

**ROYAL CIVIL SERVICE COMMISSION  
BHUTAN CIVIL SERVICE EXAMINATION (BCSE) 2024  
EXAMINATION CATEGORY: TECHNICAL**

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

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<b>Date</b>	: October 5, 2024
<b>Total Marks</b>	: 100
<b>Writing Time</b>	: 150 minutes (2.5 hours)
<b>Reading Time</b>	: 15 minutes (prior to writing time)

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**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 **8 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. The primary driving force of the Hadley cell
  - a) Rotation of the Earth
  - b) Air pressure variation across latitudes
  - c) Temperature difference between the equator and poles
  - d) Coriolis effect
  
2. Adjacent land and water is heated by the sun on a calm day, after a few hours a surface wind develops. What is the direction of the winds?
  - a) Water to land
  - b) Land to water
  - c) Parallel to the land and water
  - d) Vertically from water to air
  
3. Ozone layer is found in:
  - a) Troposphere
  - b) Stratosphere
  - c) Thermosphere
  - d) Mesosphere
  
4. The approximate density of air at 15° C is:
  - a) 1 g/cm<sup>3</sup>
  - b) 0 g/cm<sup>3</sup>
  - c) 1.225 kg/m<sup>3</sup>
  - d) 1000kg/m<sup>3</sup>
  
5. What amount of rainfall can you expect in Bhutan during El Nino year?
  - a) Normal rainfall
  - b) Wetter than normal
  - c) Drier than normal
  - d) United Nations Convention to Combat Desertification
  
6. The Butterfly Effect can be defined as:
  - a) Feedback loop in climate change
  - b) Small change in starting conditions can lead to vastly different outcomes
  - c) Outcomes are independent of the changes in the starting conditions
  - d) Study of impact of butterflies
  
7. Speaker of the fourth National Assembly of Bhutan.
  - a) Lungten Dorji
  - b) Wangchuk Namgyel
  - c) Namgyal Dorji
  - d) Prime Minister

8. The formula for volume of a cylinder with given radius ( $r$ ) and height ( $h$ ):
- $\pi r^2 h$
  - $2 \pi r^2 h$
  - $\pi r h$
  - None of the above
9. By 2023, the global average temperature has warmed above the pre-industrial level by:
- $0.5^\circ \text{C}$
  - Less than  $0.8^\circ \text{C}$
  - More than  $1^\circ \text{C}$
  - More than  $1.5^\circ \text{C}$
10. Windward side of a mountain have a wet climate due to:
- Rising air compresses and warms, causing evaporation of water vapour
  - Rising air compresses and cools, causing condensation of water vapour
  - Rising air expands and warms, causing condensation of water vapour
  - Rising air expands and cools, causing condensation of water vapour
11. 1 litre of water is equivalent to:
- 1 kg
  - $1000 \text{ cm}^3$
  - Both (a) and (b)
  - None of the above
12. What is true about dew point?
- Temperature of air at constant pressure to achieve 100% relative humidity
  - Temperature of water when relative humidity is 100%
  - Temperature of air at constant pressure when air is dry
  - Temperature when dew is formed
13. Temperature increases with altitude in stratosphere and thermosphere, true or false:
- True
  - False
14. Which weather is likely indicated by rapidly falling air pressure?
- Skies are clearing
  - Storm approaching
  - Temperature is decreasing
  - Humidity is decreasing
15. Convert  $100^\circ \text{F}$  (Fahrenheit) to  $^\circ \text{C}$  (Celsius)
- $36.7^\circ \text{C}$
  - $37^\circ \text{C}$
  - $37.7^\circ \text{C}$
  - $38^\circ \text{C}$

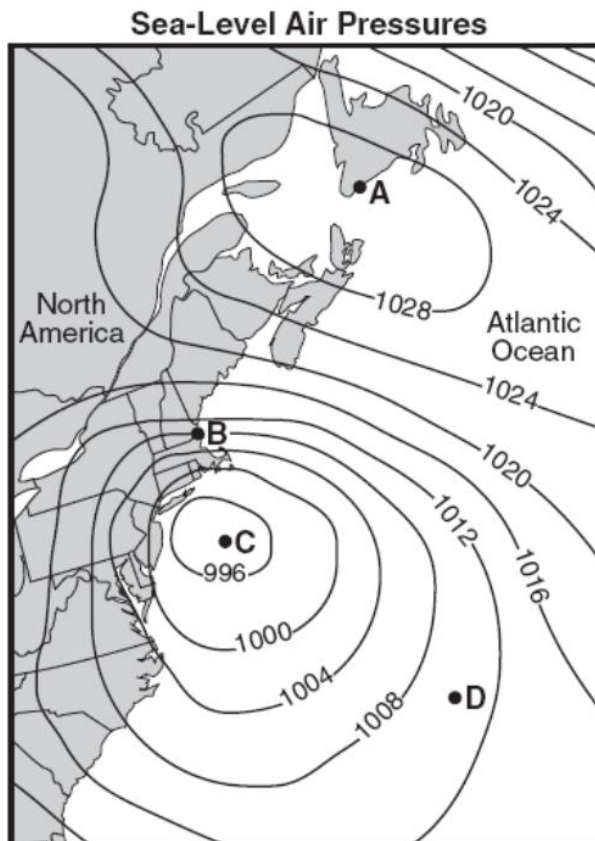
16. Bhutan Broadcasting Service Television is now aired in?
- Standard definition (SD)
  - High definition (HD)
  - 4K
  - 8K
17. Average temperature of a large city is warmer than the surrounding forest area, which phenomena describes this?
- Urban heat island effect
  - Urban heating effect
  - Climate change
  - Cooling due to evaporation
18. Intertropical Convergence Zone (ITCZ) is associated with:
- Hurricanes
  - Drought
  - Calm weather
  - Heavy rainfall
19. Surface winds blow around a high pressure system in the Northern Hemisphere, the direction of:
- Clockwise and outward
  - Clockwise and inward
  - Anti-clockwise and outward
  - Anti-clockwise and inward
20. Wind is caused by?
- Fronts
  - Horizontal pressure difference
  - Rotation of the earth
  - Surface friction
21. The radiation of the sun heats:
- Air in the troposphere
  - Thermosphere which heats the other layers till the troposphere
  - Troposphere directly on a clear sky
  - Surface of earth which heats air in troposphere
22. 1 knot in km/hr is approximately:
- 1.5
  - 1.8
  - 2.1
  - 2.4
23. Weather near a large water body tend to be warmer in summer and colder in winter than the surrounding land area?
- True
  - False

