

HYDROGEOLOGY**Time Allowed : Three Hours****Maximum Marks : 200****Question Paper Specific Instructions**

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

*There are **NINE** questions divided under **FIVE** sections.*

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

*The **ONLY** question in Section **A** is **compulsory**.*

*Out of the remaining **EIGHT** questions, the candidate has to attempt **FOUR**, choosing **ONE** from each of the other Sections **B**, **C**, **D** and **E**.*

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

Symbols, abbreviations and notations have their usual standard meanings.

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

Wherever required, graphs/tables are to be drawn on the Question-cum-Answer (QCA) Booklet itself.

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 (QCA) Booklet must be clearly struck off.

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

SECTION A
(Compulsory Section)

Q1. Write short notes on the following in not more than 5 sentences each :

5×8=40

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|-----|----------------------------|---|
| (a) | Perched Aquifer | 5 |
| (b) | Hydrograph and its Uses | 5 |
| (c) | Dispersion Coefficient | 5 |
| (d) | Slug Tests and their Types | 5 |
| (e) | Gaining and Losing Streams | 5 |
| (f) | Photolinear Features | 5 |
| (g) | Gravimeter and its Types | 5 |
| (h) | Darcy | 5 |

SECTION B

Attempt any **one** question.

- Q2.** (a) What are aquifers, aquitards and aquicludes ? Explain the types of aquifers with suitable illustrations. Point out the differences of hydraulic conductivities of various zones (layers) in those types. 15
- (b) The water table was at an elevation of 82.00 m above mean sea level, at a certain point in an unconfined aquifer of 4 km² area. Due to natural recharge in a rainy period, its level became 83.60 m above mean sea level. A volume of 3.0 billion litres of water was pumped out of the aquifer reducing the water level to the elevation of 81.10 m above mean sea level. Assuming that the water table in the entire aquifer will respond in a similar way, estimate the following :
- (i) The specific yield of the aquifer.
- (ii) The volume of recharge during rainy period. 15
- (c) What is meant by Water Table ? What are the uses of water level measurements ? Explain the causes of Water Table fluctuations in aquifers. 10
- Q3.** (a) What are equipotential lines ? How do they help in drawing flow nets ? Give the significant uses of flownet analysis in groundwater studies. 15
- (b) What is the main difference between Regular springs and Artesian springs ? Explain the basic hydrogeological settings that are necessary to have artesian wells, with a suitable diagram. 10
- (c) What are the major components of a Water Balance Equation ? How do they help in evaluating the changes of groundwater storage, by using specific components of input-output ? 15

SECTION C

Attempt any **one** question.

- Q4.** (a) Derive expressions for equivalent hydraulic conductivity of a stratified aquifer, consisting of several homogeneous and isotropic horizontal layers, for horizontal and vertical flow. 15
- (b) Derive expressions for unsteady flow in a confined aquifer for Cooper-Jacob method. What are the assumptions related to it ? Explain steps involved to estimate the storage coefficient and transmissivity of the aquifer. 10
- (c) A sample of length 40 cm and a diameter 6 cm of a medium-grain sandy formation having median grain size of 0.80 mm is tested using constant head permeameter. Assuming that the hydraulic conductivity of the sample is 12 m/day, estimate the maximum value of piezometric head difference to be used in the test. (Given : $\mu = 1.0 \times 10^{-3} \text{ N.s/m}^2$) 15
- Q5.** (a) Derive the general equation for unsteady flow condition. Show that for homogeneous and isotropic aquifers, steady state flow follows the Laplace equation. 15
- (b) Derive expressions for steady radial flow to a fully penetrating well in an unconfined aquifer being pumped at a constant rate. What will be the expression for radius of influence in this case ? Use suitable sketches. 10
- (c) In a recovery test of a discharge well in a confined aquifer, after 90 minutes of stopping the pumping, residual drawdown was observed as 25 cm in an observational well located at 20 m from the discharge well. Assuming that the discharge well was pumped for a period of 12 hours at a constant rate of 1.5 million litres/day, estimate the transmissivity of the aquifer. (Given : $\log_{10}(2) = 0.30103$; $\log_{10}(3) = 0.477121$) 15

SECTION D

Attempt any **one** question.

- Q6.** (a) Give an account on the applications of remote sensing techniques in identifying groundwater promising zones. 10
- (b) Explain the basic principles of Electrical Resistivity Method for groundwater exploration. Describe the field procedures and data interpretation techniques of electrical profiling and sounding, with their uses. 15
- (c) Explain the basic principles of Seismic methods of prospecting. Describe the instrumentation, field measurements and applications of the two prevailing seismic methods. 15
- Q7.** (a) What is a Test Drilling ? What kinds of measurements are made during the drilling process ? How do they help in understanding the subsurface hydrogeological studies ? 10
- (b) What is meant by Geophysical Well-logging ? Describe the types of well-logging methods employed in groundwater exploration, with their applications. 15
- (c) What is Recovery Test ? What is Residual Drawdown ? Derive expressions to estimate the transmissivity of the formation. Use suitable sketch. 15

SECTION E

Attempt any **one** question.

- Q8.** (a) What are the factors that cause salinisation of groundwater ? Discuss the salinity of groundwater in semi-arid regions of India. 15
- (b) Describe the various methods of determining the age of groundwater. 15
- (c) What are hydrochemical facies of groundwater ? Discuss the sequence of hydrochemical evolution of groundwater. 10
- Q9.** (a) Discuss the concept of artificial aquifer creation and recharge by injection method. 15
- (b) How is the chemical data of groundwater represented graphically ? Add a note on Piper's Trilinear diagram and its applications. 10
- (c) Discuss the causes of groundwater pollution due to solid and liquid waste disposal in urban areas and its remediation techniques. 15