Roll No												

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

TEST 1

Winter Semester: 2021 - 22

Course Code: PET 2002

Course Name: Fundamentals of Geophysical Logging Techniques

Program & Sem: B.Tech. & IV

Date: 25-04-2022, Monday

Time: 03:00 PM to 04:00 PM

Max Marks: 30

Weightage: 15%

Instructions:

(i) Read the all questions carefully and answer accordingly.
(ii) Question paper consists of 3 parts.
(iii) All the questions are compulsory.

Part A [Memory Recall Questions]

Answer all the questions. Each question carries FIVE marks. (2Qx5M = 10M)

Q.NO. 1: (a) List the objectives of studying petrophysics.
(b) Discuss the difference between 'Wireline Logging' and 'Logging While Drilling'.
[2M + 3M] (C.O.No. 1) [Knowledge]

Q.NO. 2: (a) Bullet-point the services covered during Cased Hole Logging.
(b) Each geoscience and engineering division derives information from petrophysics and some of them are listed below. Select four pieces of information from the list that a Production Engineer derives from petrophysics and write the same exactly in the answer script.

(i) Pressure testing from wireline formation testing tools
(ii) Cement evaluation for cased hole logging
(iii) Rock compaction studies
(iv) Monitoring well performance from production logging
(v) Pore pressure prediction from mud logging
(vi) Relative permeability and capillary curves from special core analysis
(vii) Sand failure prediction (sanding) from rock strength analysis
(viii) Identify bedding planes, fractures, and sub-seismic faults from imaging logs
(ix) Where and how many wells to place in the reservoir from reservoir monitoring
(x) Casing inspection for corrosion monitoring

[3M + 2M] (C.O.No. 1) [Knowledge]

Part B [Thought Provoking Questions]

Answer all the questions. Each question carries FIVE marks. (2Qx5M = 10M)

Q.NO. 3: The petrophysicist has to measure the down-hole rock and fluid properties. Since the rock and fluid are all down-hole, the only type of measurements that can be made is indirect. Almost the complete range of physics (Resistivity, Nuclear, Acoustic, Magnetic Resonance, etc.) is used in trying to achieve the goal of quantifying rock and fluid properties down-hole. The petrophysicist uses not

only data covering the complete range of physics, but also uses a wide range of scales of resolution, from microscopic analysis on cores to the hundred meter-plus resolution of wellbore seismic. Summarize the methods sequentially from hundred meter-plus resolution to the microscopic analysis used for studying rock and fluid properties.

(C.O.No. 1) [Comprehension]

Q.NO. 4: The data acquired from Open Hole Logging, either via wireline or logging while drilling is then interpreted to reveal the rock and fluid properties. Its complexity can vary depending on the formation. The Open Hole data is recorded using a variety of principles and has to be interpreted to obtain the rock and fluid properties. Gather the information expected to attain from Open Hole Log data and also cite examples of at least two Open Hole Logs.

(C.O.No. 1) [Comprehension]

Part C [Problem Solving Questions]

Answer all the questions. Each question carries FIVE marks. (2Qx5M = 10M)

Q.NO. 5: (a) If the Bottom Hole Temperature (BHT) at 11000 ft is 200°F (Point A) in shared Chart 1, then list down the information that can be extracted from Point X marked in the same Chart. Submit Chart 1 for evaluation.

(b) If the Resistivity of a water sample is 0.4 ohm-m at 25°C, then find NaCl concentration at 25°C. Suppose the NaCl concentration is kept constant at 50°C, then discuss the information that can be extracted additionally from the same Chart. Submit Chart 2 for evaluation.

