

Chapter 8

Solar Radiation, Heat Balance and Temperature

Very Short Answer Type Questions

1.What factors cause variation in insolation?

Answer:

The factors that cause these variations in insolation are :

- the rotation of earth on its axis;
- the angle of inclination of the sun's rays;
- the length of the day;
- the transparency of the atmosphere;
- the configuration of land in terms of its aspect.

2.What is aphelion?

Answer:

During its revolution around the sun, the earth is farthest from the sun (152 million km) on 4th July. This position of the earth is called aphelion.

3.What is perihelion?

Answer:

On 3rd January, the earth is the nearest to the sun (147 million km). This position is called perihelion.

4.What does Plank's law state?

Answer:

Plank's law states that hotter a body, the more energy it will radiate and shorter the wavelength of that radiation.

5.What factors affect the temperature of a place?

Answer:

The temperature of air at any place is influenced by

- the latitude of the place;
- the altitude of the place;
- distance from the sea, the air- mass circulation;
- the presence of warm and cold ocean currents;
- local aspects.

6.What is terrestrial radiation?

Answer:

The insolation received by the earth is in short wave forms and heats up its surface. The earth after being heated itself becomes a radiating body and it radiates energy to the atmosphere in long wave form. This energy heats up the atmosphere from below. This process is known as terrestrial radiation”

7.What are the causes behind loo in tropical regions?

Answer:

In tropical regions particularly in northern India during summer season local winds called ‘loo’ is the outcome of advection process.

8.Why does sun look red during rising and setting and why does sky look blue?

Answer:

Within the troposphere water vapour, ozone and other gases absorb much of the near infrared radiation. Very small- suspended particles in the troposphere scatter visible spectrum both to the space and towards the earth surface.

This process adds colour to the sky. The red colour of the rising and the setting sun and the blue colour of the sky are the result of scattering light of the atmosphere.

9. How does some amount of energy is reflected to the atmosphere? or what is albedo?

Answer:

While passing through the atmosphere some amount of energy is reflected, scattered and absorbed. Only the remaining part reaches the earth surface. The reflected amount of radiation is called the albedo of the earth.

10. How do sunrays while passing through atmosphere gets absorbed?

Answer:

Out of 100% received, 65 units are absorbed, 14 units within the atmosphere and 51 units by the earth's surface. The earth radiates back 51 units in the form of terrestrial radiation. Of these, 17 units are radiated to space directly and the remaining 34 units are absorbed by the atmosphere (6 units absorbed directly by the atmosphere, 9 units through convection and turbulence and 19 units through latent heat of condensation).

11. Atmosphere gets heated up indirectly by terrestrial radiation and not directly by sunrays. Explain.

Answer:

The long wave radiation is absorbed by the atmospheric gases particularly by carbon dioxide and the other green house gases. Thus, the atmosphere is indirectly heated by the earth's radiation. The atmosphere in turn radiates and transmits heat to the space. Finally, the amount of heat received from the sun is returned to space, thereby maintaining constant temperature at the earth's surface and in the atmosphere.

12. What is meant by insolation?

Answer:

The earth's surface receives most of its energy in short wavelengths. The energy received by the earth's is known as incoming solar radiation which in short is termed as insolation.

13.Differentiate between Perihelion and Aphelion.

Answer:

During its revolution around the sun, the earth is farthest from the sun, on 4th July. This position of earth is called Aphelion.

And on 3rd January, the earth is the nearest to the sun. This position is called Perihelion.

14.Why the annual insolation received by the earth on 3rd January is more than that of 4th July?

Answer:

The solar output received at the top of atmosphere varies slightly in a year due to the variations in the distance between the earth and the sun. Therefore, the annual insolation received by the earth on 3rd January is more than the amount received on 4th July.

Short Answer Type Questions

1.What is inversion of temperature? When | and in what regions does it take place?

Answer:

At times, the situations are reversed and the normal lapse rate is inverted. It is called Inversion of temperature. Inversion is usually of short duration but quite common nonetheless. A long winter night with clear skies and still air is ideal situation for inversion. The heat of the day is radiated off during the night, and by early morning hours, the earth is' cooler than the air above. Over polar areas, temperature inversion is normal throughout the year. Surface inversion promotes stability in the lower layers of the atmosphere.

