

INDIA METEOROLOGICAL DEPARTMENT

QUESTION BANK

OF

ADVANCED METEOROLOGICAL TRAINING

COURSE (AMTC)

SEMESTER-II EXAMINATION

BASED ON 176-181 BATCHES

(2015-2021)

PAPER-III: ADVANCED PHYSICAL

METEOROLOGY

**India Meteorological Department
Meteorological Training Institute
Advanced Meteorological Training Course
SEMESTER- II Final Examination**

PAPER-III : Advanced Physical Meteorology

Q.1. Fill in the blanks:

1. Total mass of droplets in unit volume of air is known as _____ and its unit is _____.
2. Water droplets with temperature higher than -40°C freeze when they come into contact with _____ and _____ is an example of such particles.
3. The saturation vapour pressure on the surface of a big drop is _____ than the saturation vapour pressure on the surface of a small drop.
4. The cloud droplets grow by _____ and _____ processes.
5. When the forces _____ and _____ acting on a falling drop balance each other, it will fall with a steady speed.
6. The fair weather electric field is acting _____ direction and the ionic conduction current with respect to fair weather electric field has a value of _____.
7. The glow discharge which takes place over the masts of ships exposed to intense thunderstorms is termed as _____.
8. Maximum ionization in the atmosphere is from the source of _____.
9. According to Simpson, drops while getting shattered will be left with _____ charge.
10. _____ is a measure of vertical mixing of pollution in the atmosphere whereas _____ is a measure of horizontal mixing.
11. _____ is the measure of total mixing of air in a layer and the unit for the same is _____.
12. _____ are the clouds often observed in the upper stratosphere.
13. The layer of the atmosphere in which the neutral particles are able to escape from earth's gravitational field is called _____ and it exists beyond the height of _____.

14. The level of minimum meridional horizontal temperature gradient occurring at about 25 km in the stratosphere is called _____ region.
15. Amount of ozone contained in a vertical column of unit cross sectional area at standard pressure and temperature condition is called _____ and the same is expressed in _____ in general.
16. Ozone has a strong absorption band between wavelengths _____ and _____ in solar radiation whereas it has an absorption band centred around _____ in terrestrial radiation.
17. Specific conductivity is related with _____ and _____.
18. _____ and _____ are two examples of supply current.
19. _____ is the source by which ionization occurs both over land and oceans and its impact is maximum at a height of about _____.
20. The level of minimum meridional horizontal temperature gradient occurring within the stratosphere is called _____ and it is at a height of about _____.
21. The oscillation of lower stratospheric winds between easterlies and westerlies is termed as _____ and its periodicity is about _____.
22. _____ gives a measure of vertical mixing in an atmospheric layer where as _____ provides a measure of horizontal transport of air in a layer.
23. Depletion of ozone is mainly due to its interaction with _____ and _____ is the international treaty to protect ozone layer.
24. Super cooled water droplets freeze once they come into contact with _____ and _____ is one example of such particles.
25. Collection efficiency is the product of _____ and _____.
26. Conductivity is proportional to _____ and _____.
27. The glow discharge which takes place over the mast of ships exposed to severe thunderstorms are termed as _____.
28. The first leader stroke which approaches the ground from the cloud base is called _____ whereas the subsequent leader strokes are called _____.
29. The level of minimum horizontal temperature gradient meridional direction existing in the stratosphere is called and it is observed at a height of about.....

30.is the source of condensation nuclei with greater than 1 micron size in the stratosphere and theare the clouds observed in the upper stratosphere.
31. Amount of ozone contained in a vertical column of unit cross sectional area at standard values of temperature and pressure is called and it is usually expressed in
32. Coldest temperature of the earth is observed in and its temperature is lowest inseason.
33. and are the two processes by which growth of cloud droplets takes place.
34. The clouds whose top extends beyond freezing level are called and such clouds can be seeded with for initiation of precipitation.
35. Collection efficiency is the product of and
36. Temperature of the tropopause over the equator is about _____ °C.
37. A _____ trend in temperature is observed in the upper mesosphere during recent decades.
38. Number per cc of Aitken nuclei is more over _____ as compared to that over the _____.
39. Vertical distribution of atmospheric ozone shows the maximum concentration in the _____.
40. Drag force on a cloud droplet is equal to _____.
41. _____ is a naturally occurring ice nuclei.
42. The ground is normally at _____ electrical potential in comparison to the cloud base.
43. The electrically charged region of earth's atmosphere is called _____.
44. The atmospheric boundary layer is region where _____ is exchanged between solid earth and free atmosphere.
45. Low level inversion _____ pollutant concentrations at the ground.
46. Rainwater below a PH value of _____ is called acid rain.

