

**ES1201 – Earth System Processes**  
End-Semester Examination: 4<sup>th</sup> May 2019  
Total marks: 50; Time allotted: 2 hours 30 min

**PART – A (Total Marks: 17)**

- 1) Explain the factors controlling the explosive nature of volcanoes. (3)
- 2) Explain Regelation. Define various types of Morains in a glacier environment. (2+3)
- 3) Explain basic principle of Amino acid racemization method. (3)
- 4) Define – (i) Pahoehoe lava (ii) Erratics (iii) Flute (iv) Detrital Remnant Magnetization (v) Parabolic dune and (vi) Shield volcanoes. (1 x 6)

**PART – B (Total Marks: 33)**

*For multiple-choice questions, please write down the correct answer(s) in the answer sheet (not on the question paper). Please note that some questions have multiple correct answers. Questions 8-17 carry 1 mark each.*

- 1) With the help of a diagram, explain why gyres in the Northern Hemisphere are diffused and move slowly at the eastern boundary, but are narrow and fast-moving along the western boundary. (4)
- 2) Explain how Ekman transport leads to upwelling and downwelling in oceans in response to surface high and low pressure centers. (3)
- 3) What is mass-independent fractionation of sulfur? How does it provide evidence for the Great Oxidation Event? (3+3)
- 4) Draw a systems diagram with the following components: i) surface temperature, ii) atmospheric CO<sub>2</sub> concentration, iii) silicate weathering, iv) ice cover over continents. Label positive couplings with a normal arrow (→) and negative couplings with a dashed arrow (– →). Identify overall feedback loop(s) and their nature (i.e., positive or negative). (3)
- 5) Assuming an atmospheric vertical temperature profile of T<sub>atm</sub> and an adiabatic profile of T for an air parcel, draw altitude vs temperature profiles for: i) unstable atmosphere, and ii) stable atmosphere. (2)
- 6) Briefly discuss the role of greenhouse gases in solving the Faint Young Sun paradox. (3)
- 7) The evil scientist Dr. X intends to destroy earth. His plan is to trick mankind to commercially use, and therefore release into the atmosphere via leakage, a gaseous chemical that is a strong greenhouse agent. He has two options to choose from: a gas AAA that absorbs strongly at a wavelength of 35 μm and another gas BBB that absorbs strongly at 10 μm. Which gas should Dr. X choose and why? (2)
- 8) For a natural system consisting of couplings and feedback loops, which of the following are true?  
a) a system with a single negative feedback loop has a stable equilibrium state; b) a system with two negative feedback loops has an unstable equilibrium state; c) the response to feedbacks is not instantaneous; rather, it is time-dependent; d) a system with a single positive feedback loop has a stable equilibrium state
- 9) The Oparin-Haldane hypothesis postulated:

a) that the early earth had a strongly reducing atmosphere; b) that the early earth had a moderately oxidizing atmosphere; c) that UV radiation and lightning could have produced simple organic monomers in the early atmosphere; d) that early life arose near oceanic vents

10) Assuming Martian atmosphere to be predominantly  $\text{CO}_2$ ,  $T = 220 \text{ K}$ , acceleration due to gravity =  $3.7 \text{ m s}^{-2}$ , and universal gas constant =  $8314 \text{ g m}^2 \text{ mol}^{-1} \text{ K}^{-1} \text{ s}^{-2}$ , the scale height would be:

a) 1.1 km; b) 15.4 km; c) 11.2 km; d) 26.3 km

11) For each 7.4 km rise in altitude ( $T=250 \text{ K}$ ), the density of air drops by a factor of:

a) 2.0; b) 5.2; c) 2.7; d) 3.3

12) The presence of surface friction:

a) causes an enhancement of the Coriolis force; b) causes geostrophic flow to deviate from moving parallel to isobars; c) causes the air mass to deflect towards the high pressure region; d) causes horizontal convergence of air at the low pressure center

13) The polar front:

a) is the convergence zone where polar easterlies meet the sub-polar westerlies; b) is a well-defined zone with no seasonal variations in location; c) can compress and expand depending on the season; d) can be discontinuous

14) Considering the eastern shoreline of a continent and a southerly wind in the NH, Ekman transport will cause:

a) coastal downwelling; b) a boost in phytoplankton activity along the coast; c) a reduction in phytoplankton activity along the coast; d) coastal upwelling

15) El-Niño:

a) occurs when the Western Pacific warm pool is pushed towards the far western boundary; b) occurs when there is a weakening or reversal of equatorial trade winds; c) limits upwelling in the Eastern Pacific; d) can be identified by positive values of the Southern Oscillation Index

16) The Thermohaline Circulation:

a) is driven by the flow of surface winds; b) operates only down to the Ekman depth; c) starts with the formation of bottom water at high latitudes; d) is affected by climate change instantaneously

17) The existence of cap carbonates provides evidence for:

a) the Faint Young Sun hypothesis; b) the Great Oxidation Event; c) Snowball Earth; d) Late Heavy Bombardment