[2.5M + 2.5M] (C.O.No. 2) [Application]

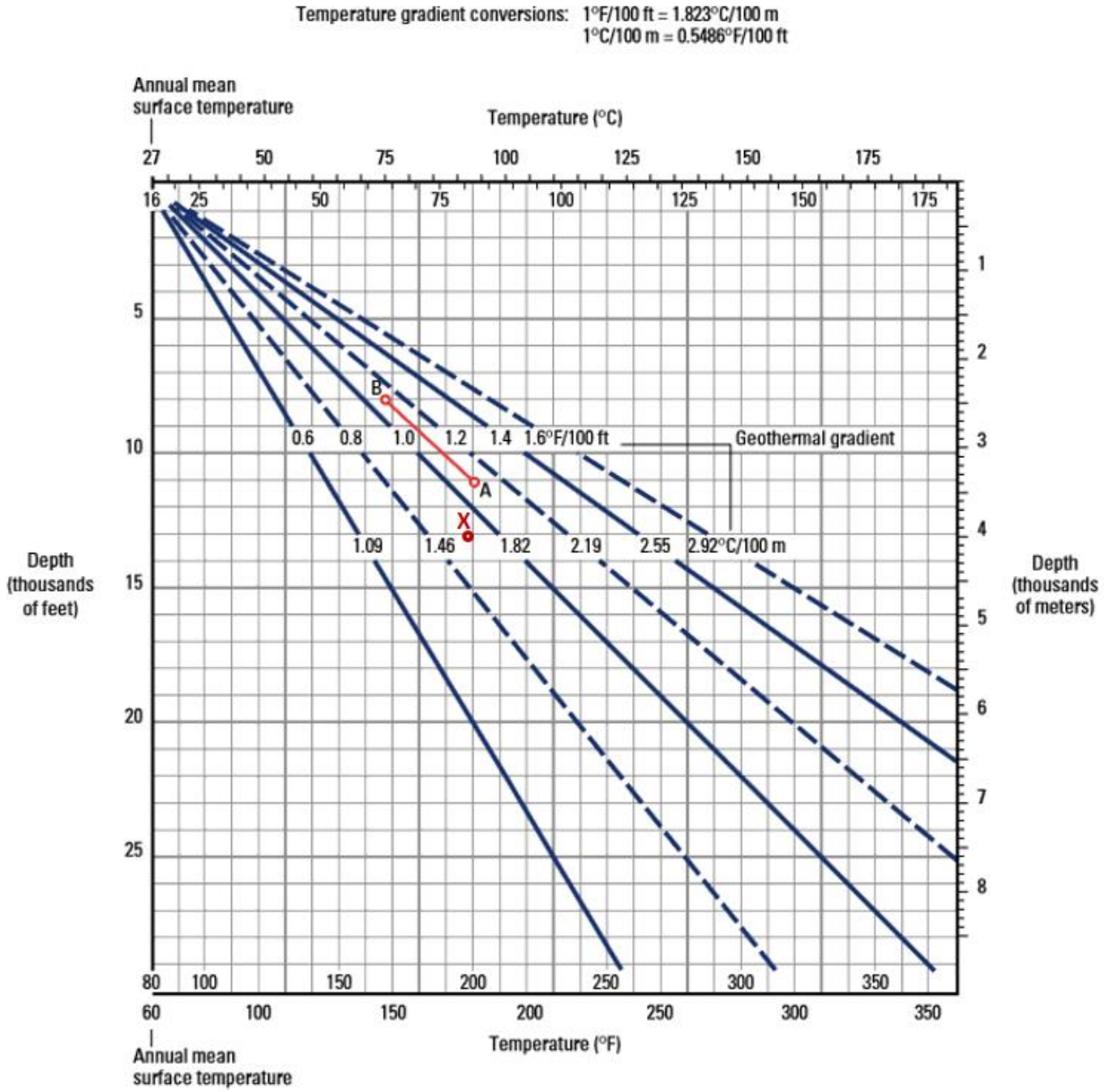
Q.NO. 6: Calculate Formation Resistivity Factor (F_R) using the established formula and also find the same with the help of the “Formation Resistivity versus Porosity” Chart (Chart 3), when Ø = 6%, m = 2, and a = 0.81. Submit Chart 3 for evaluation.

