

NATS 1750

Test #2

Test #2 Results

1. If Earth was three times as far from the Sun the Solar Constant would be:

(a) one ninth of its present value

(b) the same

(c) twice as large

(d) four times larger

(e) sixteen times smaller

As planet gets further away → energy received DECREASES with (distance)²

Therefore, new solar constant = old solar constant $(1/3)^2$
= old solar constant $(1/9)$

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2. Identify a pair of important IR absorbing/greenhouse gases.

(a) O_2 and CH_4

O_2 is not a greenhouse gas

(b) CH_4 and N_2

N_2 is not a greenhouse gas

(c) N_2 and CFC

neither are greenhouse gases

(d) Iron and water

iron is not a greenhouse gas

(e) water and CO_2

both are greenhouse gases

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3. The Earth is closest to the Sun

(a) at equinox.

(b) at aphelion.

(c) at summer solstice

(d) in early January.

(e) none of the above.

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4. Which one of the following statements is true?
- (a) The greenhouse effect is man-made FALSE
 - (b) IR absorbing gases like CO₂ make Earth's temperature 100 C warmer than it would be without them FALSE
 - (c) Nitrogen, N₂ is not a greenhouse gas TRUE!
 - (d) Methane and CFC's are not effective greenhouse gases FALSE
 - (e) Greenhouse gases greatly increase Earth's albedo FALSE

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5. On the December solstice which one of the following is true?

(a) The insolation at the top of the atmosphere is greatest at the North Pole

FALSE

(b) The Equator has 12 hours of daylight.

TRUE!

(c) At noon the Sun is overhead at 23.5 N, the tropic of Cancer

FALSE

(d) The North Pole has 24 hours of sunlight

FALSE

(e) The South Pole has 24 hours of darkness

FALSE

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6. The Earth's seasons are caused primarily by
- (a) the variation of the solstice.
 - (b) the slightly non-circular shape of the Earth's orbit.
 - (c) the 23.5 tilt of the Earth's rotation axis.
 - (d) the 11 year solar cycle.
 - (e) astrologers.

Test #2 Results

7. The length of the daylight period is shortest at Sydney, Australia, on approximately
- (a) 21st March.
 - (b) 21st June.**
 - (c) 21st September.
 - (d) 21st December.
 - (e) 4th January.

Important to know → Australia is in the southern hemisphere

Test #2 Results

8. Averaged over the whole year latitudes of 60 North receive less solar radiation at the ground than the Equator because
- (a) the solar zenith angle at 60 N is usually greater
 - (b) the solar zenith angle at 60 N is usually smaller
 - (c) the Equator receives less solar radiation on the June solstice but more during the equinox and December solstice periods
 - (d) the 60 N is cloudier.
 - (e) both (a) and (c)

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9. Which one of the following statements is true?

- (a) The greenhouse effect is a phenomenon partly caused by too many people with cars. TRUE!
- (b) Without IR absorbing gases such as H₂O the Earth's temperature would be about 30 C warmer.
- (c) Nitrogen N₂ is a greenhouse gas.
- (d) Methane and CFC's are not effective greenhouse gases.
- (e) Clouds cool the atmosphere by absorbing IR and warm the atmosphere by trapping solar radiation.

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10. If the radius of the Earth was 12,600 km instead of 6,300 km then
- (a) the Earth would be hotter
 - (b) the Earth would be cooler
 - (c) the Solar Constant would be two times larger
 - (d) the Earth would receive four times as much energy from the Sun**
 - (e) the Earth would receive twice as much energy from the Sun

Radius \rightarrow 2x bigger

Therefore, Area of Earth seen by sun (πR^2) \rightarrow 4x bigger

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11. At winter solstice in the northern hemisphere which one of the following is false?
- (a) The insolation (total energy received from sun in a 24 hour period) at the top of the atmosphere is larger at the north pole than at the equator.
 - (b) At noon the Sun is overhead at 23.5 S, the tropic of Capricorn.
 - (c) The Equator has 12 hours of daylight.
 - (d) The North Pole has 24 hours of darkness
 - (e) Toronto has less than 12 hours of daylight.

