भू-विज्ञान परीक्षा
GEOLOGIST EXAM-2018

GEO-PHYSICS
Paper – III

Time Allowed : Three Hours

Maximum Marks : 200

Question Paper Specific Instructions

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

*There are **TEN** questions divided under **TWO** sections.*

*Candidate has to attempt **SIX** questions in all.*

*Questions no. **1** and **6** are **compulsory**. Out of the remaining **EIGHT** questions, **FOUR** questions are to be attempted choosing **TWO** from each section.*

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

Attempts of questions shall be counted in sequential 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 Question-cum-Answer Booklet must be clearly struck off.

*Answers must be written in **ENGLISH** only.*

Neat sketches may 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.

Constants which may be needed :

Kepler's constant	=	$3{\cdot}986004418 \times 10^5$ km^3 s^{-2}
Mean radius of Earth	=	6378 km
Mass of electron (m_e)	=	$9{\cdot}11 \times 10^{-31}$ kg
Charge of electron (e)	=	$1{\cdot}602 \times 10^{-19}$ C
Planck's constant (h)	=	$6{\cdot}62 \times 10^{-34}$ J-sec
Boltzmann's constant (k)	=	$1{\cdot}38 \times 10^{-23}$ J/K

SECTION A

Q1. (a) Explain electromagnetic energy and its two units in which electromagnetic wavelength is measured. *5*

(b) (i) Describe three principal applications of the seismic method. *3*

(ii) What is a notch filter and what is its application ? *2*

(c) Explain passive and active remote sensing with suitable examples. *5*

(d) Calculate seismic data fold, if number of channels in a streamer is 120, shot and group interval is 25 m. *5*

(e) Describe reflectance, absorbance and transmittance with balance equation. *5*

(f) Describe satellite orbit and swath in detail. On which factors does orbit selection depend ? *5*

(g) What do you mean by deconvolution ? Find out the convolution of two signals given below : *5*

$x_1(n) = [0, 1, 2, 3]$

$x_2(n) = [-1, -1, 3, 4]$

(h) What is Radioactive series ? How many steps (α and β) emission take place from parent $^{92}_{238}U$ to stable daughter product $^{82}_{206}Pb$? *5*

Q2. (a) (i) What is the energy of a photon with a wavelength of 400 nm ? *5*

(ii) List out four weather satellites. *2*

(iii) Explain the Stefan-Boltzmann law of radiation. *3*

(b) (i) Describe ghost and peg-leg in seismic data with neat sketch diagram. *5*

(ii) Explain the principle of seismic reflection data acquisition in marine environment with neat sketch diagram. *5*

(c) (i) Discuss ocean basin, ocean ridge and ocean trench with suitable examples. *5*

(ii) What is radiometric age dating ? How can you calculate the absolute age of a rock ? *5*

Q3. (a) (i) Distinguish between satellite image and map. *5*

(ii) What are the percentages of incoming natural radiation reflected back, absorbed by the atmosphere, and absorbed by the Earth's surface ? *3*

(iii) Give the values of emissivity of polished metal surface, granite, basalt (rough) and water (pure). *2*

(b) (i) Describe the reflection coefficient. Explain the cases if reflection coefficient is zero, less than zero and one. *5*

(ii) List vibrator sources used in marine survey. *2*

(iii) Explain dynamic correction with appropriate equation. *3*

(c) (i) What is nuclear logging ? Name three nuclear logs. *5*

(ii) Draw gamma ray log curve for shale-sand-shale formation. *2*

(iii) In a rock formation, the geothermal gradient is 0·022°C/m and the mean annual surface temperature is 20°C. Find out the formation temperature at the formation depth 2440 m. *3*

Q4. (a) (i) Explain interaction mechanism of electromagnetic radiation. *6*

(ii) What are LiDAR and RADAR ? Which type of remote sensing is performed by LiDAR and RADAR ? *4*

(b) (i) Differentiate between CDP and CMP with neat sketch diagram. *5*

(ii) Discuss the common offset gather and the common receiver gather with neat sketch diagram. *5*

(c) (i) Explain how shale volume can be calculated from natural gamma ray log. *5*

(ii) Discuss principle of ringing which occurs in time domain when sharp boundaries are present in the frequency domain. *5*

Q5. (a) (i) Explain geostationary satellite orbits and the sun-synchronous satellite orbits and their applications in remote sensing. *7*

(ii) Which are the sensors used for land use and land cover studies ? *3*

(b) (i) Describe marine seismic data processing flow chart. *6*

(ii) Discuss applications of magnetic method. *4*

(c) (i) Explain induced magnetization and remanent magnetization with examples. *5*

(ii) Explain how and where Eötvös correction applies. *5*

SECTION B

Q6. (a) An X-ray beam of wavelength 0·71 Å is diffracted by a cubic KCl crystal of density $1{\cdot}99 \times 10^3$ kg m^{-3}. Calculate the interplanar spacing for (200) planes and the glancing angle for the second order reflection from these planes. The molecular weight of KCl is 74·6 amu and Avogadro's number is $6{\cdot}023 \times 10^{26}$ kg^{-1} $mole^{-1}$. *5*

