NOTE: I made a mistake and two questions (6 & 33 in this version) had two correct answers instead of just one. So credit was given if you selected either of the correct choices.

Name______________________    Clicker #____________________

Enter your name and clicker number in the space provided above. On your answer sheet you must enter your name, clicker number, and test form. When you are finished with this exam you must hand in your answer sheet AND the test. Be sure to mark your answers on the answer sheet.

Answer as many questions as you can by picking the BEST answer. If you have a question, raise your hand. Good luck.

1. Use the following values to determine the amount of terrestrial radiation emitted by the surface of the Earth which is then absorbed by materials in the atmosphere. Assume that an energy balance exists for the surface, the atmosphere, and the entire Earth/atmosphere system. All values are expressed as a percentage of the solar constant. I suggest drawing a planetary energy budget.

   25% = Absorption of solar radiation by the atmosphere which is then lost to space as terrestrial radiation.
   40% = Heat transfer from the surface to the atmosphere by evaporation + convection. This amount is then emitted to space as terrestrial radiation.
   5% = Amount of terrestrial radiation emitted by the surface that is lost directly to space.
   25% = Planetary albedo of the entire earth/atmosphere system.
   60% = The amount of terrestrial radiation emitted by greenhouse gases in the atmosphere that is redirected back to the surface of the Earth where it is absorbed.

   A) 65%
   B) 90%
   C) 100%
   D) 105%
   E) 130%
Use the graph show above to answer the following question.

2. What is the relative humidity of air with the conditions defined by the point labeled with the letter “E”?
   
   A) 2.5%
   B) 2%
   C) 50%
   D) 25%
   E) 12%

3. Some important plankton and coral species in the ocean produce shells made of calcium carbonate (CaCO₃). These organisms may become stressed in the future because_____.

   A) there will be too little dissolved CO₂ in ocean water
   B) there will be too little carbonic acid (H₂CO₃) formation
   C) there will be too much soluble carbonate ion (CO₃⁻) in ocean water
   D) more CO₂ will cause the pH of ocean water to increase
   E) increased CO₂ reduces levels of soluble carbonate ions in ocean water
4. According to Bazzaz and Fajer (1992), C₄ plants (when compared to C₃ plants) have special anatomical and biochemical features that ________.

A) reduce water loss
B) disproportionately improve their performance in a CO₂-rich world in ways that may give them a competitive advantage
C) allow them to acquire nutrients more effectively  
D) allow them to concentrate CO₂ near the active site of the key enzyme for photosynthesis (RUBP carboxylase)
E) make their leaves less nutritious for plant-eating insects

5. Most complex systems (including biological and ecological systems) have hierarchical structures. Which of the following sequences is NOT listed in a way that forms a hierarchy?

A) Coach Huggins; the WVU basketball team; the Big East conference; the National Collegiate Athletic Association (NCAA)  
B) Biology 221; the Biology Department; the Eberley College of Arts & Sciences; West Virginia University
C) organisms; populations; communities; ecosystems; landscapes
D) Morgantown; Monongalia County; the United States; West Virginia
E) cell; tissue; organ; organ system; organism

6. The portion of a Tropical Hadley Cell where parcels of warm surface air rise is called the rising limb of a Tropical Hadley Cell. Which of the following statements about the rising limb of a Tropical Hadley Cell is correct?

A) It is always found at the geographical Equator.
B) It creates regions of low atmospheric pressure at the surface of the Earth.
C) For large areas of the ocean, its position lags behind the movement of the subsolar line to a greater extent than it does for large areas of land.
D) It is associated with periods of low rainfall and drought in the tropics.
E) Is associated with the Horse Latitudes.

