitude?
2. Elevation is the height of a point on Earth's surface; altitude is the height above Earth's surface
3. Elevation is the height above Earth's surface; altitude is the height of a point on Earth's surface
4. Elevation is the height on Earth's surface; altitude is the geographic latitude
5. Elevation and altitude both mean the same thing

Correct Answer: A

1. What process is responsible for the blue color of the sky?
   1. Reflection
   2. Absorption
   3. Scattering
   4. Diffusion

Correct Answer: C

1. Which mode of heat transfer dominates in fluids like air and water?
   1. Radiation
   2. Convection
   3. Conduction
   4. Reflection

Correct Answer: B

1. Which surface has the highest albedo?
   1. Grass
   2. Asphalt
   3. Snow
   4. Water

Correct Answer: C

1. What is the average global albedo of Earth?
   1. 10%
   2. 30%
   3. 50%
   4. 70%

Correct Answer: B

1. What is the relationship between albedo and absorption?
   1. Direct
   2. Inverse
   3. No relationship
   4. Logarithmic

Correct Answer: B

1. What happens to solar radiation as atmospheric path length increases?
   1. It increases
   2. It stays the same
   3. It decreases
   4. It turns into infrared

Correct Answer: C

1. Why does asphalt feel hotter than grass during the day?
   1. It absorbs more sunlight
   2. It has a higher albedo
   3. It reflects more radiation
   4. It contains water

Correct Answer: A

1. Which of the following surfaces would warm the fastest?
   1. Ocean
   2. Concrete
   3. Forest
   4. Wet soil

Correct Answer: B

1. What is true about the Kelvin scale?
   1. Its unit size is larger than Celsius
   2. It starts at the freezing point of water
   3. It has no negative values
   4. It’s commonly used in weather forecasts

Correct Answer: C

1. What is the unit of temperature on the absolute scale?
   1. Degrees Celsius
   2. Joules
   3. Fahrenheit
   4. Kelvin

Correct Answer: D

1. Temperature is defined as:
   1. Total heat energy
   2. Change in kinetic energy
   3. Average kinetic energy of molecules
   4. Motion of particles

Correct Answer: C

1. How is temperature measured properly in meteorology?
   1. At ground level in sunlight
   2. Near buildings
   3. 4–6 feet above ground in shaded, ventilated area
   4. In a sealed box

Correct Answer: C

1. Which temperature scale is most commonly used in the U.S.?
   1. Kelvin
   2. Celsius
   3. Rankine
   4. Fahrenheit

Correct Answer: D

1. What unit is used to express radiant energy in climate studies?
   1. Degrees
   2. Joules
   3. Watts per square meter (W/m²)
   4. BTUs

Correct Answer: C

1. Which of the following is true of latent heat?
   1. It is released during melting
   2. It is stored during condensation
   3. It changes temperature directly
   4. It drives phase changes

Correct Answer: D

1. Compared to water, how does the specific heat of land affect how quickly it heats?
2. Land has higher specific heat and heats slowly
3. Land has higher specific heat and heats quickly
4. Land has lower specific heat and heats slowly
5. Land has lower specific heat and heats quickly

Correct Answer: D

1. What type of energy is dominant in the upper thermosphere?
   1. Sensible heat
   2. Kinetic energy
   3. Potential energy
   4. Latent heat

Correct Answer: B

1. What is the main reason temperatures are cooler at higher elevations?
   1. Increased UV rays
   2. Higher air pressure
   3. Lower heat capacity of thin air
   4. Less radiation emitted

Correct Answer: C

1. What is energy balance in Earth’s system?
   1. More incoming than outgoing radiation
   2. Equal incoming and outgoing radiation
   3. Constant atmospheric temperature
   4. Energy loss to the Moon

Correct Answer: B

1. How do coastal cities compare to inland cities at the same latitude during summer and winter?
2. Warmer in summer; warmer in winter
3. Warmer in summer; cooler in winter
4. Cooler in summer; warmer in winter
5. Cooler in summer; cooler in winter

