

**ROYAL CIVIL SERVICE COMMISSION
BHUTAN CIVIL SERVICE EXAMINATION (BCSE) 2021
EXAMINATION CATEGORY: TECHNICAL**

**PAPER III: SUBJECT SPECIALISATION PAPER FOR METEOROLOGY AND CLIMATE
STUDIES**

Date	: October 31, 2021
Total Marks	: 100
Writing Time	: 150 minutes (2.5 hours)
Reading Time	: 15 minutes (prior to writing time)

GENERAL INSTRUCTIONS:

1. Write your Registration Number clearly and correctly on the Answer Booklet.
2. The first 15 minutes is to check the number of pages of Question Paper, printing errors, clarify doubts and to read the instructions. You are NOT permitted to write during this time.
3. This paper consists of **TWO SECTIONS**, namely SECTION A & SECTION B:
 - **SECTION A** has two parts: Part I - 30 Multiple Choice Questions
Part II - 4 Short Answer Questions
All questions under SECTION A are COMPULSORY.
 - **SECTION B** consists of two Case Studies. Choose only **ONE** case study and answer the questions of your choice.
4. All answers should be written on the Answer Booklet provided to you. Candidates are not allowed to write anything on the question paper. If required, ask for additional Answer Booklet.
5. All answers should be written with correct numbering of Section, Part and Question Number in the Answer Booklet provided to you. Note that any answer written without indicating the Section, Part and Question Number will NOT be evaluated and no marks will be awarded.
6. Begin each Section and Part on a fresh page of the Answer Booklet.
7. You are not permitted to tear off any sheet(s) of the Answer Booklet as well as the Question Paper.
8. Use of any other paper including paper for rough work is not permitted.
9. **You must hand over the Answer Booklet to the Invigilator before leaving the examination hall.**
10. This paper has **7 printed pages**, including this instruction page.

GOOD LUCK

SECTION A

PART I: Multiple Choice Questions [30 marks]

Choose the correct answer and write down the letter of your chosen answer in the Answer Booklet against the question number e.g. 31 (d). Each question carries ONE mark. Any double writing, smudgy answers or writing more than one choice shall not be evaluated.

1. Which treaty/convention agreed to limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels?
 - a) Paris Agreement
 - b) Kyoto Protocol
 - c) Montreal Protocol on Substances that Deplete Ozone Layer
 - d) United Nations Convention to Combat Desertification

2. A qualitative or quantitative representation of the climate system based on the physical, chemical and biological properties of its components, their interactions and feedback processes and accounting for some of its known properties – is a general description of
 - a) Climate change
 - b) Climate model
 - c) Feedback loop
 - d) Meteorology

3. The branch of mathematics that studies continuous change is
 - a) Algebra
 - b) Geometry
 - c) Calculus
 - d) Trigonometry

4. What does it mean to be carbon neutral?
 - a) There is no emission of carbon.
 - b) The amount of carbon sequestration is more than the carbon emission.
 - c) The amount of carbon sequestration and carbon emission are equal.
 - d) Exploring solar energy.

5. Deflection taken by objects as they travel long distances around the earth occurs due to
 - a) Speed of the object
 - b) Air pressure
 - c) Coriolis effect
 - d) El Nino

6. What is the most significant impact of climate change to Bhutan?
 - a) Sea level rise
 - b) Degradation of forest
 - c) Decrease in rainfall
 - d) The risk of floods and extreme weather

7. Weather forecasting is
 - a) Initial value problem
 - b) Boundary value problem
 - c) Random prediction
 - d) Similar to astrology

8. What is a climate projection?
 - a) A response of the climate system to a scenario of future emissions or concentrations of greenhouse gases (GHGs) and aerosols and changes in land use.
 - b) A change in the state of the climate.
 - c) Information to enhance users' knowledge and understanding about the impacts of climate change to aid decision-making.
 - d) An increase in global mean surface temperature.

9. Which among the following is NOT a Global Climate Model (GCM)?
 - a) CanESM2
 - b) WMO
 - c) MRI-CGCM3
 - d) IPSL-CM5A-LR

10. Which of the following has the highest albedo and more reflected solar radiation?
 - a) Fresh snow
 - b) Forest
 - c) Water
 - d) Black surface

11. Most weather events occur in
 - a) Stratosphere
 - b) Troposphere
 - c) Mesosphere
 - d) Ground

12. Seasons like spring, summer autumn and winter occurs due to
 - a) tilt of earth's axis from the vertical.
 - b) shape of the earth.
 - c) movement of sun.
 - d) rotation of the earth.

13. Inaccuracy of weather forecasts usually occurs due to
 - a) prediction of the future is difficult.
 - b) climate change.
 - c) science is not sufficiently evolved.
 - d) chaotic nature of the atmosphere.

