UNIVERSITY COLLEGE LONDON

EXAMINATION FOR INTERNAL STUDENTS

MODULE CODE : **GEOLGG25**

ASSESSMENT PATTERN : **GEOLGG25A**

MODULE NAME : **Geodynamics and Global Tectonics**

DATE : **08-May-15**

TIME : **10:00**

TIME ALLOWED : **2 Hours 30 Minutes**

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GEOL3003_M300_GG25 GEODYNAMICS & GLOBAL TECTONICS

*Answer **FOUR** of the following six questions. All questions carry equal marks. Where a question consists of more than one part (a, b, c etc.) all parts carry equal weight unless stated otherwise.*

1)

a) Derive an expression for the Rayleigh number. [40%]

b) Estimate the value of the Rayleigh number for convection of Earth's mantle. [20%]

c) Compare the value you have computed to the critical Rayleigh number and discuss the implications of this comparison. [40%]

2) Ares is an Earth-like planet with a reversing magnetic field and two plates: plate A encompasses the northern hemisphere and plate B encompasses the southern hemisphere. Points a, b, c, and d lie on the equator and the zero meridian passes through point a. The pole of rotation A relative to B is at 45° N, 0° E with an angular velocity of 10^{-10} radians per year. The planet's radius r = 3400 km.

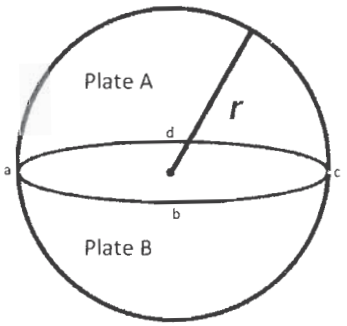
a) What is the nature of the plate boundary between plates A and B? [20%]

b) State where magnetic lineations might be found and sketch the pattern that would be observed. [20%]

c) Calculate the relative velocity between plates A and B at locations a,b,c,d. [20%]

d) Discuss the possible existence of such a two-plate planet. [20%]

e) Discuss briefly how the stability or instability of a two-plate system depends upon the pole position and/or relative size of the two plates. [20%]



3) Assume a value for the thermal diffusivity $\kappa=10^{-6}$ m^2/s.

a) Non-dimensionalize the heat diffusion equation, justify your choice of characteristic values and derive an expression for the cooling time and estimate how much time is required for a dike of 10 m thickness to solidify. [40%]

b) Estimate the thickness of 100 million year old oceanic lithosphere. [20%]

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c) Estimate how much time is required for a sphere of solid rock with no internal heat sources and radius equal to that of the Earth to cool by conduction alone. [20%]

d) Discuss whether Earth cools more quickly or more slowly than your answer to in (c). [20%]

4)

a) Derive an expression for the Maxwell relaxation time. [40%]
b) Discuss the significance of the Maxwell relaxation time in geodynamics. [20%]
c) Estimate the value of the Maxwell relaxation time for Earth's convecting upper mantle. [20%]
d) Is the Maxwell relaxation time of the lithosphere longer or shorter than this value? [20%]

5) Assume a fault with strike due north, dip=45° down to the east, and a stress field σ_{xx}=-200 MPa, σ_{zz}=-100 MPa, σ_{xz}=0 MPa. Take compressive stresses to be negative.

a) Find the principal components and directions of the stress tensor. [25%]
b) Find the magnitudes of the normal and shear tractions acting on the fault. [25%]
c) What kind of a fault is it? [15%]
e) In what tectonic setting would you expect to find this fault? [15%]
f) Where on Earth might you find this fault? [20%]

6) In the context of the hypothesis put forth in class, *succinctly* describe a theory for plate tectonics that couples mantle flow and lithosphere, accounts for variations in rheological properties and describes as completely as possible observed tectonic phenomena. Illustrate your question and use all relevant knowledge (Hint: You may want to focus at first on mantle convection and the genesis of oceanic lithosphere).

END OF PAPER