Smoke and dust particles get collected beneath the inversion layer and spread horizontally to fill the lower strata of the atmosphere. Dense fogs in mornings are common occurrences especially during winter season. This inversion commonly lasts for few7 hours until the sun comes up and beings to warm the earth. The inversion takes place in hills and mountains due to air drainage.

2.How does the energy received in upper layer of the atmosphere keep changing at different times of the year?

Answer:

The solar output received at the top of the atmosphere varies slightly in a year due to the variations in the distance between the earth and the sun. During its revolution around the sun, the earth is farthest from the sun (152 million km) on 4th July. This position of the earth is called aphelion.On 3rd January, the earth is the nearest to the sun (147 million km). This position is called perihelion. Therefore, the annual insolation received by the earth on 3rd January is slightly more than the amount received on 4th July.

However, the effect of this variation in the solar output is masked by other factors like the distribution of land and sea, and the atmospheric circulation. Hence, this variation in the solar output does not have great effect on daily weather changes on the surface of the earth.

3.How does the amount of insolation received depends on the angle of inclination of the rays?

Answer:

The amount of insolation received depends on the angle of inclination of the rays. It depends on the latitude of a place. The higher the latitude the less is the angle they make with the surface of the earth resulting in slant sunrays. The area covered by vertical rays is always less than the slant rays. If more area is covered, the energy gets distributed and the net energy received per unit area decreases. Moreover, the slant rays are required to pass through greater depth of the atmosphere resulting in more absorption, scattering and diffusion.

4.Explain about spatial distribution of insolation on the earth's surface.

Answer:

The insolation received at the surface varies from about 320 Watt/m² in the tropics to about 70 Watt/m² in the poles. Maximum latitude insolation is received over the subtropical deserts, where the cloudiness is the least. Equator receives comparatively less insolation than the tropics. Generally, at the same latitude the insolation is more over the continent than over the oceans. In winter, the middle and higher latitudes receive less radiation than in summer.

5.Explain the distribution of temperature in July.

Answer:

Distribution of temperature in July

- During this period the sun shines vertically over head near the tropic of cancer. It is summer for the northern hemisphere and winters for the southern hemisphere.
- In the northern hemisphere the isotherm bends equator wards while crossing the oceans and pole wards 'while crossing the landmass. In the southern hemisphere it is vice-versa.
- The isotherms are most irregular and zig-zig in northern hemisphere on the other hand the isotherms are relatively more regular and straight in southern hemisphere.

- Maximum temperature of about 30 degree centigrade occurs entirely in the northern hemisphere between 10° and 40° north latitude however the lowest temperature below 0° C is recorded over northern hemisphere in the central parts of green land.

6.Explain the factors affecting insolation at the surface of earth.

Answer:

The factors affecting insolation at the surface of earth are:-

1. The rotation of earth on its axis: The fact that the earth on its axis makes an angle of 6614 with the plane of it's orbit round the sun has a greater influence on the amount of insolation received at different latitudes.

2. The angle of inclination of the sunrays: The higher the latitude the greater is the angle they make with the surface of the earth resulting in slant sunrays. The areas covered by vertical rays is always less than the slant rays. If more areas is covered the energy gets distributed and the net energy received per unit area decreases. Thus, the slant rays are required to pass through greater depth of the atmosphere resulting in more absorption, scattering and diffusion.

3. The transparency of the atmosphere:

The atmosphere is largely transparent to the short wave solar radiation. The incoming solar radiation passes through the atmosphere before striking the earth's surface. Within the troposphere water vapour, ozone and other gases absorb much of the near infrared radiation.

4. The configuration of land in terms of its aspect: The insolation received at the surface varies from about 320 watt/ m² in the poles. Maximum insolation is received over the subtropical deserts, when the cloudiness is the least. Equator receives less rainfall as compared to tropics

7. Distribution of temperature in the month of July.

Answer:

- During this period the sun shines vertically over head near tropic of cancer it is the summer for northern hemisphere and winter for southern hemisphere.
- The isotherms are relatively more regular and straight in southern hemisphere.
- Maximum temperature of over 30°C occurs entirely in northern hemisphere between 10° and 40° temperature below 0° C is recorded over northern hemisphere in the central parts of Greenland.

