CHUKA UNIVERSITY

UNIVERSITY EXAMINATIONS

EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF SCIENCE

PHYS 494: APPLIED GEOPHYSICS

STREAMS: BSC **TIME: 2 HOURS**

DAY/DATE: THURSDAY 19/12/2024 **8.30 A.M. – 10.30 A.M.**

INSTRUCTIONS:

Useful constants

Universal gravitational constant $G=6.67*10^{-11}$ m^3/kg^2

Density of crustal material=2670 kg/m^3

Mean radius of the earth Re=6400 km

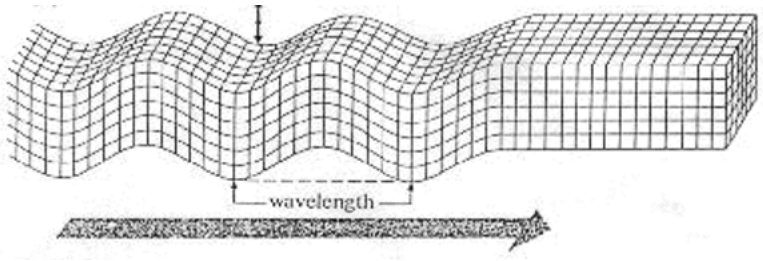
Acceleration due to gravity $g=9.8$ m/s^2

Mass of the earth $Me=6*10^{24}$ kg

Answer question one and any other three questions

QUESTION ONE (30 MARKS)

a) Identify with reasons the type of waves in the diagram below [3 marks]



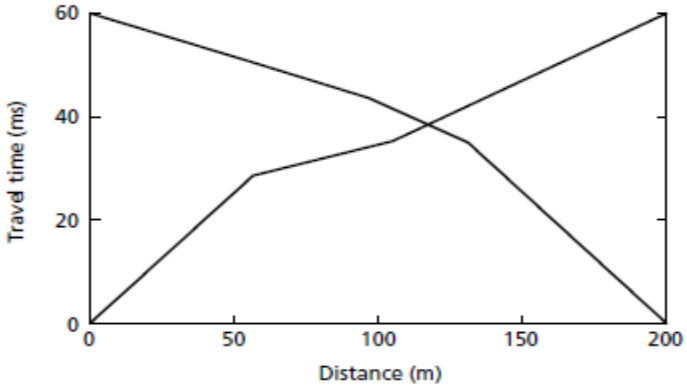
b) Differentiate between reflection and transmission coefficients [2 marks]

c) i) Discuss four advantages of geophysical prospecting in engineering site investigation [4 marks]

ii) Compare the direct method and indirect method of interpretation of potential field methods of exploration [4 marks]

d) Compression ray travels with a velocity of 2.1×10^3 m/s in a rock material of density 267 kg/m^3 and at a velocity 1.6×10^3 in a rock layer of density 295 kg/m^3, calculate its reflection coefficient [4 marks]

e) What subsurface structure is responsible for the travel time shown below for both forward and reverse traverse? Explain



[5 marks]

f) State two advantages and one limitation of seismic refraction method in geophysical investigation [3 marks]

g) Explain the meaning of a hidden layer in seismic refraction [2 marks]

h) State the three electrical properties of rocks and minerals that are significant in electrical prospecting [3 marks]

QUESTION TWO (20 MARKS)

a) State any four assumptions made in deriving travel time equation for seismic refraction [4 marks]

b) Derive the travel time equation for a two-layer seismic refraction [6 marks]

c) Table 2 below shows arrival times for direct and refracted waves in a 2-layer refraction seismic experiment

Distance from shot point (m)	Direct wave time (ms)	Refracted wave time (ms)
0	0	13.58
6	4.29	14.91
12	8.57	16.24
18	12.86	17.58
24	17.14	18.91
30	21.43	20.24
36	25.71	21.58
42	30.00	22.91
48	34.29	24.24
54	38.57	25.58
60	42.86	26.91
66	47.14	28.24

i) Plot a travel time graph [4 marks]

ii) Find velocities V_1 and V_2 in the two layers [4 marks]

iii) Find the cross over distance and use it to calculate depth of the over-burden [2 marks]

QUESTION THREE (20 MARKS)

a) Discuss the two factors controlling the resistivity of earth materials [2 marks]

b) Werner and Schlumburger electrode configurations are the main electrode arrangements used in resistivity investigations.

Sketch the four electrode configurations in electrical resistivity survey for these modes of survey. [5 marks]

c) Derive the fundamental equations for each electrode arrangement [6 marks]

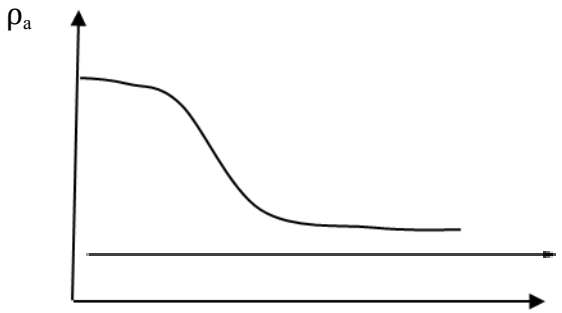
d) Using any one electrode arrangement discuss how vertical electrical surveying can be conducted [7 marks]

QUESTION FOUR (20 MARKS)

a) List and briefly discuss two main properties used to identify ores in geophysical explorations [4 marks]

b) What is forward modelling, explain the forward modelling procedure [5 marks]

c) In the interpretation of vertical electrical sounding, the graph below of apparent resistivity against electrode separation was obtained



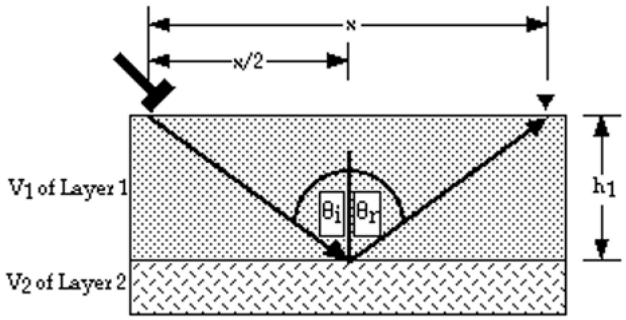
Describe the subsurface represented by the graph [4 marks]

a) State any three limitations of resistivity method [3 marks]

b) Describe how to minimize the ambiguity in geophysical data interpretation [4 marks]

QUESTION FIVE (20 MARKS)

a) Use the diagram below to derive time-velocity relation for a seismic reflection [6 marks]



b) A ray, travelling in a rock with seismic velocity 3 km/sec, encounters an interface with a rock of 4 km/sec at an angle of 45°. At what angle from the normal does it leave the interface? [4 marks]

c) If we have a two-layer situation where V1= 1950 m/s and V2= 3900 m/s (P-wave velocities), what will the P-wave critical angle be? [5 marks]

d) A 600 m thick layer of sandstone overlies a granite basement with a higher velocity. A seismic wave is generated at the surface and travels vertically downward. At the sandstone / granite interface, the incident wave is split into a reflected wave and transmitted wave. Compute Reflection and Transmission Coefficients? Take seismic velocities of sandstone and granite as 2100 m/s and 2700 m/s respectively, densities as 4.1 kg/m^3 and 5.6 kg/m^3 respectively

[5 marks]

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