47. _____ is a photochemical product.
48. Cloud water droplets get charged due to friction created in the _____.
49. The clouds with their tops below 0 C are called warm clouds [Yes/No]
50. INSAT is a geostationary satellite [Yes/No]
51. Ceilometer measures -----
52. MODIS in Terra satellite orbits the Earth at an altitude of -----.
53. A _____ trend in troposphere is observed in _____ .
54. Liquid water content of Cb clouds is about _____ gm/m³ .
55. Concentration of ice nuclei vary from _____ to, _____ and is more over _____ .
56. Ozone concentration in the atmosphere column increases with _____ .
57. Rising surface pressure is found to be associated with _____ in total ozone in the column at the station.
58. QBO in winds is commonly seen in the _____ tropical _____ .
59. Mean molecular weight of air _____ with height above _____ km .
60. During undisturbed weather the ground is at.....potential.
61.ions have higher mobility than the larger ones.
62. Fair weather atmospheric current flows.....the ground.
63. In a thunderstorm cloud water in Phase enhances cloud electrification.
64. When a cumulous cloud intakes air from the bottom it contains.....charged particles.
65. Low level boundary layer turbulence is caused by mechanical and.....forcings.
66. The taller emission stack will result inlow pollution when the plume touches ground.
67. A plume is mathematically described by a function.
68. Ozone is anin a redox reaction.
69. Acid rain is said to occur at a pH of around.....with the given concentration of CO₂ in the atmosphere
70. The growth of a drop by the collision–coalescence process is governed by efficiency.

71.is an example of mobile source of air pollution
72. Homogeneous nucleation takes place when RH is
73. Subsidence over a region willthe pollution
74. Example for hygroscopic nuclei is
75. In cold clouds, ice particle grows at the expense of.....
76. Any precipitation which has PH value less thanis consider as acid rain.
77. Downward push of dry air from the helicopter for fog dispersal is known as
78. Nitrogen forms a part of biogeochemical cycle because there are both the precesses of nitrification and _____active in Nature, Sulphur dioxide emission from thermal power plants come from_____.
79. The Short wave radiation absorption in atmospheric aerosols is principally contributed by_____.
80. An -----above the chimney stack causes fumigation conditions at the ground.
81. The pH of naturally occuring rain water is close to _____ as a result ambient CO₂.
82. ----- isotopes in air samples can help differentiate fossil fuel combustion and biogenic emissions.
83. Chemical reactions where oxidation states of the elements either increase or decrease are known as ----- .
84. Radiative Forcings of Aerosols are caused principally by photon Scattering and -----.
85. Primary biogenic Fixation of atmospheric carbon dioxide is due to the process of -----.
86. Presence of CO and NO leads to formation of ----- in the atmosphere
87. The growth of a drop by the collision–coalescence process is governed by efficiency.
88. Homogeneous nucleation takes place when RH is
89. Es(Water) - Es(Ice) is maximum at
90. As the curvature of drop increases, evaporation
91. Groups of multi cell thunderstorms are called-----systems.
92. Tropospheric ozone acts as gas.
93. Ozone hole generally occurs during southern hemispheric
94. Dry adiabatic lapse rate is deg cel/km
95. For unstable atmosphere actual lapse rate is than dry adiabatic lapse rate.