8. Explain the distribution of temperature in January.

Answer:

1. In January the isotherms deviate to north over the ocean and to the south over the continent. This can be seen on the North Atlantic Ocean.
2. The pressure of warm ocean currents, Gulf Stream and north Atlantic drift, make the northern Atlantic Ocean warmer and the isotherms bend towards the north.
3. Over the land the temperature decreases sharply and the isotherms bend towards south in Europe.
4. It is much pronounced in the Siberian plan. The mean January temperature along 60° E longitude is minus 20° both at 80° N and 50° N latitude. The mean monthly temperature for January is over 27° C in equatorial oceans over 24°C in the tropics and 2° C- 0° C in middle latitudes and -18° C to -48° C in Eurasian continental interior.
5. The effect of the ocean is well pronounced in southern hemisphere. Here, the isotherms are more or less parallel to latitudes and the variations in temperature is more gradual than in the northern hemisphere. The isotherm of 20°C, 10°C, and 0°C run parallel to 35°S, 45° and 60°S latitudes respectively.

9. How does the unequal distribution of heat over the planet earth in space and time cause variations in weather and climate?

Answer:

Weather and climate gets affected by the unequal distribution of temperature on the earth. The areas where there is high temperature, wind blows from low temperature areas. Therefore, wind move upward from equatorial regions and blow towards two poles.

Due to this wind, pressure on both the poles increases. In winter season, wind blows from land regions to oceanic regions. Therefore these wind are dry. On the other hand, during summers, wind blow from ocean towards land. Therefore, these winds are humid. Unequal distribution of temperature is main cause of blowing of wind. Rainfall and cyclone also arise due to unequal distribution of temperature. In this way, unequal distribution of temperature affects climate and weather.

10. What are the factors that control temperature distribution on the surface of the earth?

Answer:

Factors controlling temperature distribution: The temperature of air at any place is influenced by

1. the latitude of the place;
2. the altitude of the place;
3. distance from the sea, the air- mass circulation;
4. the presence of warm and cold ocean currents;
5. local aspects.

1. The latitude: The temperature of a place depends on the insolation received. It has been explained earlier that the insolation varies according to the latitude hence the temperature also varies.

2. The altitude: The atmosphere is indirectly heated by terrestrial radiation from below. Therefore, the places near the sea-level record higher temperature than the places situated at higher elevations.

3. Distance from the sea: Another factor is the location of a place with respect to the sea. Compared to land, the sea gets heated slowly and loses heat slowly. Land heats up and cools down quickly. Therefore, the differences in the temperature over the sea is less compared to land. And this places near the sea has a moderate temperature.

4. Air-mass and ocean currents: Air- masses affects the temperature. The places which come under the influence of warm air- masses experience higher temperature and the place that comes under the influence of cold air-masses experience low temperature.

11. In India, why is the day temperature maximum in May and why not after the summer solstice?

Answer:

The main cause behind temperature being highest in May is due to summer solstice. At that time sun shines on the Tropic of Capricorn. Tropic of Capricorn passes through middle of India. But it remains till end of May in India. It is because rain starts on Malabar coast at the end of the May. Due to this, temperature does not increase in South India. Although increase in temperature continues in India till 21 June and we find highest temperature in first week of June in India.

12. Why is the annual range of temperature high in the Siberian plains?

Answer:

Siberian plains are quite far off from sea. Uneven climate is found in areas located away from oceans and seas. The mean monthly temperature for January is between -18°C to -48°C in the Siberian plains. In summers, it is up to 20°C . Therefore, the annual range of temperature is -68 ($-48-20$) which is extremely high. The pressure of warm ocean currents, Gulf Stream and north Atlantic drift, make the northern Atlantic Ocean warmer and the isotherms bend towards the north. Over the land, the temperature decreases sharply and the isotherms bend towards south in Europe.

Long Answer Type Questions

1.Explain about inversion of temperature?

Answer:

At times, the situations are reversed and the normal lapse rate is inverted. It is called inversion of temperature. Inversion is usually of short duration but quite common nonetheless. A long winter night with clear skies and still air is ideal situation for inversion. The heat of the day is radiated off during the night, and by early morning hours, the earth is cooler than the air above.