Correct Answer: C

1. What term describes the larger temperature range found in inland areas away from large bodies of water?
2. Maritime effect
3. Specific heat
4. Continentality
5. Heat dome

Correct Answer: C

1. What does a large annual temperature range suggest?
   1. Constant weather
   2. Oceanic influence
   3. Inland location
   4. High humidity

Correct Answer: C

1. Where is daily temperature range typically highest?
   1. Coastal regions
   2. Forested zones
   3. Urban centers
   4. Deserts

Correct Answer: D

1. What causes seasonal temperature lag?
   1. Equator’s location
   2. Delay in atmosphere’s response to insolation
   3. Time zones
   4. Wind patterns

Correct Answer: B

1. What happens to temperature at high altitudes?
   1. It increases linearly
   2. It remains constant
   3. It fluctuates randomly
   4. It generally decreases

Correct Answer: D

1. What is net radiation (Q\*)?
   1. Incoming radiation only
   2. Outgoing longwave radiation
   3. Balance of all incoming and outgoing radiation
   4. Difference between solar and UV radiation

Correct Answer: C

1. The highest amount of net radiation is found
2. over polar seas
3. over midlatitude continents
4. over subtropical deserts
5. over tropical oceans

Correct Answer: D

1. When is net radiation (Q\*) typically negative?
   1. Noon
   2. Afternoon
   3. Nighttime
   4. Sunrise

Correct Answer: C

1. What is ground heat flux (G)?
   1. Radiation from clouds
   2. Energy transfer between atmosphere and ocean
   3. Heat transferred between Earth’s surface and subsurface
   4. Heat from volcanic activity

Correct Answer: C

1. The greenhouse effect involves:
   1. Water vapor reflecting UV rays
   2. CO₂ absorbing and re-emitting longwave radiation
   3. Methane blocking solar radiation
   4. Ozone cooling the troposphere

Correct Answer: B

1. According to the urban heat island effect, which statement is true when comparing urban and rural areas?
2. Urban residential areas have the highest late afternoon temperatures
3. Large parks have no effect on urban temperatures
4. Urban areas are typically 1 to 3°C warmer than nearby rural areas
5. Temperature differences between urban and rural areas are minimal

Correct Answer: C

1. Which of the following statements about urban areas is false?
2. Urban surfaces are often sealed, increasing runoff
3. Urban areas have lower albedo and higher net radiation values
4. Urban areas are typically warmer than surrounding rural areas
5. Urban areas usually have less pollution than nearby regions

Correct Answer: D

1. How does land heating differ from water heating?
   1. Land heats more slowly
   2. Water absorbs more sunlight
   3. Land has lower specific heat
   4. Water conducts better

Correct Answer: C

1. During evaporation, what happens to surface temperature?
   1. Increases
   2. Decreases
   3. Remains constant
   4. Becomes erratic

Correct Answer: B

1. Which of the following most effectively absorbs longwave radiation?
   1. Oxygen
   2. Nitrogen
   3. Water vapor
   4. Argon

Correct Answer: C

1. Which radiation type does Earth primarily emit?
   1. Shortwave
   2. Gamma
   3. Longwave
   4. Microwave

Correct Answer: C

1. High latent heat transfer (LE) indicates:
   1. Melting of ice
   2. Evaporation
   3. Increased wind speed
   4. Cloud condensation

Correct Answer: B

1. What is the main reason why clouds can both cool and warm the Earth?
   1. They only reflect sunlight
   2. They only absorb heat
   3. They reflect solar radiation and absorb longwave radiation
   4. They are composed of ice

Correct Answer: C

1. The average kinetic energy of molecules in a substance is measured as:
   1. Heat
   2. Radiation
   3. Temperature
   4. Conductivity

Correct Answer: C

1. Which phase change absorbs the most energy?
   1. Condensation
   2. Freezing
   3. Evaporation
   4. Deposition

Correct Answer: C

1. Which of the following energy balance components has the most significant impact on the temperature of the air above the surface?
   1. sensible heat transfer
   2. latent heat transfer
   3. ground heat transfer
   4. none of the above affect the temperature of the air.