7. What factors can contribute to the formation of downwelling water?

A) Lower water temperatures.
B) Higher salinity.
C) Sea ice formation.
D) Both A & B
E) Both A, B, & C
8. Every 41,000 years, the tilt of the Earth’s rotational axis varies between 22.1° to 24.5° from being perpendicular to the Earth’s orbital plane around the Sun. Currently the axis is tilted 23.5°. At its smallest (22.1°) value, this tilt of the rotational axis will result in summers in the Northern Hemisphere being ________ and winters being ________.

A) warmer; cooler
B) **cooler; warmer**
C) cooler; cooler
D) same as they are now; cooler
E) warmer; warmer

9. What is causing the difference in the temperature when corn (a C₄ plant) is fumigated with elevated concentrations of carbon dioxide (CO₂)?

A) Greater rates of photosynthesis.
B) More photorespiration.
C) **Lower rates of transpiration due to smaller stomatal openings.**
D) Less soil moisture.
E) Higher rates of transpiration due to more soil moisture.

10. If the orographic effect creates a rain forest on the windward side of a tall mountain, then what accounts for the observation that the rising air on the windward side is cooled to a lesser extent by expansion than the descending air on the leeward side is warmed by compression? Assume the parcels of air begin and end at the same elevation.

A) The descending air is protected from the prevailing winds.
B) The rising moist air warms more rapidly than the sinking dry air cools.
C) The change in pressure is less for the descending air.
D) Dry air has a lower adiabatic lapse rate than moist air.
E) **None of the above.**
11. If large hurricanes form around regions of low pressure at the surface of the Earth, then as surface air moves into the region of low pressure from ALL directions it will create surface winds that _____.

   A) swirl clockwise in the Southern & Northern Hemisphere
   B) swirl counterclockwise in the Southern & Northern Hemisphere
   C) swirl clockwise in the Northern Hemisphere & counterclockwise in the Southern Hemisphere
   D) swirl counterclockwise Northern Hemisphere & clockwise in the Southern Hemisphere
   E) none of the above

12. An ecologist observes that the diet of a bird species consists of large grass seeds rather than the smaller seeds of other plants found in a given area. She hypothesizes that they choose the larger seeds because they have more nitrogen than the smaller seeds at this site. To test her hypothesis she measures the nitrogen content of both the large and smaller seeds obtained from plants growing where the birds are feeding. She finds that the larger grass seeds have a much higher amount of nitrogen. What is an appropriate conclusion for her to draw from these results?

   A) The results prove her hypothesis to be true.
   B) The results show that, at least at this location, birds select large seeds due to the greater amounts of nitrogen they contain.
   C) The results support but do not prove her hypothesis.
   D) Increasing the nitrogen content of smaller seeds by fertilizing the plants that produce them will result in them being eaten by this bird species.
   E) The results do not support her hypothesis because she didn’t experimentally alter the nitrogen content of the seeds.

13. Surface-water currents entering the Atlantic Ocean from the Mediterranean Sea are much warmer than the surrounding water, yet they are able to sink below surface waters in the Atlantic because __________.

   A) the Atlantic is thermally stratified
   B) strong trade winds mix this water below the thermocline
   C) they experience Ekman drift because they are on the western side of continents.
   D) they have a greater saturation vapor density
   E) they are more saline than the underlying water
14. The large degree to which humans depend on, and affect, their environment is supported by the fact that about _______ % of the accessible fresh water on Earth is used by humans (mostly for irrigation).

   A) 40%
   B) 70%
   C) 30%
   D) 20%
   E) 50%

15. Surprisingly, the main result from the study of Shaw et al. (2002) was that _______.

   A) elevated CO₂ reduced the positive effect of any combination of the other factors examined (enhanced nitrogen, temperature, & precipitation)
   B) elevated CO₂ enhanced the effect of adding water
   C) the effect of adding CO₂ and nitrogen was greater than the effect of adding CO₂ alone
   D) elevated CO₂ enhanced the effect of warming
   E) elevated CO₂ had no effect when it was combined with any of the other factors examined (enhanced nitrogen, temperature, & precipitation)

16. What would be an accurate conclusion to draw from the information about amphibian decline that you read in the assigned articles and that you were given in lecture.