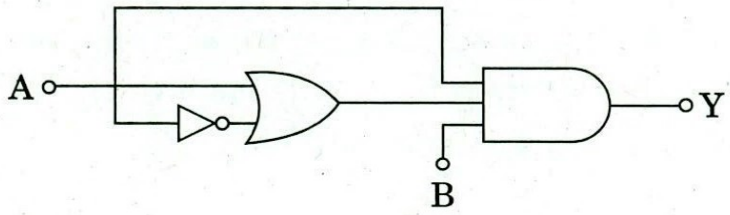
(b) Derive the conditions for light amplification using Einstein's coefficients. *5*

(c) Determine the transition temperature, and the critical field at 4·2 K for a given specimen of a superconductor if the critical fields are $1{\cdot}41 \times 10^5$ and $4{\cdot}205 \times 10^5$ Am^{-1} at 14·1 K and 12·9 K, respectively. *5*

(d) Calculate the ratio of the current for a forward bias of 0·6 V to the current for the same value of reverse bias applied to a Ge p-n diode at 27°C. *5*

(e) Discuss the working of a satellite communication system with block diagrams. *5*

(f) Obtain the Boolean expression for the output Y in the logic circuit shown in the figure. Simplify the expression and show that the circuit is equivalent to an AND gate with inputs A and B. *3+2*



(g) If the uncertainty in the position of a moving particle is equal to the wavelength associated with it, show that the uncertainty in its velocity is equal to $(\frac{1}{2\pi})$ times its velocity. *5*

(h) Explain the role of an earth station in satellite communication set-up. *5*

Q7. (a) (i) Differentiate between crystalline and amorphous solids. *3*

(ii) Distinguish between orthorhombic and triclinic crystal systems. *2*

(iii) Calculate the surface density of atoms in the (111) plane of a body-centered cubic structure. Assume that the lattice constant a = 5 Å. In addition, assume the atoms to be hard spheres, with the closest atoms touching each other. *5*

(b) Derive expressions for the voltage gain and the input resistance of an inverting amplifier using an Op-Amp. *10*

(c) Apply Heisenberg's uncertainty principle to explain the following :

(i) Non-existence of electrons within the nucleus.

(ii) Existence of finite zero-point energy. *5+5*

Q8. (a) What is the mode locking technique of generating short laser pulses ? Discuss its types with diagrams. *10*

(b) Compare the characteristics of CO_2 gas laser and Nd-YAG laser with energy level diagrams. *10*

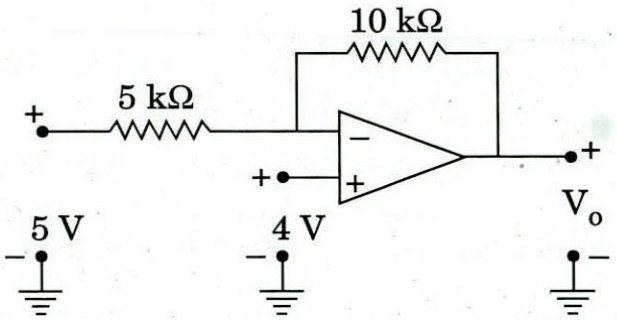
(c) (i) A material has energy levels separated by 1·95 eV. Calculate the temperature at which the population inversion of two levels will be one half. (Given $k = 1{\cdot}38 \times 10^{-23}$ J/K). *5*

(ii) A particle limited to z-axis has the wave function $\psi(z) = bz$ between $0 \leq z \leq 2$; the wave function $\psi(z) = 0$ elsewhere. Find the probability that the particle can be found between z = 0 and z = 0·5. Also find the expectation value <z> of the position of the particle. $2\frac{1}{2}+2\frac{1}{2}$

Q9. (a) Describe the changes that occur in electrical, magnetic and thermal properties of substances when they change from normal state to superconducting state. *10*

(b) (i) An FET amplifier in the common-source configuration uses a load resistance of 250 kΩ. The ac drain resistance of the device is 100 kΩ and the transconductance is 0·5 mA/V. What is the voltage gain of the amplifier ? *5*

(ii) Calculate the voltage V_0 in the circuit shown in the figure. *5*



(c) Discuss quantum mechanically, the problem of one-dimensional linear harmonic oscillator and obtain its eigenvalues. Also write the significance of zero-point energy. *8+2*

Q10. (a) (i) Discuss the longitudinal mode of resonators. *5*

(ii) If a radar of 1 MW peak power and antenna gain of 1000 irradiates a 1 m^2 target with a 10 μsec pulse at 1000 km range, what energy density arrives back at the radar and in how much elapsed time ? *4+1*

(b) (i) Distinguish between active and passive satellites. *5*

(ii) What do you understand by orbit, apogee and perigee of a satellite ? *5*

(c) (i) Explain the design and working principle of an optical fibre. *5*

(ii) A communication system uses 10 km of optical fibre having a loss of 2·3 dB/km. Calculate the out power at the receiving end if the power at input is 400 μW. *5*