14. Monsoon refers to
- weather disturbance.
 - heavy rain.
 - season in some parts of the earth.
 - seasonal reversal in wind direction and pressure distribution.
15. What is vorticity?
- Cyclonic or anti-cyclonic rotation which can be used to assess upper level divergence.
 - Vertical velocity
 - Horizontal velocity
 - Air pressure
16. If the wind speed is reported to be 3.7 km/hr, what is the speed in knots?
- 1 knot
 - 2 knots
 - 3 knots
 - 7.4 knots
17. Bhutan and India agreed to jointly develop a small satellite for Bhutan to be launched at the end of 2021.
- False
 - True
18. Which of the following is true about a geo-stationary satellite?
- It's fixed on the ground.
 - Has same relative position with respect to the sun.
 - The location changes around the Earth.
 - Stays over the same location on Earth.
19. Which statement is true about an intertropical convergence zone (ITCZ)?
- It's a low pressure belt near the equator.
 - It's a high pressure belt in the tropics.
 - It is a jet stream.
 - None of the above.
20. For a right angled triangle with sides a, b and hypotenuse c, which formula describes the Pythagoras theorem?
- $a^2 + b^2 = 0$
 - $a^2 + b^2 + c^2 = 0$
 - $a^2 + b^2 = c^2$
 - $a^2 + b^2 + c^2 = 1$
21. A company wanting to measure employee satisfaction – selects 3 departments at random and conducts interview with all the employees in the 3 departments. What is the type of survey design?
- Stratified
 - Systematic
 - Cluster
 - Random

22. At what height above the ground can you expect jet streams?
- 8 to 15 km
 - 3 to 5 km
 - 500 millibar
 - Sea level
23. Which among the following is NOT a greenhouse gas?
- Carbon dioxide CO₂
 - Nitrogen N
 - Methane CH₄
 - Nitrous oxide N₂O
24. Which El Niño Southern Oscillation (ENSO) pattern is associated with low air pressure and a cooling phase?
- Orographic effect
 - El Niño
 - La Niña
 - Coriolis effect
25. Southern Oscillation Index (SOI) is based on
- temperature difference between Darwin and Tahiti.
 - air pressure difference between Darwin and Tahiti.
 - movement of warm water in the South.
 - physics equation.
26. What are the general effects of ENSO on the Indian monsoon?
- El Niño suppresses the monsoon rainfall and La Niña increases it.
 - El Niño increases the monsoon rainfall and La Niña decreases it.
 - Both increases the monsoon rainfall.
 - Both decreases the monsoon rainfall.
27. What is nationally determined contributions (NDC)?
- Carbon credit contributions made by each country.
 - Trust fund.
 - Voluntary contributions to climate research.
 - Efforts by countries to reduce national emissions.
28. What report is used to alert pilots on rapidly changing weather conditions?
- Terminal Aerodrome Forecast (TAF)
 - Special weather report (SPECI)
 - Airman's Meteorological Information (AIRMET)
 - Meteorological Aerodrome Reports (METAR)

29. Parametrization in numerical weather prediction is done to
- introduce new parameters in the model.
 - make the models more complex.
 - reduce the run time of the model.
 - replacing small scale or complex processes in a model.
30. Indian ocean dipole (IOD) is
- effect of Indian ocean on the weather.
 - movement of warm water.
 - air pressure difference in the Indian ocean.
 - oscillation of sea surface temperature in the Indian ocean.

PART II – Short Answer Questions [20 marks]

This part has 4 Short Answer Questions. Answer ALL the questions. Each question carries 5 marks. Mark for each sub-question is indicated in the brackets.

- Drying of streams, shortage of drinking water and irrigation water are reported frequently on news. What is causing this? Suggest ways to resolve this issue?
- For the given data set (1, 3, 3, 5, 8), find the mean, median, mode and the standard deviation.
Note: SD is given by

$$\sqrt{\frac{1}{N} \sum_{i=1}^N (x_i - \bar{x})^2} .$$

Where x_i = value of data set, \bar{x} = mean, N = Number of sample
Answer can be expressed as a root

- What are jet streams and how are they caused?
- What are the primary sources of rainfall in Bhutan?

SECTION B: Case Study [50 marks]

Choose either CASE I OR CASE II from this section. Each case study carries 50 marks. Mark for each sub-question is indicated in the brackets.

CASE I

Weather is the state of the atmosphere at a given place and time, a description of hot or cold, wet or dry, clear or cloudy among others. Weather forecasting is one of the most challenging scientific problem. It involves using data of the current state of the atmosphere and projecting how it will evolve in the future using the understanding of atmospheric processes. Numerical weather prediction using powerful computers have helped in running mathematical models. In the context of weather forecasting, answer the following questions:

1. What is a tropical cyclone and some of its impacts? How does it impact Bhutan? (10 marks)
2. What is a weather radar, how does it work and what are some uses of radars? What are some types of radar bands and their uses? (15 marks)
3. Southern Bhutan receives heavy rainfall compared to the rest of the country. Explain and give reasons. (10 marks)
4. Suggest ways to deal with forecast uncertainties? (10 marks)
5. What is the importance of weather forecasting and public weather services? (5 marks)

CASE II

The Intergovernmental Panel on Climate Change (IPCC) states that the warming in the climate system is unequivocal and substantial and sustained reductions in greenhouse gas emissions are required. Limiting the rise in global temperature below 2°C till 2100 above the pre-industrial level was agreed in 2015 at the Conference of Parties, COP21. Climate change is likely to increase the temperature and the precipitation. There is an increasing trend of meteorological and hydrological disasters. Climate is one of the main factors for severe floods. The state of the environment in Bhutan is a gift of the far sighted visionary leadership of our Kings. In the light of a changing climate answer the following questions:

1. What is a general circulation model, also termed as global climate model (GCM)? (5 marks)
2. What is reanalysis data? (5 marks)
3. What are the global impacts of climate change? What are the main impacts of climate change to Bhutan? (15 marks)
4. What are the benefits of conservation of the environment to Bhutan? (10 marks)
5. What are the mitigation and adaptation options for Bhutan? (15 marks)

TASHI DELEK