   A) All amphibian species are susceptible to current levels of UV-B radiation.
   B) All amphibian species are in decline.
   C) Of the species examined, those with low photolyase activity were often more sensitive to current levels of UV-B radiation.
   D) All species with high levels of photolyase activity were not declining.
   E) Current levels of UV-B radiation do not affect any amphibians in ways that may contribute to their declining abundance.

17. During a strong El Nino event, the thermocline in the waters off the Peruvian coast of South America _______.

   A) occurs at a greater depth than when an El Nino event is not occurring
   B) is closer to the surface than when an El Nino is not occurring
   C) is not affected because it is too deep to be altered by surface winds
   D) is destroyed by the large mass of cold water moving across the Pacific
   E) none of the above
18. The Suess effect is the ______ in the concentration of radioactive carbon \(^{14}\text{C}\) in atmospheric CO\(_2\) that is due to ______.

A) increase; the burning of vegetation  
B) increase; the burning of fossil fuels  
C) decrease; the greenhouse effect  
D) decrease; burning of fossil fuels  
E) increase; the greenhouse effect

19. Between 30-60° south latitude, surface winds __________.

A) are deflected to the left of the direction of travel and blow from west to east  
B) are deflected to the left of the direction of travel and blow from east to west  
C) are deflected to the right of the direction of travel and blow from west to east  
D) are deflected to the right of the direction of travel and blow from east to west  

20. ______ refers to the timing of a critical event in the life history of an organism.

A) Transpiration  
B) Down regulation  
C) Enhancement ratio  
D) Phenology  
E) Convection

21. What factors cause the seasons?

A) The changing distance between the Earth and the Sun.  
B) **The tilt of the Earth’s axis of rotation.**  
C) The elliptical shape of the Earths orbit around the Sun.  
D) Seasonal changes in the output of electromagnetic radiation by the Sun  
E) Both A & C

22. The term “ecosystem” was first used by ______.

A) Ernst Haeckel  
B) **Arthur Tansley**  
C) Andrew Blaustein  
D) Ray Lindeman  
E) Charles Darwin
23. For most of the ocean, it is difficult for surface and deep water to mix due to ________.

A) the doldrums  
B) Ekman drift  
C) **thermal stratification**  
D) the formation of sea ice  
E) the intertropical convergence zone

24. Surface water in the ocean (~ the upper 100 m) is typically ________.

A) cooler than deep water  
B) unaffected by surface winds  
C) denser that deep water  
D) nutrient rich relative to deep water  
E) **none of the above**

25. An AC_{i} curve is a plot of ________.

A) wavelength vs. radiation flux density per wavelength  
B) time vs. atmospheric carbon dioxide (CO_{2}) concentrations  
C) time vs. the concentration of radioactive carbon (^{14}C) in atmospheric CO_{2}  
D) **the intercellular concentration of CO_{2} of a leaf vs. the rate of photosynthesis**  
E) temperature vs. water vapor pressure in the air

26. If the albedo of Earth was permanently increased to 35% of the solar constant, what amount of infrared radiation (i.e. terrestrial radiation) would the Earth emit back to space (i.e. leaving through the top of the atmosphere) once a new equilibrium was established?

A) 70% of the solar constant  
B) **65% of the solar constant**  
C) 35% of the solar constant  
D) 30% of the solar constant

27. The orographic effect can create ________.

A) rain forests on the leeward side of tall mountains  
B) **drier conditions in the rain shadow of tall mountains**  
C) warmer winter temperatures near large bodies of water  
D) wetter conditions in the rain shadow of tall mountains  
E) warmer/drier microclimates on the north-facing slopes of tall mountains in the northern hemisphere
28. Photosynthetically active radiation (PAR) has ______ than microwaves.

