भूविज्ञान परीक्षा
Geology Examination 2014

A-FDN/RB-N-QZB

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 SIX questions in all.

The ONLY question in Section A is compulsory.

In Section B, FIVE questions out of SEVEN 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 : 10×8=80

(a) What are various factors affecting the gravity variation from equator to pole ? Explain and mention the net effect at pole.

(b) Porosity of a gas bearing reservoir is estimated independently using neutron and density logging tools. How these measured porosity are related with the true porosity of reservoir ? Explain your answer.

(c) Resistivity sounding survey is conducted over a four layered earth consisting of dry surface soil, water saturated clay, saturated sand and compact sandstone from top to bottom. Draw expected apparent resistivity sounding curve, give suitable name and explain it.

(d) Which energy source in seismic prospecting uses sweep-up and sweep-down signal ? Draw sweep-up and sweep-down signals. Which one is more advantageous and why ?

(e) Describe the different types of couplings in atoms. Why is j-j coupling applicable to heavy elements ?

(f) Stable light nuclei have equal number of protons and neutrons whereas the heavy nuclei have excess of neutrons. Explain why.

(g) Ni^{2+} and Tm^{3+} ions have the same number of unpaired electrons. Why do they have different magnetic moments ? Quantify your answer.

(h) What is homogeneity of time ? Show that it leads to a conservation of energy.

Section – B

Attempt any *five* questions :

2. (a) What are the applications of downward continuation of potential field data ? Also mention its merits and demerits, if any. 12

(b) With a suitable diagram explain why terrain correction is always positive for land gravity survey. Is terrain correction also applied in magnetic data reduction ? Explain. 12

3. (a) Name three geophysical well logging tools used to determine formation porosity. Describe the phenomenon of cycle skipping in sonic logging. Explain the applications of sonic logging. 12

(b) A geophone is placed 2000 m apart from a shot point over three layered horizontal structure. The model is represented by velocities : $V_1 = 2000$ m/s, $V_2 = 3000$ m/s, $V_3 = 5000$ m/s; and layer thicknesses : $h_1 = 500$ m and $h_2 = 1000$ m. Compute the travel time of seismic wave refracted at the interface between second and third layers. 12

4. (a) Why AC current source is preferred over DC current source in resistivity survey experiments ? Explain. What is the frequency range used in AC resistivity meter ? 12

(b) What do you understand by the principle of equivalence and suppression in the interpretation of resistivity sounding data ? Explain with appropriate example. 12

5. (a) How inconsistency in Ampere's law has been removed in Maxwell's equations. Write Maxwell's equations in free space and in polarisable medium. Also explain symmetry in Maxwell's equation. 12

(b) Write the partial differential equation governing propagation of high frequency EM field in conducting and non-conducting media. How are these equations modified for low frequency EM field and why ? Name at least one geophysical method in which high frequency and low frequency EM field are used. 12

6. (a) Explain how population inversion is achieved in He-Ne laser. 10

(b) An atomic state is characterized by spectroscopic symbol $^4D_{5/2}$.

(i) What are the values of L, S and J ?

(ii) What is the minimum number of electron which could give rise to this ?

(iii) Suggest a possible electronic configuration. 10

(c) What are Einstein's coefficients ? State the relation between these coefficients. What is the condition for spontaneous emission to occur ? 4

7. (a) State the basic assumption of single particle shell model. How do the centrifugal and spin-orbit terms remove the degeneracy of the three-dimensional spherically harmonic oscillator ? 18

(b) Assuming the shell model to be correct, what should be the angular momenta and parities of $_8O^{17}$ and $_7N^{16}$? 6

8. (a) Prove that $x^2 + y^2 + z^2 = c^2t^2$ is invariant under Lorentz transformation. 12

(b) For a three dimensional system, the kinetic energy (T) and the potential energy (V) are

$$T = \frac{1}{2}\left(\dot{x}^2 + \dot{y}^2 + \dot{z}^2\right) \text{ and}$$

$$V = \frac{1}{2}\left[(1+\omega_0)x^2 + (1-\omega_0)y^2 + (1-\omega_0)z^2\right] - K(x-y+z),$$

where ω_0 and K are positive constants. Find the frequencies of normal modes of oscillation. 12