Correct Answer: A

1. Which of the following is NOT a temperature control?
   1. Latitude
   2. Elevation
   3. Longitude
   4. Cloud cover

Correct Answer: C

1. What causes the urban heat island effect?
   1. Water evaporation
   2. Reflective city surfaces
   3. Heat retention by built materials
   4. Increased cloud cover

Correct Answer: C

1. What does a high albedo surface do?
   1. Absorbs most of the incoming energy
   2. Emits high levels of longwave radiation
   3. Reflects a large percentage of solar radiation
   4. Conducts heat to the atmosphere

Correct Answer: C

1. Which substance has the highest specific heat?
   1. Sand
   2. Soil
   3. Water
   4. Asphalt

Correct Answer: C

1. Which process releases latent heat to the surrounding air?
   1. Melting
   2. Freezing
   3. Evaporation
   4. Condensation

Correct Answer: D

1. What does a positive sensible heat flux (H) indicate?
   1. Heat is entering the ground
   2. Heat is being stored in water vapor
   3. Heat is transferred from surface to air
   4. Heat is trapped in clouds

Correct Answer: C

1. Which process stores energy in water vapor?
   1. Sublimation
   2. Evaporation
   3. Condensation
   4. Freezing

Correct Answer: B

1. Heat transfer into the air is most efficient
2. when there is turbulent mixing
3. when the air is still
4. when there is no difference in the temperature between the air and the surface
5. none of the above

Correct Answer: A

1. Which of the following is NOT a method of solar radiation modification (SRM)?
2. Space mirrors
3. Cirrus cloud thinning
4. Greenhouse farming
5. Stratospheric aerosol injection

Correct Answer: C

Written Response Questions

1. Explain the difference between energy, heat, and temperature.

Correct Answer: Energy is the ability to do work. Heat is the total energy of molecular motion in a substance. Temperature is the average kinetic energy of molecules.

1. Describe the three modes of heat transfer and provide an example of each.

Correct Answer: Radiation (e.g., sunlight), conduction (e.g., pan on stove), convection (e.g., boiling water).

1. What is latent heat, and why is it important in weather processes?

Correct Answer: Latent heat is absorbed or released during phase changes without changing temperature. It fuels processes like cloud formation and storms.

1. Briefly describe the latitudinal variation of the radiation balance.

Correct Answer: There is a net gain of radiation between about 38 North and South latitude. Poleward of these latitudes there is a net loss of radiation.

1. How does specific heat affect land-water heating differences?

Correct Answer: Water’s high specific heat causes it to heat and cool slowly, leading to more moderate temperatures near oceans compared to land.

1. Why does water heat more slowly than land?

Correct Answer: Water has a high specific heat, absorbs heat through depth and mixing, and uses energy for evaporation, slowing temperature rise.

1. Explain the difference between sensible and latent heat fluxes.

Correct Answer: Sensible heat changes air temperature through conduction/convection. Latent heat is stored or released during phase changes.

1. Define albedo and give three examples of surfaces with different albedos.

Correct Answer: Albedo is the percentage of solar radiation reflected. Snow ≈ 0.87, grass ≈ 0.23, asphalt ≈ 0.05.

1. Why do physical geographers refer to the gasses of the atmosphere as a "selective absorber" of radiation?

Correct Answer: A gas that is a selective absorber is one that absorbs only particular wavelengths of light. The gasses of Earth's atmosphere are considered selective absorbers as they tend to allow shortwave solar radiation through but absorbs longwave radiation emitted by the surface.

