भू-विज्ञान परीक्षा
Geologist Exam-2015

Sl. No. 0003982

A-IGQ-O-IRB

GEO-PHYSICS

Paper II

Time Allowed : Three Hours | Maximum Marks : 200

INSTRUCTIONS

Please read each of the following instructions carefully before attempting questions.

There are EIGHT questions divided under TWO sections.

Candidate has to attempt SEVEN questions in all.

The ONLY question in Section A is compulsory.

In Section B, SIX questions out of EIGHT are to be attempted.

The number of marks carried by a question/part is indicated against it.

All parts and sub-parts of a question are to be attempted together in the answer book.

Attempts of questions shall be counted in chronological order. Unless struck off, attempt of a question shall be counted even if attempted partly.

Any page or portion of the page left blank in the answer book must be clearly struck off.

Answers must be written in ENGLISH only.

Neat sketches are to be drawn to illustrate answers, wherever required.

Unless otherwise mentioned, symbols and notations have their usual standard meanings.

Assume suitable data, if necessary and indicate the same clearly.

Section – A

1. Answer **all** of the following questions :   10×8=80 ●

   (a) Illustrate with the help of a neat diagram, the difference between the general shape of Bouguer gravity anomaly and Free Air gravity anomaly on land.

   (b) What are the different fields measured during magnetotelluric (MT) survey ? How to determine the thickness and apparent resistivity of a zone using these measured fields ?

   (c) Sketch an idealized diagram showing the effect of lithology (shale and sandstone) and porosity on natural gamma radiation and neutron-gamma radiation logs.

   (d) Describe, with the help of neat diagram(s), the difference between critical distance (X_{crit}) and crossover distance (X_c) in seismic method. Describe the relationship between these two distances.

   (e) Find the ratio between the most probable distance and the average distance of the electron from the nucleus for the ground state in a hydrogen atom.

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(f) What are quarks ? Give a list of quarks with their charge and strangeness. What is quark content of (i) proton and (ii) neutron.

(g) Find the electric field and electric potential for a homogeneously charged sphere of radius R and charge Q at a distance r for (i) $r < R$ and (ii) $r > R$.

(h) Using Lorentz transformations explain (i) length contraction and (ii) time dilation.

Section – B

2. (a) What is NMO correction applied to seismic reflection data ? Discuss the factors on which this correction depends. Draw neatly the diagrams showing the reflection time-distance curves for the cases (i) without NMO correction (ii) NMO corrected with a lower velocity (iii) NMO corrected with a higher velocity (iv) NMO corrected with a proper velocity.

12

(b) With the help of a diagram, describe the difference between the shapes of time-distance curves for the waves reflected and critically refracted from a horizontal interface.　　8
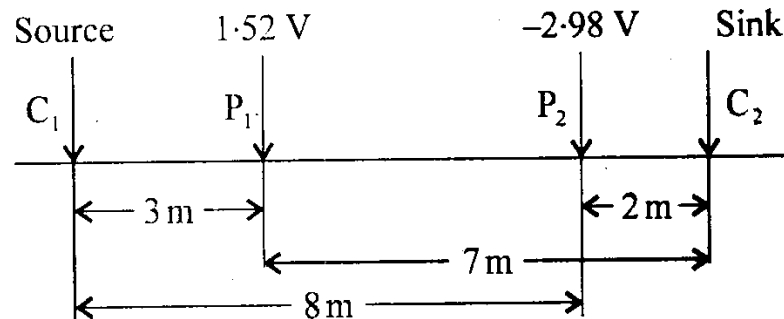
3. (a) Define the formation resistivity factor (F) along with its significance. Describe the Archie's Law to determine the water saturation (S) of a reservoir.　　10

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(b) Differentiate between micronormal and microinverse resistivity logs. Describe their utility in geophysical well logging. 10

4. (a)

Source   1·52 V   −2·98 V   Sink

C_1 P_1 P_2 C_2

|← 3 m →| |← 2 m →|

|← 7 m →|

|← 8 m →|

Derive the generalized equation for determining the apparent resistivity from an array of current and potential electrodes. Use this expression to estimate the apparent resistivity for the above situation for the current of 1 ampere. 10

(b) With the help of a neat sketch, describe the principle of electromagnetic surveying. Illustrate the difference between dip angle and horizontal loop EM surveying. 10

5. (a) Describe the corrections applied to magnetic data to remove the effect of main magnetic field and diurnal variations of the magnetic field. 10

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(b) Estimate the first guess of the thickness of the sediments in a sedimentary basin if the Bouguer gravity observed over the basin is -88 mGal. Assume the density contrast as -0.4 gm/cm^3. 10

6. (a) What are normal and anomalous Zeeman effects? Give with necessary theory the Zeeman splitting of sodium D_1 and D_2 lines. 12

(b) Give selection rules in L-S and j-j coupling schemes in atoms. The spectroscopic term symbols for particular states of different atoms are quoted as $^4S_1$, $^4D_{5/2}$, $^2D_{3/2}$, and $^2P_{3/2}$. Which of these are correct and which not? Elaborate. 8

7. (a) Obtain Maxwell's equations and hence establish the equation for the motion of electromagnetic waves in a homogeneous and isotropic dielectric medium having zero conductivity. 12

(b) Obtain forms of Poisson's and Laplace's equations. Solve Laplace's equation in spherical coordinates. 8

8. (a) Derive Debye T^3-law for specific heat of solids stating clearly the underlying assumptions. **12**

(b) The maximum energy of deutrons coming out from a cyclotron accelerator is found to be 20 MeV. Find the maximum energy of protons that can be obtained from this accelerator. **8**

9. (a) Derive the expression $E = mc^2$ for the mass-energy equivalence starting from the relativistic expression for mass of a moving particle. Show that $E = mc^2$ reduces to the usual kinetic energy expression in the non-relativistic case. **12**

(b) A ball slides on a smooth rod which is fixed at one end is rotating with the uniform angular velocity in a vertical plane. Find the Lagrangian and hence the equations of motion for the ball. **8**

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