24. Oscillation of sea surface temperature
- Intertropical convergence zone
  - Indian Ocean Dipole
  - Madden–Julian oscillation
  - None of the above
25. What is the best method for finding the average annual precipitation of a catchment?
- Thiessen’s mean method
  - Arithmetic method
  - Isohyetal method
  - Simple mean method
26. The intensity of a cyclone decreases after land fall due to:
- Friction due to obstruction at land
  - Cut off of moisture
  - Decrease in wind speed
  - Decrease in temperature on land
27. Where are you likely to find strong winds close to the ground?
- Centre of a low pressure system
  - Periphery of a high pressure system
  - In the transition zone between two air masses
  - Where the pressure difference is less
28. Additional hazard to aircraft taking off or landing in or near thunderstorm:
- Turbulence
  - Wind shear
  - Reduced speed
  - Compass error
29. Which form of precipitation is most likely to fall, from clouds containing only water, in mid-latitudes?
- Drizzle
  - Hail
  - Moderate rain with large drops
  - Heavy rain with large drops
30. Which of the aviation weather charts can a pilot most easily find a jet stream?
- Wind/temperature chart
  - Significant weather chart
  - Surface chart
  - Meteorological Aerodrome Reports (METAR)

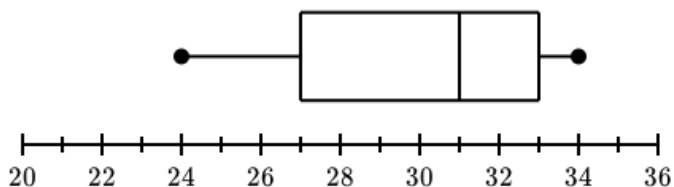
**PART II – Short Answer Questions [20 marks]**

**This part has 4 Short Answer Questions. Answer ALL the questions. Each question carries 5 marks.**

1. The map shows sea level air pressure in millibars for an eastern coast of North America. Points A, B, C and D are sea-level locations on the Earth's surface. Which location would have recorded the highest wind speed? What would be the approximate air pressure at point D?



2. Find the median, first and third quartile, interquartile range and range from the box plot.



3. Explain different stages of a hydrological cycle?
4. Briefly describe the different meteorological observations and types of data collected.

**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 forecasting is a challenging and complex problem owing to the chaotic nature of the atmosphere. Weather forecasting is the prediction of the weather by the application of principles of physics and the use of a number of empirical and statistical methods. Prediction of the future is made based on the initial conditions of the current state of the atmosphere and projecting into the future using physical laws and the understanding of atmospheric processes. In the context of weather forecasting, answer the following questions:

1. What are weather models and how are they used for forecasting? Suggest ways to improve weather forecasting accuracy? What kind of data is used in weather models? **(15 marks)**
2. A flash flood occurred in Dechencholing, Thimphu on the 10 of August 2024. Investigation revealed that the flood was triggered by heavy rainfall caused by a convective thunderstorm. Describe what is convective thunderstorm? What conditions make convective storm likely? What are the tools used to help detect convective thunderstorm? **(15 marks)**
3. What is now casting? What tools are used for now casting? **(10 marks)**
4. What are the impacts of El Niño–Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD) on rainfall of Bhutan? **(10 marks)**

**CASE II**

Climate change is widespread, rapid and intensifying according to the Intergovernmental Panel on Climate Change (IPCC). Climate change is projected to increase the temperature and the global water cycle. One of the main impacts of climate change is the rise of extreme weather events like heavy rainfall and severe floods. Bhutan is also highly vulnerable to the impacts of climate change due to its geographical location and the fragile mountain ecosystem. In the light of increase in extreme weather events answer the following questions:

1. What is Early Warning System? Suggest how the early warning system can work efficiently during an extreme weather event? **(10 marks)**
2. Write a short note on flood forecasting. The "Early Warnings for All" initiative is a ground breaking effort to ensure that everyone on Earth is protected from hazardous weather, water, or climate events through life-saving early warning systems by the end of 2027 of the World Meteorological Organization. What do you think are some challenges to this initiative? **(15 marks)**
3. Climate projections are simulations of Earth's climate for future decades based on assumed 'scenarios' for the concentrations of greenhouse gases, aerosols, and other atmospheric

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constituents. Global Climate Models help in understanding the Earth's climate into the future. How does one use the climate projections that run into 100's of years into the future? **(10 marks)**

4. What are the long term impacts of climate change and how should countries like Bhutan prepare for the changing climate? **(15 marks)**

**TASHI DELEK**