Geophysics 210 - Physics of the Earth

Final exam

Section	GEOPH 210 Lecture A01
Instructor	Dr. Martyn Unsworth
Date	Thursday December 13th 2007
Time allowed	9:00 a.m. – noon

Total = 95 points

*Please attempt **ALL** FIVE questions.*

*Notes and books may **NOT** be used during the exam.*

Calculators are permitted.

Show all working, as credit will be given for your method as well as the final answer.

All questions should be directed to the invigilator.

Please hand in this exam, with your answer booklet

Name ________________________________

Question 1 – Short answers

(a) What seismological evidence is there that whole mantle convection occurs.

(3 points)

(b) Describe one way that a nuclear explosion can be distinguished from an earthquake.

(3 points)

(c) What two important mineral transitions occur in the mantle over the depth range of 200-700 km? Give approximate depths for both.

(6 points)

(d) Name a strike slip fault that forms a plate boundary. **(2 points)**

(e) How did Eratosthenes measure the radius of the Earth? **(4 points)**

(f) Define the Curie depth **(3 points)**

(Q1 Total = 21 points)

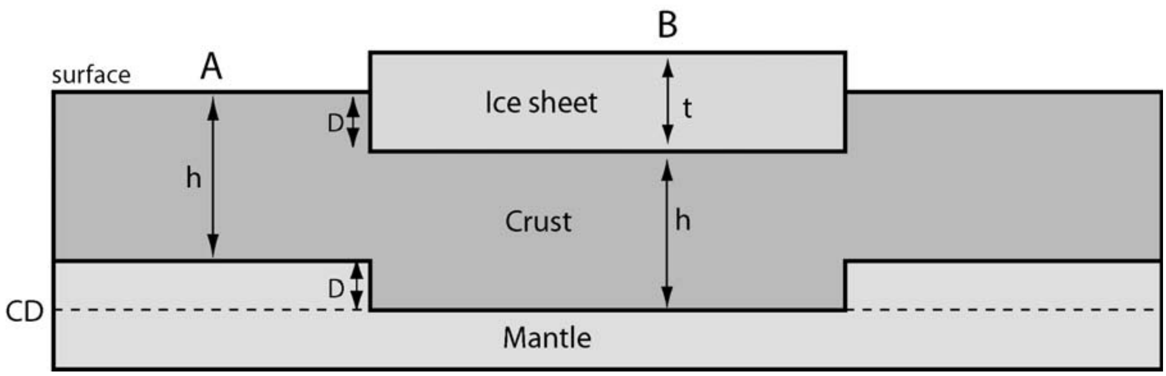
Question 2 – Isostacy

The Earth's crust has a thickness h = 35 km in northern Canada.

An ice sheet forms with thickness t = 1 km

Ice density = 920 kg m^{-3} , crustal density = 2800 kg m^{-3} and mantle density = 3100 kg m^{-3}

The Earth's crust is depressed by an amount D



Assume that **Airy's hypothesis** of isostacy is valid at this location.

Airy's hypothesis requires that Σ (*thickness* x *density*) from the surface to the compensation depth (CD) is the same at locations A and B.

(a) Compute the value of D. Show all working **(7 points)**

(b) What observation gave rise to Airy's hypothesis of isostacy **(4 points)**

(Q2 Total = 11 points)

Question 3 – Global Seismology

Draw raypaths and travel times on figure on NEXT PAGE

An earthquake occurs on planet with radius = R_E
The earthquake occurred at E and was measured by 12 seismic stations.
The mantle has a **uniform** P-wave velocity v_m= 8 km/s
The core has a **uniform** P-wave velocity v_c= 6 km/s

P (Direct P-wave)

(a) Show that the travel time for the direct P-wave is given by

$$t = \frac{2R_E \sin(\Delta/2)}{v_m}$$ **(3 points)**

(b) Sketch the raypaths for the direct P-wave for each station at which it is observed **(2 points)**

(c) What is the maximum value of Δ at which the direct P-wave will be observed? **(2 points)**

(d) What is the travel time at this maximum angle? **(2 points)**

(e) Sketch the travel time curve for the direct P-wave on the graph below **(3 points)**

PcP (reflection from core)