[2.5M + 2.5M] (C.O.No. 2) [Application]

STUDENT NAME:

ID NO.:

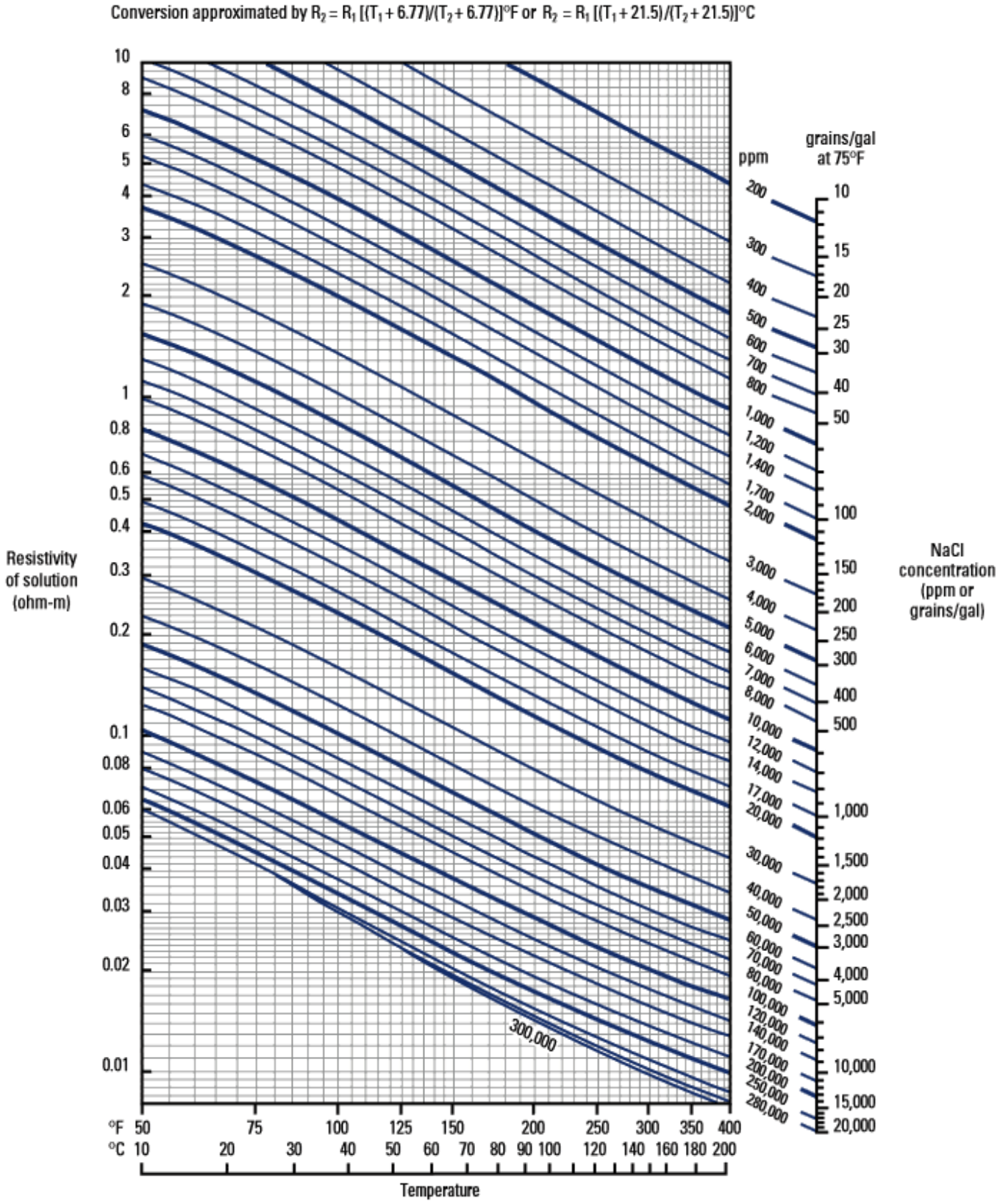
CHART 1:



STUDENT NAME:

ID NO.:

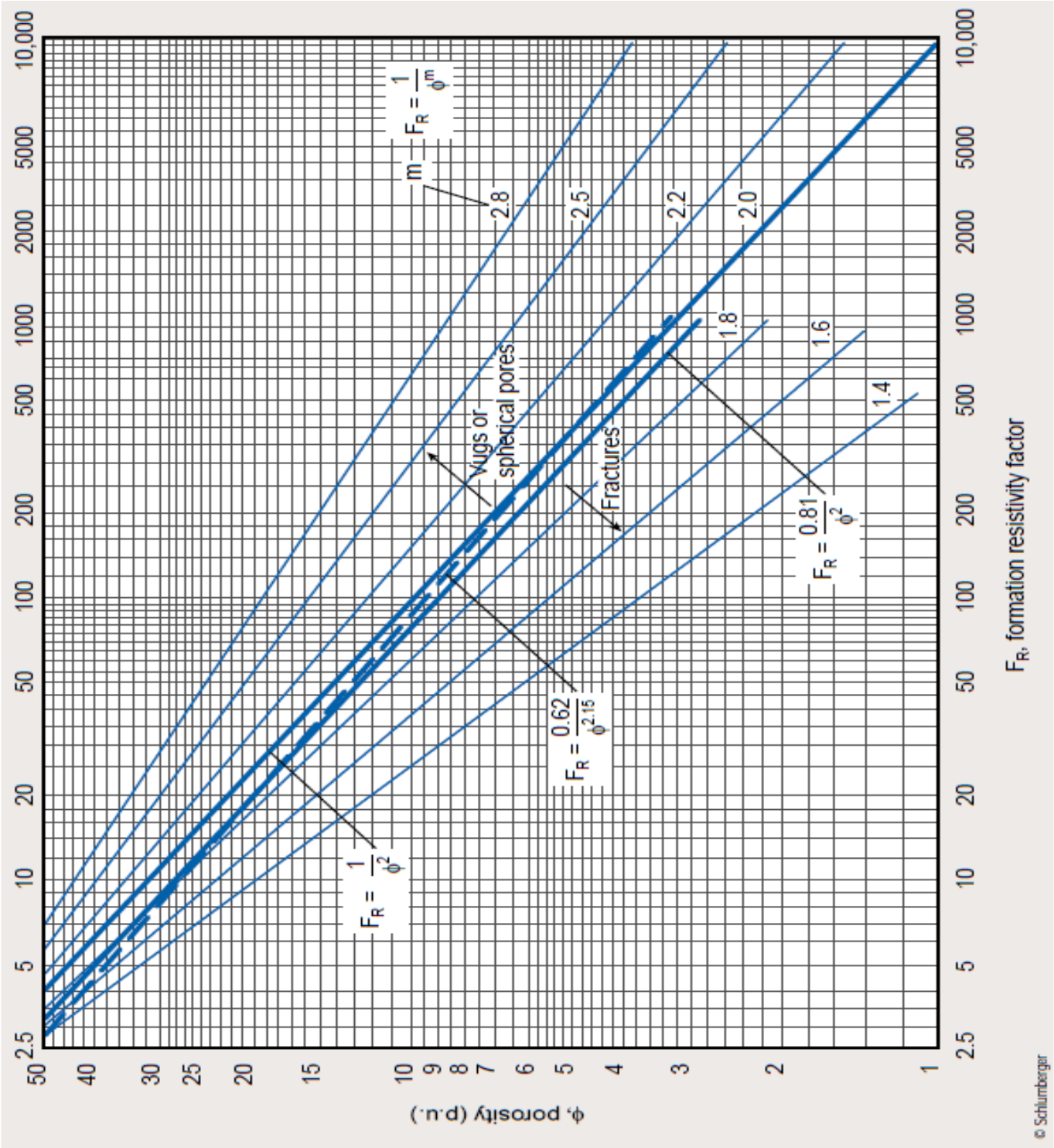
CHART 2:



STUDENT NAME:

ID NO.:

CHART 3:



Roll No												

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

TEST 2

Winter Semester: 2021 - 22
Course Code: PET 2002
Course Name: Fundamentals of Geophysical Logging Techniques
Program & Sem: B.Tech. & IV

Date: 31st May 2022
Time: 03:00 PM to 04:00 PM
Max Marks: 30
Weightage: 15%

Instructions:

(i) Read the all questions carefully and answer accordingly.
(ii) Question paper consists of 3 parts.
(iii) All the questions are compulsory.
(iv) ***Submit all the charts along with the answer-script.***

Part A [Memory Recall Questions]

Answer both the questions. Each question carries FIVE marks. (2Qx5M = 10M)