Over polar areas, temperature inversion is normal throughout the year. Surface inversion promotes stability in the lower layers of the atmosphere. Smoke and dust particles get collected beneath the inversion layer and spread horizontally to fill the lower strata of the atmosphere. Dense fogs in mornings are common occurrences especially during winter season. This inversion commonly lasts for few hours until the sun comes up and begins to warm the earth. The inversion takes place in hills and mountains due to air drainage.

2.Explain the heating and the cooling mechanism of atmosphere.

Or

Discuss the process through which earth and the atmosphere system maintain heat balance.

Answer:

(a) Conduction:

- The earth after being heated by insolation transmits the heat to the atmospheric layers near to the earth in long wave form. The air in contact with the land gets heated slowly and the upper layers in contact with the lower layers also get heated.
- Conduction takes place when two bodies of unequal temperature are in contact with one another, there is a flow of energy from the warmer to cooler body. The transfer of heat continues until both the bodies attain the same temperature or the contact is broken. Conduction is important in heating the lower layers of the atmosphere.

(b) Convection:

- The air in contact with the earth rises vertically on heating in the form of currents and further transmits the heat of the atmosphere. This vertical heating of atmosphere is known as convection.
- The convection transfer of energy is confined only to the troposphere.

(c) Advection:

- The transfer of heat through horizontal movement of air is called advection. Horizontal movement of the air is relatively more important than the vertical movement.
- In tropical regions particularly in northern India during summer season local winds called 'loo' is the outcome of advection process.

3.Explain about heat budget of the earth.

Answer:

The earth receives almost all of its energy from the sun. The earth in turn radiates back to space the energy received from the sun. As a result, the earth neither warms up nor does it get cooled over a period of time. Thus, the amount of heat received by different parts of the earth is not the same. This variation causes pressure differences in the atmosphere. This leads to transfer of heat from one region to the other by winds. The insolation received at the top of the atmosphere is 100 per cent. While passing through the atmosphere some amount of energy is reflected, scattered and absorbed. Only the remaining part reaches the earth surface.

Roughly 35 units are reflected back to space even before reaching the earth's surface. Of these, 27 units are reflected back from the top of the clouds and 2 units from the snow and ice- covered areas of the earth. The reflected amount of radiation is called the albedo of the earth. The remaining 65 units are absorbed, 14 units within the atmosphere and 51 units by the earth's surface. The earth radiates back 51 units in the form of terrestrial radiation. Of these, 17 units are radiated to

space directly and the remaining 34 units are absorbed by the atmosphere (6 units absorbed directly by the atmosphere, 9 units through convection and turbulence and 19 units through latent heat of condensation). 48 units absorbed by the atmosphere (14 units from insolation +34 emits from terrestrial radiation) are radiated back into space.

4.How do the latitude and the tilt in the axis of rotation of the earth affect the amount of radiation received at the earth's surface?

Answer:

Sunrays fall vertical on equator through the year. From 0° to 23.5° north and south, the sun keeps fluctuating. From 1st march to 21st march, the sun is southern and sunrays fall vertical on tropic of cancer. This time there is summer in northern hemisphere. From 23rd September to 22nd December, the sun is southern. During this time, the sunrays fall vertical on tropic of capricorn. On 21st march and 23rd September, sunrays fall vertical on equator. As we move towards poles from tropic of cancer and tropic of Capricorn, temperature keeps on decreasing. Therefore, after 6614 degree north and south there is cold zone. Throughout the year, the temperature remains low here. In this region, throughout the year, there is frigid snow. It is because the sun's rays fall tilted on it. In this way, the latitude and the tilt in the axis of rotation of the earth affect the amount of radiation received at the earth's surface.

5.Discuss the processes through which the earth-atmosphere system maintains heat balance.

Answer:

1. Conduction:

- The earth after being heated by insolation transmits the heat to the atmospheric layers near to the earth in long wave form. The air in contact with the land gets heated slowly and the upper layers in contact with the lower layers also get heated.
- It takes place when two bodies of unequal temperature are in contact with one another, there is a flow of energy from the warmer to cooler body. The transfer of heat continues until both the bodies attain the same temperature or

the contact is broken. Conduction is important in heating the lower layers of the atmosphere.

2. Convection:

- The air in contact with the earth rises vertically on heating in the form of currents and further transmits the heat of the atmosphere. This vertical heating of atmosphere is known as convection.
- The convection transfer of energy is confined only to the troposphere.