(f) For each seismic receiver, sketch the raypath for PcP **(2 points)**

(g) What is maximum Δ at which PcP will be observed. **(2 points)**

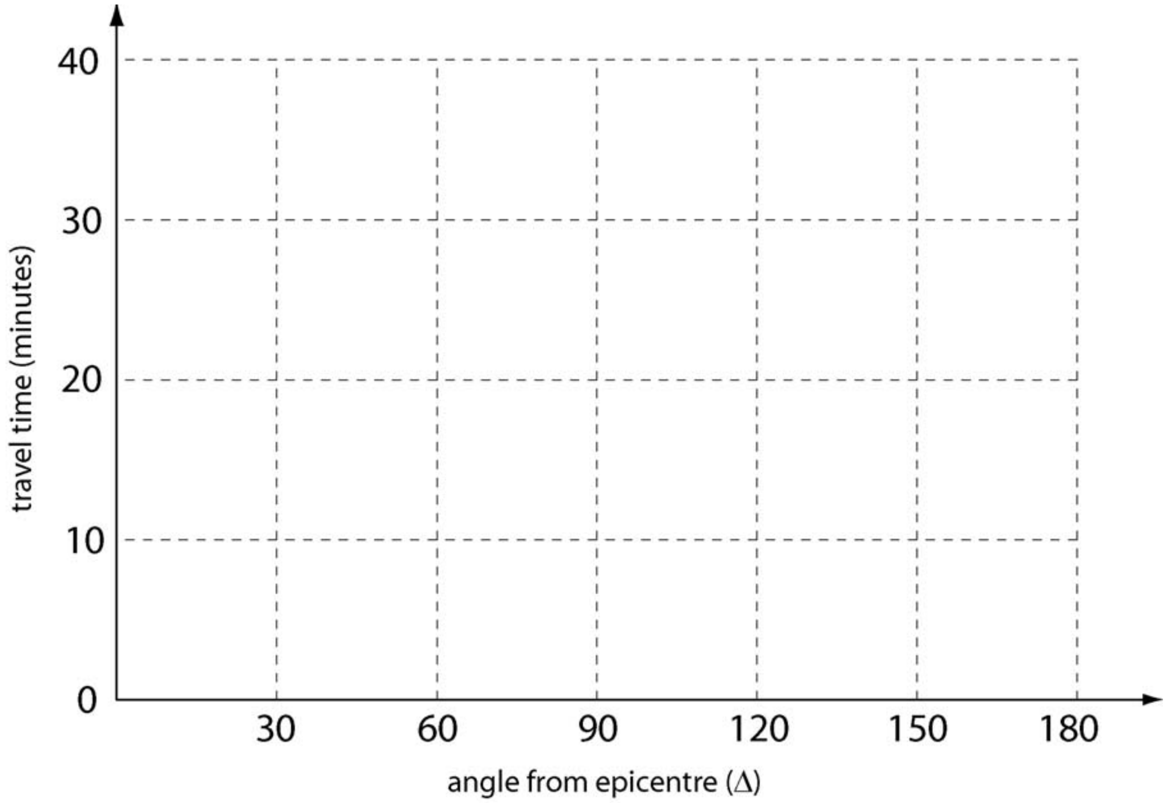
(h) What is the PcP travel time when Δ = 0° **(2 points)**

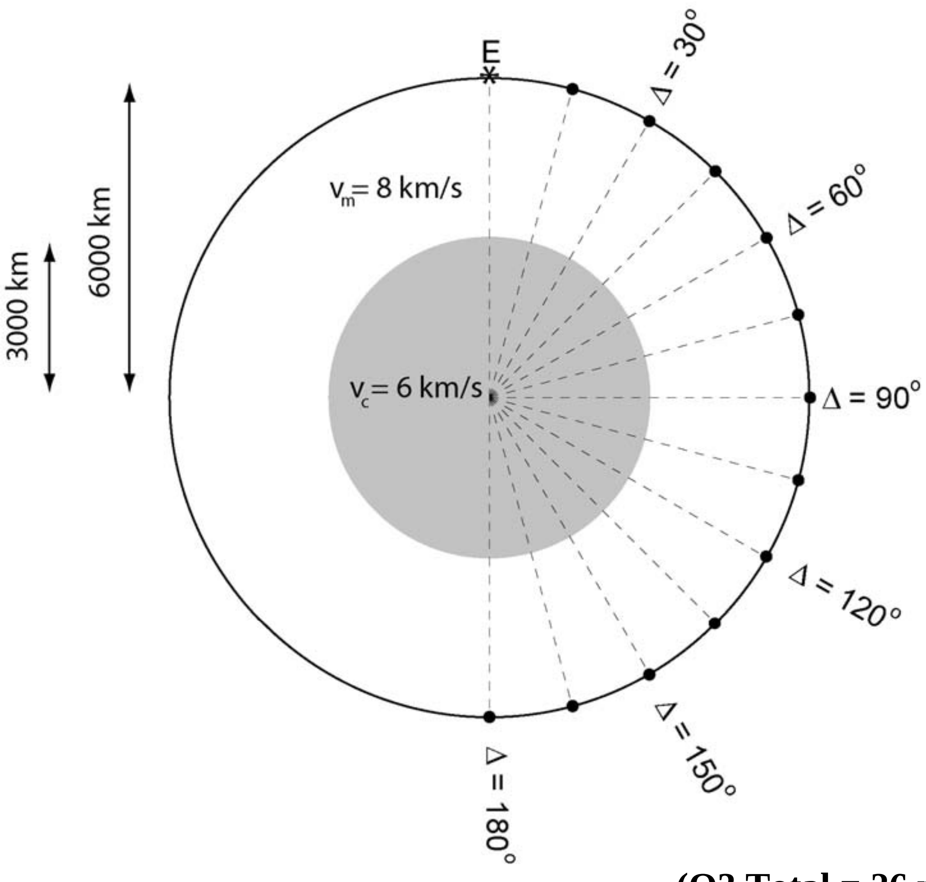
(i) Sketch the travel time curve for PcP on the graph below **(2 points)**

PKP (P-wave in mantle and P-wave in core)

(j) What is travel time for PKP at Δ=180° that travels through the centre of the Earth? **(3 points)**

(k) Sketch qualitatively the travel time for the two branches of PKP **(3 points)**





(Q3 Total = 26 points)

Question 4 – Geomagnetism

(a) Explain the origin of **diamagnetism** and **paramagnetism** on an atomic level.

