

 Test Information

Description This test includes 17 questions: multiple choice, multiple answer, calculations, short answer and essay type. Multiple answer questions have partial credit with negative scores for incorrect answers.

Write all your answers in the space provided below each question only. No separate scans are accepted. No need to give any diagrams. Use math editor to write formulas and equations. Show all the steps in calculations.

One question at a time will be displayed. No backtracking is allowed.

Instructions

Timed Test This test has a time limit of 2 hours.This test will save and submit automatically when the time expires.

Warnings appear when **half the time, 5 minutes, 1 minute, and 30 seconds** remain.*[The timer does not appear when previewing this test]*

Multiple Attempts This test allows multiple attempts.

Force Completion	This test can be saved and resumed at any point until time has expired. The timer will continue to run if you leave the test.
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This test does not allow backtracking. Changes to the answer after submission are prohibited.

QUESTION 1

5 points Save Answer

The use of either gridpoint or spectral methods in NWP models makes it possible to _____ (Select all the choices)

- Produce mathematical representation of the full atmosphere
- Completely represent all details of the atmosphere
- Solve the model equations without producing errors
- Derive and solve the model equations using a mathematical framework.

QUESTION 2

5 points Save Answer

Check all those domain elements that apply for global models _____

- ☐ Lateral boundary conditions
- ☐ Model top boundary
- ☐ Grid interaction with a larger domain model
- ☐ Boundary conditions at the surface layer

QUESTION 3

2.5 points

For longer time integrations _____ is used

- ☐ None of the above
- ☐ Regional model nested with global model in one-way interaction
- ☐ Regional model nested with global model in two-way interaction
- ☐ Regional model without nesting

QUESTION 4

2.5 points

Determine the type of the wave equation

$$\frac{\partial^2 u}{\partial t^2} - \frac{\partial^2 u}{\partial x^2} = 0$$

QUESTION 5

2.5 points

How do you explain the physical meaning of the following expression:

$$\frac{\partial}{\partial y} \left(\psi \frac{\partial \zeta}{\partial x} \right) - \frac{\partial}{\partial x} \left(\psi \frac{\partial \zeta}{\partial y} \right)$$

QUESTION 6

2.5 points

If the skill score for your temperature forecasts is +0.25 and the standard forecast used for comparison has an error of 2 deg on average. What is the error of your temperature forecasts? _____

- ☐ None of the above
- ☐ 1.75 deg
- ☐ 2.25 deg
- ☐ 2.50 deg
- ☐ 1.50 deg

QUESTION 7

7.5 points

Calculate the time step required for a grid space of 12 km if the speed of the fastest wave in the model is 100 m/s. How many time steps are required to give a 1 hour forecast?

Suppose the resolution of the same model is increased (in both x and y directions) to 3 km, what time step would be required? How many time steps would be required to give a 1 hour forecast?

QUESTION 8

5 points Save Answer

What characteristics of the model forecast equations limit the accuracy of the forecast? (Choose all that apply.)

- ☐ They cannot be solved accurately in either spectral or gridpoint models at any resolution.
- ☐ The equations contain complex terms for which initial values cannot be determined accurately.
- ☐ Approximations are used in deriving the forecast equations.
- ☐ They have approximations in the physics terms.

QUESTION 9

10 points Save Answer

What are basis functions? Give the general form of approximating a dependent variable $T(x,t)$ and explain the terms used.

QUESTION 10

5 points Save Answer

If the T number of the ECMWF is 1279, calculate the minimum wavelength (in degrees) resolved? What is the equivalent grid spacing of this spectral model? Assume at least 3 points are required to represent each wave.

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QUESTION 11

5 points Save Answer

Show that the barotropic vorticity equation:

$$\frac{d}{dt}(\zeta + f) = 0$$

can be expressed as:

$$\frac{\partial \zeta}{\partial t} + \left(u \frac{\partial \zeta}{\partial x} + v \frac{\partial \zeta}{\partial y} \right) + \beta v = 0$$

QUESTION 12

5 points Save Answer

Based on the following two contingency tables for gale and tornado forecasts, which forecasts (gale or tornado) are underforecast and which are overforecast? Explain how?

Gale forecast	Gale observed		
	Yes	No	fc Σ
Yes	15	2	17
No	11	123	134
obs Σ	26	125	151

Tornado forecast	Tornado observed		
	Yes	No	fc Σ
Yes	30	70	100
No	20	2680	2700
obs Σ	50	2750	2800

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QUESTION 13

7.5 points Save Answer

Suppose the temperature at a location is observed as 28°C with an error (standard deviation) of 0.4°C , while the first guess for the same location is given as 26°C with an error of 0.6°C . Calculate the weights to be assigned for the observed and first guess values and then find the analysis temperature by optimum interpolation. How the weights are assigned in relation to the errors?

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QUESTION 14

2.5 points Save Answer

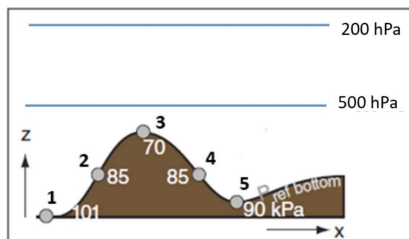
Grid point models use _____ to define meteorological fields.

- ☐ grid points
- ☐ wave functions
- ☐ linear terms
- ☐ discrete grid boxes

QUESTION 15

7.5 points Save Answer

Calculate the σ coordinate values for the model reference pressure of 500 hPa at the given 5 points, as shown in the diagram. Model top pressure is given as 200 hPa. Surface pressures are given in kPa.



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QUESTION 16**15 points**[Save Answer](#)

What is meant by initial conditions? Briefly describe how the initial conditions are created by data assimilation (objective analysis and initialization)? What is the uncertainty in the initial conditions? Explain how do you overcome this uncertainty? No diagrams are required.

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QUESTION 17**10 points**[Save Answer](#)

Describe the procedure to evaluate the effects of discretization on various types of grids (A-D) for shallow water equations. What are the discretization errors on the waves. No need to give equations.

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Click Save and Submit to save and submit. Click Save All Answers to save all answers.

[Save All Answers](#)[Close Window](#)[Save and Submit](#)