1: Draw the borehole environment that explains the distribution of fluids and resistivities near the well-bore and write the equation used to determine the Producible Oil Index (POI). [4M + 1M] (C.O.No. 2) [Knowledge]

2: List down any five basic well logging petrophysical measurements used in oil and gas industry. (C.O.No. 3) [Knowledge]

Part B [Thought Provoking Questions]

Answer both the questions. Each question carries FIVE marks. (2Qx5M = 10M)

3: The most common method of determining formation porosity is with geophysical logs or well logs. Geophysical logs are recorded by sending logging tools down the wellbore after completion or during the drilling process which measures different reservoir properties of interest to geologists and engineers. Due to the expense of obtaining core samples, typically only a few wells are cored. There are three types of logging tools that are used to estimate the amount of pore space (porosity) in rock: the neutron, acoustic velocity (or sonic), and density tool. The neutron tool operates by bombarding the formation with high-energy neutrons and is sensitive mainly to the number of hydrogen atoms in a formation. The sonic or acoustic log measures the travel time of an elastic wave through the formation which derives the velocity of elastic waves through the formation. The density log measures electron density and transforms it into bulk density, porosity is calculated by assuming the matrix density and fluid density. (a) Express the equation used to determine the formation's porosity from the density log. (b) Estimate the formation's porosity when

bulk density, matrix density, and fluid density are recorded as 2.6 g/cc, 2.71 g/cc, and 1.2 g/cc respectively. (c) Identify the appropriate chart from the list of charts (Charts 1 through

3) shared at the end and predict porosity using the same recorded values of bulk density, matrix (calcite) density, and fluid density. [1M + 2M + 2M] (C.O.No. 3) [Comprehension]

4: Under some circumstances, the FDC (Compensated Formation Density) log and Litho-Density log must be corrected for borehole size, and the SNP (Sidewall Neutron Porosity) log must be corrected for mudcake thickness. The borehole diameter (d_h), formation density (ρ_b), mud density (ρ_m), SNP apparent porosity (ϕ_{SNP}), caliper log reading in the mudcake, and bit size are recorded as 13 in, 2.20 g/cc 1.50 g/cc, 14 p.u., 75/8 in, and 77/8 respectively for a mud-filled borehole. (a) Find the appropriate chart that is used for determining corrected litho-density from the list of charts (Charts 1 through 3) shared at the end. (b) Identify the appropriate chart(s) from the list of charts (Charts 1 through 3) shared at the end and determine corrected formation density, mudcake thickness, and corrected sidewall neutron porosity using the available data shared above. [1M + (2M + 1M + 1M)] (C.O.No. 3) [Comprehension]

Part C [Problem Solving Questions]

Answer the question. The question carries TEN marks. (1Qx10M = 10M)