For each indicate if the magnetic susceptibility is **positive** or **negative**.

Name a mineral that exhibits each type of behaviour. **(10 points)**

(b) The Earth's magnetic field is generated by **three** distinct mechanisms.

Name these **three** components and the **percentage** of the total magnetic field that comes from each.

(6 points)

(c) Explain the origin of **seafloor magnetic anomalies** formed at mid-ocean ridges.

(4 points)

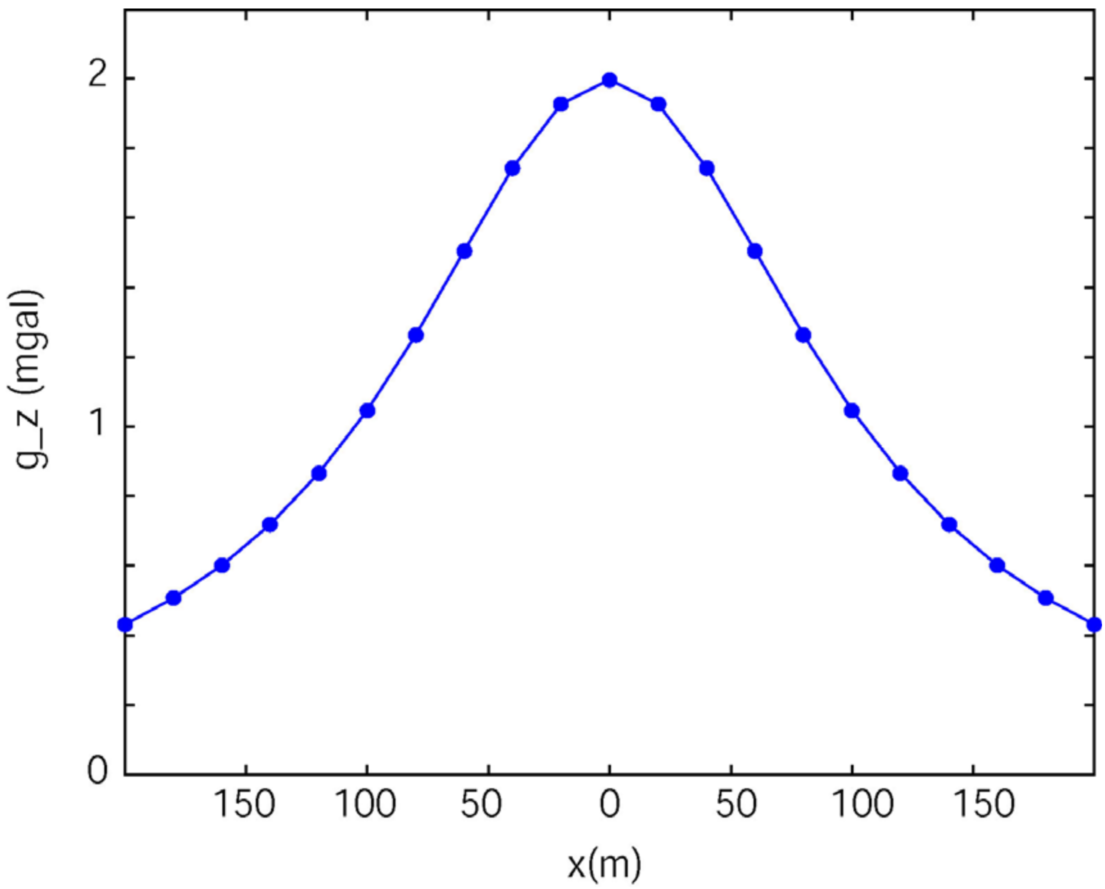
(d) Use a diagram to explain the polarity of the magnetic anomaly at a mid-ocean ridge.

Consider two cases (1) high magnitude latitude and (2) magnetic equator.

(6 points)

(Q4 Total = 26 points)

Question 5 – Gravity anomalies



The figure above shows the variation in gravity across an ore deposit that is approximately spherical in shape.

(a) Estimate the **half width** of the gravity anomaly **(2 points)**

(b) Estimate the **depth** of the ore body **(2 points)**

(c) Estimate the **excess mass** of the ore body **(4 points)**

(d) Estimate the **radius** of the ore body **(3 points)**

(Q5 Total = 11 points)