96. Stratospheric ozone prevents rays in entering into Earth's Atmosphere.

Q.2. State with brief reasons whether the following are true or false

1. Absorbing aerosols tend to stabilize the atmosphere.
2. Acidic pollutants come from Oxides of metals in the atmosphere.
3. Acoustic wave propagation from ground cannot reveal upper air temperatures.
4. Aerosols affect cloud micro physics.
5. Air must be super saturated for the cloud to form.
6. Aitken particles contribute to highest amount of aerosol volume in the atmosphere.
7. Ambient Sulphur dioxide contributes to alkalinity of rain water.
8. An unstable boundary layer will have a high wind shear in the vertical direction.
9. At higher temperatures ocean waters will dissolve less of atmospheric CO₂.
10. Coarse mode aerosols can form due to accumulation of Aitken size particles.
11. Collision and Coalescence of droplets will be more when there is a spectrum of size distribution among the droplets.
12. Collision coalescence process requires a broad spectrum of cloud droplets.
13. Concentration of ozone goes on increasing with height in the atmosphere.
14. Current density associated with fair weather electric field goes on increasing with height in the atmosphere.
15. Current density decreases with height, in the atmosphere.
16. Drift of Noctilucent clouds can be interpreted in terms of winds in mesosphere .
17. Dry adiabatic lapse rate is 5 deg cel/km
18. Due to point discharge, positive charges are carried towards the earth's surface.
19. Fanning on Plume is due to high instability present in the atmosphere.
20. Flue Gas Desulphurization is recommended in Thermal Power Plants when the coal has high Ash content.
21. For stable atmosphere actual lapse rate is greater than dry adiabatic lapse rate.
22. Hail formation is possible in all types of clouds.
23. Heat Islands are less intense in cities without a very large central district of built up area.

24. Heat Islands are less intense in cities without a very large central district of built up area.
25. If ice crystals collide with other ice crystals – they stick together – This process is known as accretion.
26. If ice crystals collide with other ice crystals – they stick together – This process is known as aggregation.
27. In case of disturbed weather, there will be changes in the fair weather electric field.
28. In case of fumigation, the concentration of pollution at the ground will be minimum.
29. In case of lofting, pollution concentration at the ground level will be maximum.
30. In recent years the tropospheric ozone is found to decrease .
31. In soil only nitrification takes place.
32. Ionization over land is more than ionization over ocean.
33. Liquid water content in all types of clouds is nearly same.
34. Lower stratospheric winds in the tropical area are always easterlies.
35. Mineral aerosols coming from the earth's crust are highly absorbing in the wavelengths of short wave radiation.
36. Ozone depletion is not reported from Arctic polar region
37. Ozone is not destroyed in the stratosphere.
38. Point discharge carries positive charges to the earth.
39. Polar region in winter stratosphere is warm .
40. Pollution level in the atmosphere will be high during winters.
41. Precipitation from warm cloud is possible when there is a spectrum of size distributions in the cloud.
42. Radar is not useful for cyclone tracking.
43. Rossby gravity waves are seen in extra tropics
44. Saturation vapour pressure over water is more than that over ice.
45. Severely Acidic Rain can dissolve toxic Heavy Metals from soil and deliver them to water bodies.

46. Shallow clouds also develop significant amount of electrical polarization.
47. Stratosphere is warmer than the troposphere immediately below it because it is closer to the sun.
48. Sub cloud layer is one of the factor which influences the size of the precipitation element.
49. Supersaturation required for the condensation to occur on big droplets is more than the supersaturation required for the condensation to occur on small droplets.
50. Terminal velocity of a cloud droplet depends upon its size.
51. The free ions in the troposphere generate a current pointing downwards.
52. The Lightning discharge never takes place in the higher reaches of a thunderstorm cloud.
53. The maximum ionization due to cosmic rays is observed at about 12 kms.
54. The negative lapse rate in mesosphere is common in summer.
55. The potential gradient associated with fair weather field decreases linearly with height.
56. The process of O₃ formation is photochemical in nature.
57. There exists a balance between production as well as dissociation of ozone in the atmosphere.
58. Thermosphere has uniform molecular weight throughout.
59. Total ozone varies very little with season over the equator & low latitudes.
60. Tropical Tropopause is cooler than Mid latitude tropopause.
61. Tropopause is a single continuous layer extending over the globe.
62. Tropospheric ozone is called GOOD Ozone.
63. Warm clouds can be seeded with hygroscopic nuclei for rain making.
64. When a solute is added to pure water, its saturation vapour pressure increases.
65. When the ventilation coefficient is large, pollution potential is large.
66. Write a chemical reaction of ozone formation in stratosphere.