A) a greater energy content per photon
B) a lower energy content per photon
C) shorter wavelengths
D) a longer wavelength of maximum emission
E) both A & C

29. The spectral irradiance curve of four objects is shown above. Which object would give the greatest value from the equation for the Stephan-Boltzman Law?

A) Object 2
B) Object 3
C) Object 1
D) Object 4
E) All would have the same value.

30. A strong El Nino event can reduce fisheries along the Peruvian coast because ______.

A) nutrient-rich surface water sinks
B) upwelling stops
C) upwelling water during these events comes from the nutrient-rich water below the thermocline
D) thermohaline circulation of deepwater slows
E) upwelling water during these events comes from the nutrient-poor water above the thermocline
31. A reduction, or complete stoppage, of the Atlantic Conveyor _________.

   A) has never occurred
   B) would trigger a mini ice age if it occurred today
   C) would cause cooler winters in western Europe & northern Scandinavia
   D) could result from a large input of freshwater into the north Atlantic
   E) both C & D

32. The coastal waters off the western United States are cooler than coastal waters off the eastern coast (assuming the latitudes are the same) because __________.

   A) the western coast is a region of downwelling water.
   B) the eastern coast is a region of coastal upwelling caused by Ekman drift
   C) surface currents transport water along the western coast from higher latitudes to the tropics
   D) cool water is being transported by surface currents along the western coast from the tropics to higher latitudes as part of an ocean gyre
   E) the water along the western coast exhibits thermal stratification

33. Which of the following statements about electromagnetic radiation (EMR) is false?

   A) Unlike many other forms of energy, it can travel through the near vacuum of outer space.
   B) Closed systems do not exchange EMR with their surroundings.
   C) The energy Earth flux per wavelength is the same for all the wavelengths of EMR emitted by the.
   D) Sunlight is a type of EMR.
   E) You emit more EMR than an icicle.

34. Estimates that the livelihood of > 50% of the world’s people depends directly on forests, rangelands, croplands, and fisheries suggests that __________.

   A) almost anything can be viewed as an ecosystem as long as it has a community of organisms interacting with each other and the physical environment through the exchange of matter and energy
   B) the Earth is essentially a closed system
   C) ecosystems are maintained by a continuous flow of energy
   D) the health of an economy cannot be separated from the health of its natural support systems
   E) good and bad environments exist for every species
35. The region of rapidly declining temperatures with increasing depth in the ocean is called _______.

A) an ocean gyre
B) thermal stratification
C) the thermocline
D) Ekman drift
E) thermal haline circulation

36. The position on the surface of the Earth where solar radiation strikes at a right angle _______.

A) always matches the position of the intertropical convergence zone
B) matches the position of the descending limb of the tropical Hadley cell
C) is always at the geographical equator
D) is at the Horse Latitudes during the equinoxes
E) none of the above

37. Why does the amount of terrestrial radiation emitted by the Earth’s surface exceed the amount of solar radiation it absorbs?

A) Because of the latent heat of evaporation it gains.
B) Because it also absorbs infrared radiation emitted by materials in the atmosphere.
C) Because of convective heat transport by rising parcels of air.
D) Because a large fraction of solar radiation is reflected back to space.
E) Because not all the solar radiation that reaches the surface is absorbed there.

38. The band of clouds shown in the picture is associated with _______.

A) downwelling ocean water
B) the intertropical convergence zone (ITCZ)
C) low atmospheric pressure at the surface of the Earth
D) the Horse Latitudes
E) both B & C
39. Activism with the objective of protecting or “improving” the environment is called ________.
   
   A) environmentalism  
   B) environmental science  
   C) ecosystem ecology  
   D) global ecology  
   E) landscape ecology

40. A study that examines how predation by birds affects the gypsy moth population in a central Appalachian hardwood forest is best suited for publication in which of the following scientific journals?
   
   A) The Journal of Community Ecology  
   B) Landscape Ecology  
   C) The Journal of Organismal Biology  
   D) Ecosystems  