THE OPEN UNIVERSITY OF SRI LANKA
FACULTY OF NATURAL SCIENCES
DEPARTMENT OF PHYSICS

005

B.Sc. DEGREE PROGRAMME- LEVEL 05 - 2023/24
PHU5308 – FUNDAMENTALS OF GEOPHYSICS
FINAL EXAMINATION
DATE: 19th April 2024

DURATION: TWO HOURS
TIME: 9.30 am. – 11.30 am

Paper consists of ***Six (06)*** questions. Answers should be illustrated with sketch maps and diagrams where appropriate. Each question carries equal marks.

1 a From basic principles, show that the travel time equation used in refraction seismic Survey for a horizontal, planar and homogeneous two-layer case is given by (8 marks)

$$t_x = \frac{x}{v_2} + \frac{2h\sqrt{v_2^{\,2} - v_1^{\,2}}}{v_1 v_2}$$

b b) A 200 m long seismic refraction profile was acquired on the site of the new Geological Sciences building to determine the depth to the underlying bedrock for piling purposes. Assuming horizontal planar layers, calculate the velocity of each layer and the depth to the Underlying bedrock. (17 marks)

Offset (m)	Travel time (ms)
0.0	0.0
20.0	33.3
40.0	57.2
60.0	70.6
80.0	83.9
100.0	97.2
120.0	110.6
140.0	123.9
160	137.2
180	150.6
200	163.9

2

a Derive travel-time equation of reflected seismic wave arrivals (two-layer case, horizontal interface): (8 marks)

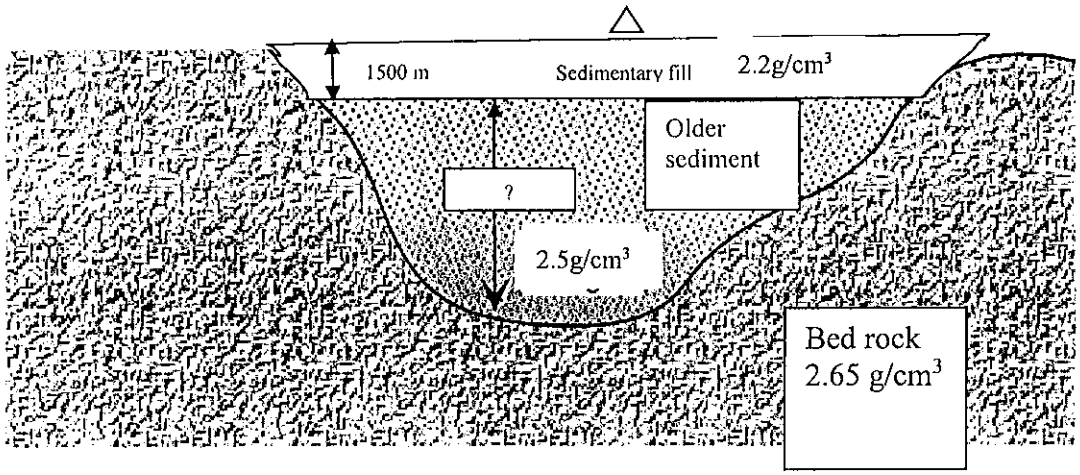
$$T(x) = \sqrt{\left(X/V_1\right)^2 + \left(2d/V_1\right)^2}$$

b Suppose that seismic reflection survey was done over layered sequence shown in the following figure where interval velocities and layer thicknesses are given. Determine the average and root mean square velocities as function of zero offset reflection time. (17 marks)

v1 = 1000 m/s	50 m
v2 = 2500 m/s	100 m
v3 = 1500 m/s	75 m
v4 = 3000 m/s	150 m
v5 = 4000 m/s	

3. The sedimentary fill shown in the following diagram is known to consist of young flat lying sediments of density 2.2 g/cm^3 to depth of 1500 m followed by an unknown thickness of older sediments of density 2.5 g/cm^3 and overlying bed rock of 2.65 g/cm^3.

1 *Gal* = 10^{-2} *m/s*^{2};