1. Compare and contrast conduction, convection, and radiation.

Correct Answer: Conduction is the heat transfer via molecular collisions. Convection is heat transfer by circulation. Radiation is heat transfer via electromagnetic radiation.

1. How do clouds influence Earth’s radiation balance?

Correct Answer: Clouds reflect solar radiation (cooling) and absorb/re-emit longwave radiation (warming), affecting net radiation.

1. What is net radiation?

Correct Answer: Net radiation is an accounting of incoming and outgoing components of radiation. It also is the amount of energy used to do work in the earth system.

1. Generally speaking, where is the highest and lowest amounts of insolation and net radiation on a global basis?

Correct Answer: Insolation: highest amount in the tropical/subtropical deserts; minimum at the poles. Net radiation: maximum in the tropical/subtropical oceans; minimum at the poles.

1. What is albedo and what determines the albedo of a surface?

Correct Answer: Albedo is the proportion of light reflected from the surface. It is mostly determined by the color of the surface though sun angle influences albedo for some surfaces like water.

1. Describe the urban heat island effect and its causes.

Correct Answer: Urban areas absorb more heat due to low albedo surfaces (concrete/asphalt), reduced vegetation, and waste heat emissions.

1. What is the role of the atmosphere in modifying incoming solar radiation?

Correct Answer: It absorbs, scatters, and reflects radiation, reducing the amount reaching Earth’s surface.

1. How does convection influence surface temperature?

Correct Answer: Warm air rises, carrying heat upward, while cooler air sinks, helping distribute heat vertically in the atmosphere.

1. Compare the thermal response of asphalt and a water puddle on a hot day.

Correct Answer: Asphalt heats quickly due to low specific heat and dark color; water heats slowly and uses energy for evaporation.

1. Why are temperatures in the thermosphere high but not “hot”?

Correct Answer: Molecules move fast (high temperature), but are sparse, so little heat is transferred—thus it feels cold.

1. Describe the energy budget equation for the Earth-atmosphere system.

Correct Answer: Q\* = H (sensible) + LE (latent) + G (ground); net radiation powers non-radiative heat transfers at the surface.

1. What happens to surface temperature at night and why?

Correct Answer: It cools as outgoing longwave radiation exceeds incoming radiation, often leading to negative net radiation.

1. What is the difference between direct and diffuse radiation?

Correct Answer: Direct radiation travels straight from the Sun; diffuse radiation is scattered by particles before reaching the surface.

1. What factors control surface insolation?

Correct Answer: Sun angle, atmospheric path length, cloud cover, aerosols, and surface albedo.

1. Explain how daily and annual temperature ranges are calculated.

Correct Answer: Daily: high minus low temperature in 24 hours; annual: warmest minus coldest monthly average.

1. What is a temperature lag, and why does it occur?

Correct Answer: Delay between peak insolation and peak temperature due to Earth’s surface slowly absorbing and releasing heat.

1. How does altitude influence air temperature and heat capacity?

Correct Answer: Higher altitudes have cooler temps and thinner air, which holds less heat and radiates it less efficiently.

1. Compare maritime and continental temperature effects.

Correct Answer: Maritime areas have smaller temperature ranges due to water's moderating effect; inland areas have larger ranges.

1. How does evaporation cool the Earth's surface?

Correct Answer: Evaporation absorbs latent heat from the surface, removing energy and lowering the temperature.

1. What determines the amount of radiation emitted by a body?

Correct Answer: The amount of radiation emitted by a body depends on the temperature of the emitting body.

1. What causes red skies at sunrise and sunset?

Correct Answer: Longer atmospheric path length scatters shorter blue wavelengths, leaving reds and oranges visible.

1. Summarize the implications of global warming on temperature extremes.

Correct Answer: Global warming increases average temperatures and intensifies extremes like heatwaves, droughts, and rapid ice melt.

1. Compare and contrast latent heat transfer in humid and arid regions.

Correct Answer: There is more latent heat flux in a humid region because there is more water available than in a desert region.

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