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12. The sky is red at sunset because

(a) the atmosphere bends the red light towards the Earth like a prism

(b) the air molecules reflect red light more than blue light

(c) most of the shorter wavelength radiation has been scattered away

(d) the Sun is weaker

(e) ozone is red

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13. At summer solstice in the northern hemisphere the South Pole has
- (a) 12 hours of daylight.
 - (b) 24 hours of daylight.
 - (c) 24 hours of darkness.**
 - (d) 12 hours of daylight.
 - (e) 6.35 hours of daylight.

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14. Over an entire year the North Pole receives

(a) slightly less solar radiation m^{-2} than the South Pole

(b) more solar radiation m^{-2} than the Equator

(c) slightly more solar radiation m^{-2} than the South Pole

(d) the same amount of solar radiation m^{-2} as the South Pole

(e) none of the above

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15. The length of the daylight period varies throughout the year with latitude and season. On the equinox the length of the daylight period is
- (a) 9 hours at a latitude 23.5 N
 - (b) 8 hours everywhere
 - (c) 9 hours at the Arctic Circle
 - (d) 24 hours everywhere
 - (e) 12 hours everywhere

Test #2 Results

16. We have some air in a sealed rigid container at a temperature of 30 °C.
If we increase the temperature of the air to 60 °C:

- (a) the pressure will double
- (b) the pressure will increase four times
- (c) the density will double
- (d) the density will decrease
- (e) the pressure will increase by about 10%

Need to convert from °C to K. (add ~270°)

30 °C → 300 K

60 °C → 330 K

From 300 K to 330 K → temp increase of 10%

→ pressure increase of 10% (P increases the same as T)

Test #2 Results

17. We have some air in a sealed rigid container at a temperature of $0\text{ }^{\circ}\text{C}$. If we increase the temperature of the air to $273\text{ }^{\circ}\text{C}$:

(a) the pressure will double

(b) the pressure will increase four times

(c) the density will double

(d) the density will decrease

(e) the pressure will increase slightly

Need to convert from $^{\circ}\text{C}$ to K. (add 273°)

$0\text{ }^{\circ}\text{C} \rightarrow 273\text{ K}$

$273\text{ }^{\circ}\text{C} \rightarrow 546\text{ K}$

From 273 K to $546\text{ K} \rightarrow$ temp doubles

\rightarrow pressure doubles (P increases the same as T)

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18. Which of the following is true about the Saturation Vapour Pressure (SVP) of water ?
- (a) As the temperature increases the SVP increases with a constant slope.
 - (b) As the temperature increases the SVP increases strongly**
 - (c) The SVP over water depends on the pressure of the air.
 - (d) The SVP over the oceans often exceeds 1000 mbar.
 - (e) All of the above.

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19. The Relative Humidity of an air sample
- (a) can only be increased by adding more water vapour
 - (b) can only be decreased by removing some water vapour
 - (c) can be decreased by increasing the temperature of the air
 - (d) can always be increased by cooling the air
 - (e) both (a) and (b)

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20. The water vapour content of air

(a) depends on the temperature of the air

(b) is given by the SVP at the temperature of the air

(c) is described by the Specific Humidity

(d) increases with the temperature of the air

(e) all of the above.

Test #2 Results

Heating the Earth:

The Earth is heated by **6000 K** radiation from the Sun, diluted by spreading out on its journey from the Sun. The main gases that form our atmosphere, O_2 and N_2 , are largely **transparent** to sunlight and so it is the surface that is actually heated most by the Sun's energy rather than the atmosphere. The surface then degrades the energy of these 'hot' photons and emits electromagnetic energy as a body with a temperature of **300 K** (27°C). From **Wien's** law we find that most of the energy from Earth is emitted in the IR region with the maximum peaking at about **10 μm** . However, at these wavelengths the atmosphere is no longer **transparent** since water and carbon dioxide absorb much of this IR radiation. In addition, gases such as CFCs, methane, nitrous oxide and ozone also play a minor role in absorbing the IR radiation from the surface. These molecules in the atmosphere then **re-emit** this absorbed energy both upwards and downwards. The upward directed radiation escapes to space. However, the downward radiation, directed to the surface, is also efficiently **absorbed** by the surface. In this manner, the Earth's surface is heated twice: once by the **sun** and once by the re-emitted IR radiation from water and carbon dioxide in the atmosphere. Of the two main IR or **greenhouse** gases, **water** is the more important of the two. This forms the basis of the greenhouse effect, which is clearly **a natural** phenomenon. Clouds also play an important role because they are also good absorbers and emitters of **IR radiation** so they also act in a similar fashion to greenhouse gases.