OCES 2003 Midterm, Spring 2022

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Set on: Tue 29th Mar; due: Tue 29th Mar

Blurb

- The midterm is multiple choice of 20 questions and marked out 30
  - 25 is roughly around the A- boundary, anything below 15 is probably a fail
  - late hand in penalty is 10% per minute, so by all means take more time, with the understanding you are increasing your risk of getting hit by the late hand in penalty
- Olympiad style: 2 marks for each correct answer, -1 for each incorrect answer, 0 for skipping
  - there are actually 40 marks available, but even if you get 40/30 you still only get 30/30
  - you can get full marks without answering all questions
  - you should be thinking about 3 minutes per question
  - questions are a mix of interpretation/recall and computational questions
- Hand in answers to my e-mail (see above) or Canvas as:
  - an e-mail with "OCES 2003 midterm" and a string of characters such as "abcdxaabbccdd...", where Q1 answer is *a*, Q2 answer is *b*, Q5 answer is skip etc., so I should be getting 20 characters
  - as above, but as direct text entry in Canvas
  - marked up pdf but with your answers circled (no marking to be interpreted as skipping the question, or you can explicitly write "skip", up to you)
  - some other piece of paper with answers on there (working optional but ultimately no marks given there, but it might be easier for us to point out where you went wrong if you did go wrong)

!!! By handing something in, you agree to the usual Academic Honour code and Integrity declarations. For more, see http://qa.ust.hk/aos/academic_integrity.html.

Problems

1. Taking z to be pointing downwards and p to be the hydrostatic pressure, the sign of $\partial p/\partial z$ is

   (a) none of the other answers here are correct
   (b) zero
   (c) negative
   (d) positive

2. Which of these are technically admissible units for *freshwater* precipitation that can be interpreted as a volume rate?

   (a) ml s^{-1}
   (b) kg $month^{-1}$ divided by density of freshwater
   (c) mm m^2 yr^{-1}
   (d) all of these are technically feasible

3. Mechanical forcing as given in the lectures directly affect

   (a) velocity
   (b) momentum
   (c) neither (*a*) or (*b*)
   (d) both (*a*) and (*b*)

4. On Earth and by definition, gravity is acting

   (a) at right angles to the geoid everywhere
   (b) perpendicular to the ellipsoid everywhere
   (c) at 90° to the ocean sea surface everywhere
   (d) uniformly over the Earth's land surface everywhere

5. Hydrostatic balance is the balance between

   (a) Coriolis effect and horizontal pressure gradient
   (b) vertical pressure gradient and viscosity
   (c) weight and horizontal pressure gradient
   (d) none of the other answers here are correct

6. In the Northern hemisphere, and assuming geostrophic balance, geostrophic flow would be

   (a) to the left of the negative pressure gradient
   (b) to the right of the negative pressure gradient
   (c) directed to the right of the isobars
   (d) directed to the left of the isobars

7. A subtropical gyre by definition is a

   (a) positive curl region
   (b) negative curl region
   (c) cyclonic region
   (d) anti-cyclonic region

8. From Stommel's original model as given in the lecture 11, one of the key dynamical ingredient to the overall gyre circulation is

   (a) eddies
   (b) bottom bathymetry
   (c) wind forcing
   (d) buoyancy forcing

9. If the Earth's rotation reverses, and assuming the associated wind patterns stay fixed (they won't stay fixed but for argument sake lets say they do), then

   (a) the Sverdrup interior flow will reverse directions
   (b) there is no intensification on either side, and the gyre circulation will become symmetric
   (c) we still get western intensification
   (d) no vorticity balance possible

10. If Rossby number is large, then a large-scale flow driven by the negative pressure gradient in the Northern Hemisphere would be

    (a) in the direction opposite of the negative pressure gradient
    (b) in the direction of the negative pressure gradient
    (c) directed to the right of the negative pressure gradient
    (d) directed to the left of the negative pressure gradient

11. Taking the Gulf Stream scales to be $U = 0.3$ m s^{-1}, $f = 10^{-4}$ s^{-1} and $L = 100$ km, the Rossby number Ro is closest to

    (a) 10
    (b) 1
    (c) 0.1
    (d) 0.01

12. If the rotational axis $\boldsymbol{\Omega}$ is pointing North everywhere on Earth, the Coriolis effect $2\boldsymbol{\Omega} \times \boldsymbol{u}$ at the equator for a purely Eastward flow points

    (a) east
    (b) none of the other answers here are correct
    (c) vertically down
    (d) south

13. In Hong Kong during the Summer months we experience a South-Westerly wind, which implies a coastal Ekman

    (a) none of the other answers here are correct
    (b) on-shore surface transport
    (c) downwelling
    (d) upwelling

14. Eastern boundary current systems are particularly active biological regions, largely because there is an ambient supply of nutrients via Ekman upwelling. Given these Eastern boundary currents are on the eastern side of the basins, because of Ekman upwelling we can immediately say that the winds governing these regions throughout the world should be

    (a) equatorward
    (b) poleward
    (c) southwards
    (d) very warm

15. Monsoons are

    (a) seasonal variations in the solar forcing
    (b) none of the answers here
    (c) yearly variations in the rain
    (d) daily variations in the wind

16. The Great Pacific Garbage Patch coinciding with the location of the Pacific subtropical gyre might be expected because the gyre

    (a) none of the other answers here
    (b) is a lower pressure region
    (c) is an area of flow convergence
    (d) receives the more rainfall

17. For a purely zonal flow in the Northern Hemisphere with a negative meridional gradient as you go north, that flow

    (a) is cyclonic
    (b) has positive curl
    (c) neither (*a*) or (*b*)
    (d) both (*a*) and (*b*)

18. In the Stommel model for western intensification the western boundary layer could be seen to scale like $L \sim \beta/r$ (notation as in slides in lecture 11 and 12). If Earth increases it's rotation rate by a factor of two, the boundary layer width L would

    (a) none of the other answers here are correct

    (b) decrease in width by a factor of two because r is increasing by a factor of two

    (c) stay the same width because r is increasing but β is decreasing by the same amount

    (d) increase in width by a factor of two because r is decreasing by a factor of two

19. If the ocean is unstratified, the work done against buoyancy to bring up a parcel of water with weight 10,000 N (1m^3 volume of water with density 1000kg m^{-3}, subject to $g = 10$ m s^{-2}) from 4000m depth to the surface would be

    (a) 10^6 J

    (b) 10^6 kJ

    (c) 10^6 MJ

    (d) none of the other answers here

20. Taking the moon's mass to be 7.4×10^{22} kg and is at a distance of 3.8×10^8 m away from the Earth's surface, with the gravitational constant $G = 6.7 \times 10^{-11}$ m^3 kg^{-1} s^{-2}, the graviational acceleration due to the moon on the Earth's surface is around

    (a) 3.4×10^{-5} m s^{-1}

    (b) 0.5 km hr^{-2}

    (c) 1.4 inch s^2

    (d) 3.4×10^{-2} mm^2 s^{-1}