Q.3. Answer any one of the following :

1. What are cold clouds? What is the composition of a cold cloud? What are the different types of precipitation elements from a cold cloud?
2. Briefly explain the Bergeron Findeisen Theory of precipitation from a cold cloud.
3. Why lightning gets generated in the atmosphere? What are the different types of lightning possible in the atmosphere?
4. Briefly explain the mechanism of thunder and lightning in the atmosphere.
5. How the charges are aligned in a thundercloud? Explain Wilson's Theory of Charge Separation in a thunder cloud.
6. Briefly explain the mechanism of thunder and lightning.
7. Briefly explain the temperature distribution of lower stratosphere in both summer and winter.
8. What is stratosphere warming? Briefly explain the main features of stratospheric warming?
9. Briefly explain the temperature distribution of lower stratosphere for both summer and winter season.
10. What is stratospheric warming? Discuss the major features of stratospheric warming.
11. What are the major sources of ionization in the atmosphere? Briefly discuss their features.
12. Discuss the mechanism of thunder and lightning.
13. Explain the photochemical reaction for the generation and dissociation of ozone.
14. What is total ozone? How it varies with latitude, season, height and weather conditions?
15. Explain the major sources of air pollution and the pollutants generated from each source.
16. What is acid rain? How the pH scale is useful to get the chemical nature of any substance?
17. Discuss the process of generation of precipitation elements from a cold cloud.
18. What is weather modification? Briefly explain about its application.
19. Briefly explain the process of initiation of precipitation from a cold cloud. How hail is getting formed in the cloud? How hail formation can be suppressed?
20. Briefly explain the factors influencing the size of precipitation elements reaching the ground.

21. What is ozone? Why ozone is important for the earth? Mention the major features of ozone. Explain the photochemical reaction associated with the formation and dissociation of ozone.
22. Briefly mention the factors involved with the formation of ozone hole and the measures taken to protect the ozone layer.
23. Briefly explain the horizontal temperature structure of the lower stratosphere for summer as well as winter season. How the winds of the polar lower stratosphere behave according to the temperature structure?
24. What is stratosphere warming? Mention the major features associated with that.
25. Explain how photochemistry is important in formation of pollutants.
26. Bio geo-chemical cycles and their environmental effects
27. Why saturation vapor pressure increases with Temperature. If T decreases what happens to saturation vapor pressure and relative humidity?
28. What is lapse rate e.g. dry lapse rate and wet lapse rate? Describe the conditions when an air parcel will experience (a) absolute stability, (b) absolute instability and (c) conditional instability.
29. Explain atmospheric conditions leading to fumigation.
30. How can building be protected from lightning strikes?
31. Differentiate between mechanical and thermal turbulence.
32. How can urban pollution lead to smog?
33. List the principal minor species of the atmosphere.
34. Why is there a term called “ respirable particulates”
35. Explain how atmospheric thermal structure in the lower atmosphere impacts dispersal of pollution from fall stocks.
36. Which are the principal constituents of rain water over India in general and how do they affect its acidity.
37. What are the meteorological aspects of an urban heat island?
38. What is remote sensing? Explain types of remote sensing with examples.
39. What are cloud macro and micro physical parameters? How are they measured with different measurement techniques?
40. Given that the electrical conductivity of the fair weather atmosphere is 2×10^{-14} mho/m and the electric Field is 200 V/m compute the current density and the electrical current flowing between the atmosphere and the ground. Presume the radius of earth as 6400 km.