3. Advection:

- The transfer of heat through horizontal movement of air is called advection. Horizontal movement of the air is relatively more important than the vertical movement.
- In tropical regions particularly in northern India during summer season local winds called 'loo' is the outcome of advection process.

6. Compare the global distribution of temperature in January over the northern and the southern hemisphere of the earth.

Answer:

In January, there is summer in southern hemisphere and winter in northern hemisphere. The main reason behind it is that sun has northern face and sunrays fall vertical in northern hemisphere. The areas which are closer to equator have temperature up to 27°C and over the land the temperature decreases sharply and the isotherms bend towards south in Europe. It is much pronounced in the Siberian plain. The mean January temperature along 60° E longitude is minus 20° C both at 80° N and 50° N latitudes. The mean monthly temperature for January is over 27° C, in equatorial oceans over 24° C in the tropics and 2° C – 0° C in the middle latitudes and -18° C to -48° C in the Eurasian continental interior.

MAP SKILL

1. On an outline map of the world, locate the distribution of surface air temperature in the month of January.

Answer:

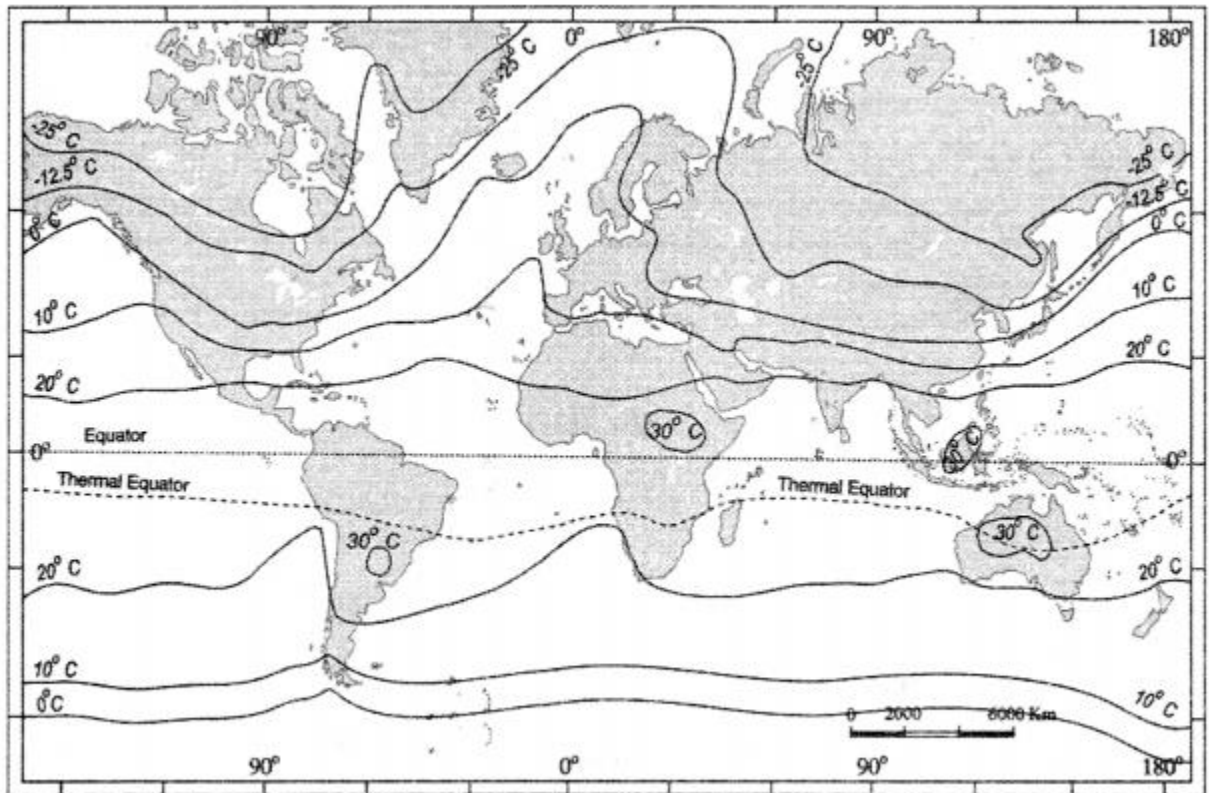


Fig: The distribution of surface air temperature in the month of January.

