Instructions:

a. Read all the questions CAREFULLY. Then complete all questions and sub-questions to the best of your ability.
b. The time allowed is 60 minutes including 5 minutes reading time to start.
c. No written or electronic assistance is allowed; a student’s results will be forfeit if this is determined.
d. You will need pen/pencil, ruler, and perhaps pad paper.

QUESTION 1 (Multiple choice format – mark clearly and unambiguously the choice that you make. Allow 15 mins) Do 8 of the 10 subquestions (a-j).

a. The Greenwich Meridian:
   i. Is the standard line of latitude
   ii. Is also known as the International Dateline
   iii. Is the standard line of longitude
   iv. Is a small circle

b. Which of these convection modes is most plausible for the Earth’s mantle?
c. Ocean equatorial zones are characterized by:
   i. Divergence and downwelling
   ii. Convergence and downwelling
   iii. Divergence and upwelling
   iv. Convergence and upwelling

d. At Mid-Ocean Spreading Ridges it is NOT true that:
   i. The earthquake and volcanic activity exactly coincide in geographic pattern
   ii. The volcanism is a mix of intrusions and by-and-large quiescent extrusion (flows)
   iii. The spreading rate is of the order of 1-10 cm/yr, depending which ridge
   iv. They are made of relatively warm, less dense materials that rise above general ocean bathymetry

e. Which of these is FALSE?
   i. Submarine canyons are cut into the continental slope
   ii. The continental shelf is formed over time by erosion and deposition under changing sealevels
   iii. The lowest elevation that low sealevel stands have reached in recent geological times is about -120m
   iv. The lowest elevation that low sealevel stands have reached in recent geological times is about -200m corresponding to the average edge of continental shelves

f. Eddy Viscosity:
   i. Is only about 10 times greater than molecular viscosity
   ii. Refers to internal fluid friction on laminar flow lines
   iii. Is quantified by the Richardson Number
   iv. Quantifies the turbulent mixing in ocean waters

\[ \frac{\partial u}{\partial t} + u \frac{\partial u}{\partial x} + v \frac{\partial u}{\partial y} + w \frac{\partial u}{\partial z} = -\frac{1}{\rho} \frac{\partial P}{\partial x} + 2 \Omega v \sin \vartheta + F_x \]

g. The equation:
   i. Represents Friction effects using \( F_x \)
   ii. Is the equation for continuity
   iii. Is the geostrophic equation
   iv. Has \( u \) and \( v \) in the wrong place
   v. Has terms for diffusivity in it

h. The Boussinesq approximation:
   i. Explains Langmuir Circulation
   ii. Refers to the contrast in horizontal and vertical mixing lengths
   iii. Is a numerical method to solve equations
   iv. Is interesting, but rarely used

i. The zone where Hadley and Ferrel cells meet:
   i. Is a zone of low atmospheric pressure, high precipitation
   ii. Coincides with high evaporation
   iii. Rotates anticlockwise
iv. Is at 60 degrees north and south latitudes

j. High salinity brines:
   i. Form in polar regions only
   ii. Are always colder than surrounding waters
   iii. Upwell at divergence zones around Antarctica
   iv. Are involved with the Antarctic Circumpolar Wave
   v. Can be created by a process of rejection from ice

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**QUESTION 2** *(Use a whole blank page if you need to. Allow 20 mins)*

*Do Part a OR Part b.*

a. Draw a labelled diagram of three (3) of the large-scale geometric regularities of plate tectonic processes, whether spreading, subduction or plate movement. Also show some information about the locations of earthquakes along the geometric segments.

OR

b. Draw a detailed and labelled diagram of the zonal current system in the Pacific Ocean, paying attention to Coriolis effects, patterns of wind, the ITCZ, counter currents, and other factors.

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**QUESTION 3** *(Brief prose format, up to one page. Allow 20 mins)*

*Do Part a OR Part b.*

a. Describe in words how the el Nino phenomenon differs from the normal situation in the tropical Pacific Ocean.

OR

b. Describe in words the differences in design, operation and results of the three types of mapping sonars: (i) single-beam sonar, (ii) sidescan sonar, (iii) multibeam sonar.

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**END.**