41. Given that the electrical conductivity of the fair weather atmosphere is 2×10^{-14} mho/m and the electric Field is 200 V/m compute the current density and the electrical current flowing between the atmosphere and the ground. Presume the radius of earth as 6400 km.
42. Photochemistry of Ozone in lower troposphere.
43. Solenoidal flow in an Urban Heat Island
44. What is weather modification? What are the different types of weather modifications?
45. Write down the positive and negative impacts of acid rain.
46. What are Volatile organic compounds (VOCs)? How they are harmful to human health?
47. What are the different lifting mechanisms responsible for cloud development? Explain with neat diagrams.
48. What are cold clouds? Explain the precipitation process in cold clouds.
49. With a neat diagram explain the different types of pollution plume dispersion.
50. Why mean molecular weight of air changes with height? (above 80 km)
51. Where is the Polar Night Jet located and its seasonal extent?
52. What causes ozone depletion in the polar region?
53. Meteorological Rocket Sonde data is useful for (list the uses)
54. Why ozone is concentrated in Lower Stratosphere.
55. Write the Gaussian Plume Equation explaining all its terms.
56. Explain the terminal velocity of a cloud drop? What are the factors affecting terminal velocity?
57. What are the differences between homogeneous and heterogenous nucleation?
58. What are cold clouds? Explain the precipitation process in cold clouds and different types of precipitation from cold clouds
59. Write a note on tropospheric and stratospheric Ozone. b) Write a note on atmospheric instability with schematic of stack emissions.
60. Name which satellite(s) provides aerosol information:
 - (a) MODIS (b) TRMM (c) CloudSat
61. Empirical equation for saturation vapor pressure of water over a liquid surface is given by the following equation

$$p_{v,s} = 6.112 \exp\left(\frac{17.67TD}{TD + 243.5}\right)$$

If $T_D=20\text{ C}$ and $T=30\text{C}$, estimate the partial pressure of water, the saturation vapor pressure of water and the relative humidity. T_D is the dew point temperature.

62. When an air parcel moves upward and expands adiabatically: Do Temperature and Relative Humidity of the parcel change?
- Does its saturation vapor pressure changes?
 - When the parcel will be lifted upward moist adiabatically?
 - If at ground Temperature= $40\text{ }^{\circ}\text{C}$ and Dew Point Temperature is $=20\text{ }^{\circ}\text{C}$; when the lifted air parcel will start forming cloud?
63. Describe what type of aerosols can act as a cloud condensation nuclei and why?
- (a) hygroscopic aerosol, (b) hydrophobic aerosol

Q.4. Write short notes :

- Factors influencing the size of precipitation elements.
- Wilson's theory of charge distribution in a thunder cloud.
- Weather modification for suppression of hazardous weather.
- Major features of fair weather electric field
- Quasi Biennial Oscillation
- Curvature effect
- Wilson's theory of charge separation
- Collision and coalescence
- Tropopause features
- Umkehr method
- Classification of condensation nuclei.
- Ozone Sonde
- Solution Effect
- Features of Tropopause
- The atmospheric composition and its radiative effects
- Types of plumes emitted by stacks and their causative factors
- Homogeneous nucleation
- Sudden stratospheric warming
- Collection efficiency of cloud drops
- Ozone depletion

21. Randomized cloud seeding experiments
22. Q.B.O
23. Bergeron effect in mixed clouds
24. Spectrophotometer
25. Rocket grenade experiments
26. Fog dispersal experiments
27. Kelvin & Mixed Rossby – gravity waves .
28. Evaluation of cloud seeding experiments .
29. Mitigation of ozone depletion .
30. Bio Geo Chemical Cycles in Nature and their relevance to environmental issues.
31. Under different stability structures in the atmosphere at the lower levels how does pollutant emission stack height determine the characteristics of plume dispersal.
32. Explain the terminal velocity of a cloud drop? What are the factors affecting terminal velocity?
33. Explain curvature effect with neat diagram.
34. Describe briefly how meteorological factors influence air quality.
35. Kelvin waves.
36. Sudden warming in Stratosphere.
37. Winds in Mesosphere for recent data.
38. Write about the components of the Bio Geo Chemical Cycles in Nature giving examples.
39. Explain with diagrams how the stack emission plumes behave under different atmospheric stability conditions.
40. Photochemistry of Ozone in lower troposphere.
41. Solenoidal flow in an Urban Heat Island
42. The inductive process of cloud electrification.
43. Climate effects of Atmospheric Aerosol
44. Global C-Cycle