Multiple choice questions

1.What percent of sunrays that is received by the upper layer of the atmosphere reach the earth surface?

- (a) 43%
- (b) 51%
- (c) 53%
- (d) 40%.

Answer:

- (b) 51%

2.The process of heating up of land through horizontal movement of heat is called:

- (a) Conduction
- (b) Convection
- (c) Advection
- (d) Air drainage.

Answer:

- (a) Conduction

3.Being heavy and dense, the cold air acts almost like water and moves down the slope to pile up deeply in pockets and valley bottoms with warm air above. This is called what?

- (a) Air drainage
- (b) Earth radiation
- (c) Normal lapse rate
- (d) Inversion of temperature.

Answer:

- (a) Air drainage

4. With increase in height the temperature decreases at a normal rate. It is called:

- (a) Air drainage
- (b) Earth radiation
- (c) Normal lapse rate
- (d) Inversion of temperature.

Answer:

- (c) Normal lapse rate

5. What is normal lapse rate at 1000 metre?

- (a) 4 degree Celsius
- (b) 2 degree Celsius
- (c) 1 degree Celsius
- (d) 6.5 degree Celsius.

Answer:

- (d) 6.5 degree Celsius

6. On 4th July, the earth is farthest from sun. What is its distance?

- (a) 152 million km
- (b) 147 million km
- (c) 148 million km
- (d) 198 million km.

Answer:

- (a) 152 million km

7. On 3rd January, the earth is nearest from sun. What is its distance?

- (a) 152 million km
- (b) 147 million km
- (c) 148 million km
- (d) 198 million km.

Answer:

- (b) 147 million km

8.The air in contact with the earth rises vertically on heating in the form of currents and further transmits the heat of the atmosphere. This process of vertical heating of the atmosphere is called what?

- (a) Conduction
- (b) Convection
- (c) Advection
- (d) Air drainage.

Answer:

- (b) Convection

9.Which continent has highest temperature range?

- (a) Asia
- (b) Australia
- (c) Africa
- (d) Eurasia.

Answer:

- (d) Eurasia

10.Which of the following has longest day and nights?

- (a) Poles
- (b) Equator
- (c) Tropic of Cancer
- (d) Tropic of Capricorn.

Answer:

- (a) Poles

11.Which of the following causes inversion of temperature in mountainous regions?

- (a) Due to air drainage
- (b) Due to dust particles
- (c) Due to gravitation
- (d) Due to water vapours.

Answer:

- (a) Due to air drainage.

12.The sun is directly overhead at noon on 21st June at:

- (a) The equator
- (b) 23.5° S
- (c) 23.5° N
- (d) 66.5° N.

Answer:

- (a) The equator

13.In which one of the following cities, are the days the longest?

- (a) Thiruvananthapuram
- (b) Chandigarh
- (c) Hyderabad
- (d) Nagpur.

Answer:

- (a) Thiruvananthapuram

14.The atmosphere is mainly heated by the:

- (a) Short wave solar radiation
- (b) Reflected solar radiation
- (c) Long wave terrestrial radiation
- (d) Scattered solar radiation.

Answer:

- (c) Long wave terrestrial radiation

15.The main reason that the earth experiences highest temperatures in the subtropics in the northern hemisphere rather than at the equator is:

- (a) Subtropical areas tend to have less cloud cover than equatorial areas.
- (b) Subtropical areas have longer day hours in the summer than the equatorial.
- (c) Subtropical areas have an enhanced “green house effect” compared to equatorial areas.
- (d) Subtropical areas are nearer to the oceanic areas than the equatorial locations.

Answer:

- (b) Subtropical areas have longer day hours in the summer than the equatorial.

16. Make correct pairs from the following two columns.

(a) Insolation	(i) The difference between the mean temperature of the warmest and the coldest months
(b) Albedo	(ii) The lines joining the places of equal temperature
(c) Isotherm	(iii) The incoming solar radiation
(d) Annual range	(iv) The percentage of visible light reflected by an object.

Answer:

- (a) (iii)
- (b) (iv)
- (c) (ii) and
- (d) (i)