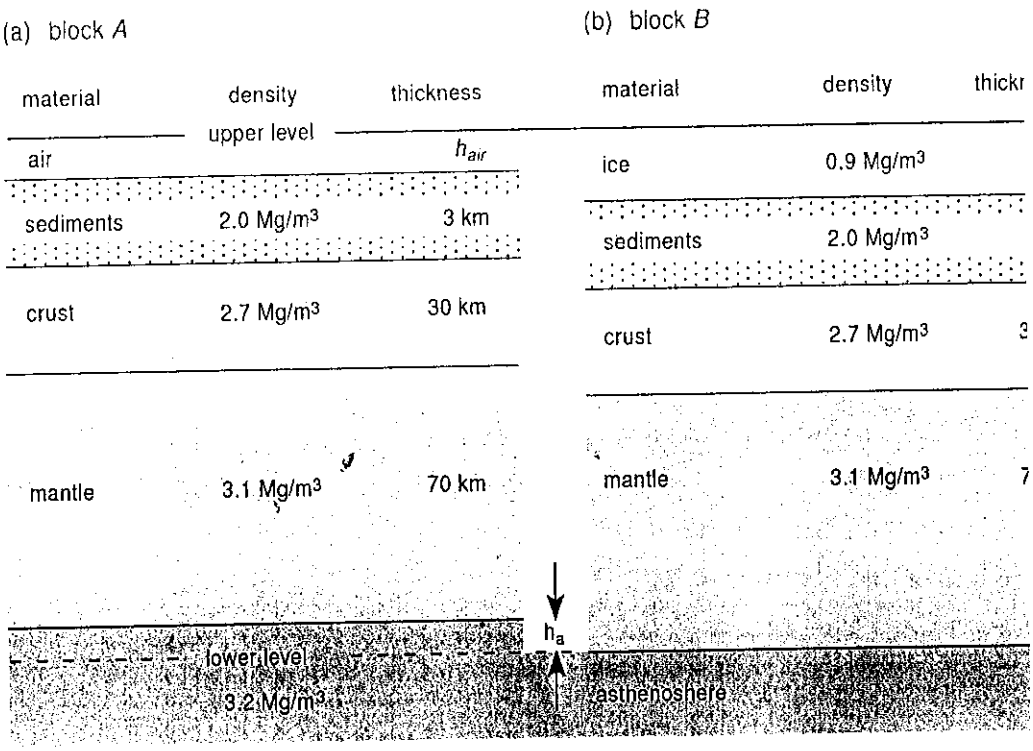
Gravity effect of horizontal cylinder $g = 2\pi G\rho z$;
uniform density = ρ;
thickness = z;
G = Universal Gravitational Constant = 6.67 x 10^{-11} Nm^2/Kg^2

a Calculate the Δg for sedimentary fill (Assume that the sedimentary basin is modelled as a horizontal cylinder). (5 marks)

b Assuming the total gravity anomaly observed in the sedimentary basin from the bed rock is 40 mGal, Calculate the Δg of the second layer (5 marks)

c What is the maximum thickness of the older sediments? (5 marks)

d Calculate the depth of the sink of continent, in case of adding a 2 km thick glacier on top of a continent. See below the diagram. (10 marks)



4. A Resistivity sounding was carried out using Schlumberger array at point 'P' (center point). The distance from 'P' to any current electrode (L/2) and the distance from 'P' to any potential electrode (l /2) is given in the Table below.

L /2 (m)	l /2 (m)	K (m)	R(Ω)	ρ(Ωm)
1.5	0.5		79.62	
2	0.5		39.05	
3	0.5		13.10	
4.5	0.5		1.91	
6	0.5		0.53	
8	0.5		0.17	
10	0.5		0.10	
12.5	2		0.23	
15	2		0.14	
20	2		0.08	
25	2		0.05	

Calculate

(a) the geometric constant (K) and resistivity values (ρ) for each electrode separation and construct the resistivity curve. (use the graph sheet in Page no 5) *(20 points)*

(b) According to the results of above (i), how many subsurface layers are present in the surveyed area? *(5 points)*

(The geometric constant for the Schlumberger array is given as, $K = \frac{\pi(L^2 - l^2)}{4l}$)

5. (a) Discuss the advantages and disadvantages of aeromagnetic surveying. *(5 points)*

(b) How and why do the methods of reduction of gravity and magnetic data differ? *(5 points)*

(c) Compare and contrast the techniques of interpretation of gravity and magnetic anomalies. *(5 points)*

(d) Assuming the magnetic moment of the Earth is $8 \times 10^{22} Am^2$, its radius as 6370 km and that its magnetic field conforms to an axial dipole model, calculate the geomagnetic elements at 60°N and 75°S. *(10 points)*

6. (a) What are the minerals that can be used for radiometric survey? *(5 points)*

(b) How many half-lives must elapse before the activity of a radioactive isotope decreases to 1% of its initial value? How long is this time for 14C, which has a decay rate of 1.21×10^{-4} yr^{-1}?

(10 points)

(c) Radiocarbon dating of a sample of wood from the tomb of an Egyptian pharaoh gave isotopic concentrations of 9.843×10^{-15} mol g^{-1} for 14C and 1.202×10^{-2} mol g^{-1} for 12C. Assuming that the initial 14C/12C ratio in the sample corresponded to the long term atmospheric ratio of 1.20×10^{-12}, determine the age of the tomb, the percentage of 14C remaining, and the original 14C concentration in the wood.

(10 points)