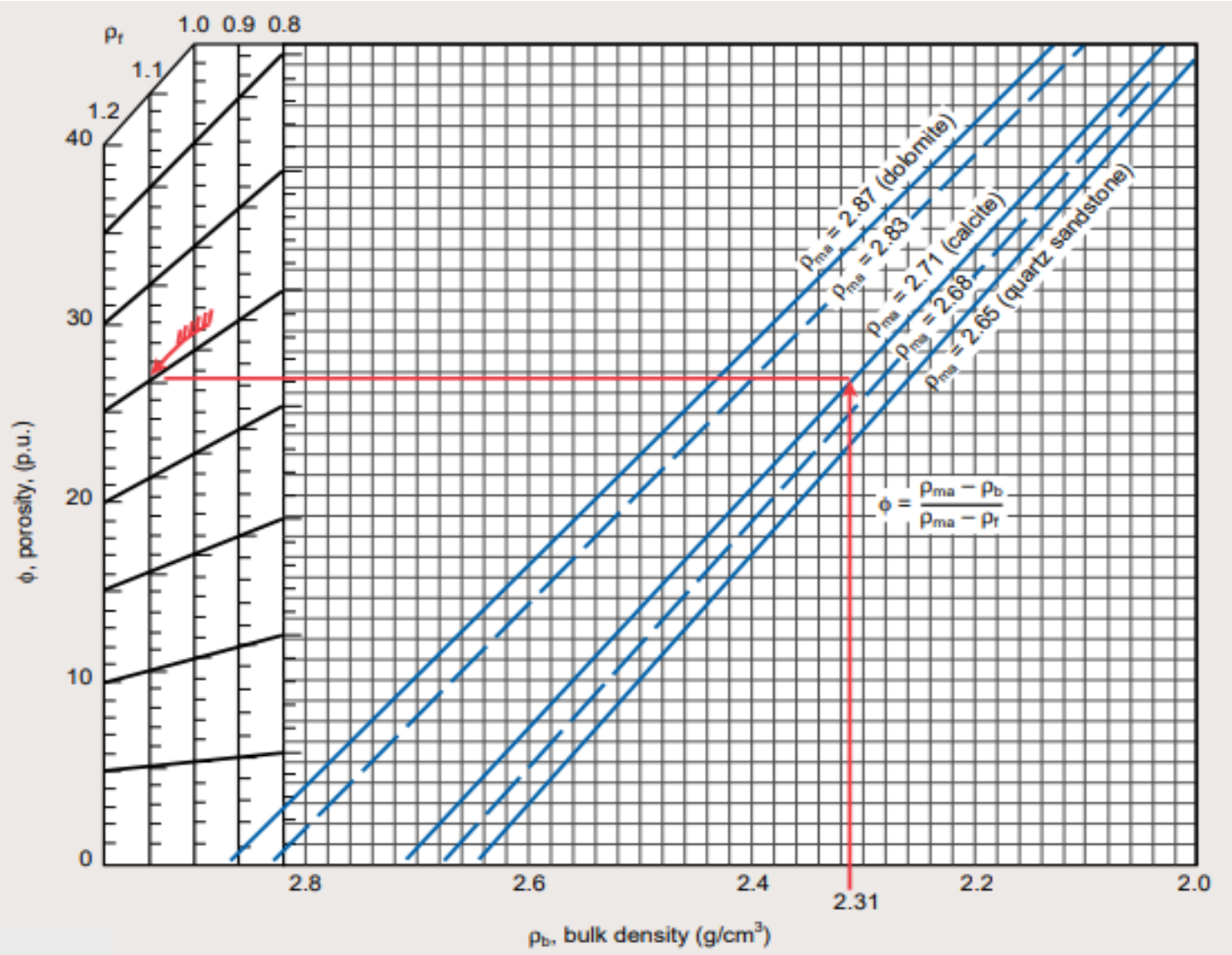
5: Epithermal neutron detection with borehole-shielded detectors considerably reduces the environmental effects on the APS (Accelerator Porosity Sonde) response and simplifies their correction. The near-to-array porosity measurement (APLU in apparent limestone porosity units) and the near-to-far porosity measurement (FPLU in apparent limestone porosity units) require different mud weight and borehole size corrections, so there are individual sets of correction nomographs for each measurement. Formation temperature, pressure, and salinity effects are, however, the same on each measurement, so there is only one set of nomographs for these corrections. Chart No. 3-A and Chart No.3-B include corrections for mud weight and borehole size for near-to-array and near-to-far porosity measurements in both English and metric units respectively. The borehole size correction is slightly mudweight dependent, even with natural muds, so there are two sets of splines—solid lines for light muds (8.345 lbm/gal) and dashed lines for heavy muds (16 lbm/gal). Intermediate mud weights can be interpolated. The nomograph for formation temperature, pressure, and formation salinity correction of both APLU and FPLU curves appears in Chart No. 3-C. The formation salinity correction is dependent on the amount of salt (NaCl) in the formation. This is a function of both the salinity of fluid in the formation and its volume. The last part of the nomograph, therefore, applies to the correction of a multiplier proportional to the true porosity of the formation. For an openhole well, uncorrected limestone porosity, mud weight, borehole size, borehole temperature, pressure, and formation salinity are recorded as 30 p.u., 14 lbm/gal, 13 inch, 100°F, 2.5 kpsi, and 200 kppm respectively. (a) List down the corrections that can be determined from the data shared and the Chart No. 3. (b) Determine corrected values for all the components listed above. [1M + 9M]

(C.O.No. 3) [Application]

STUDENT NAME:

ID NO.:

CHART 1:

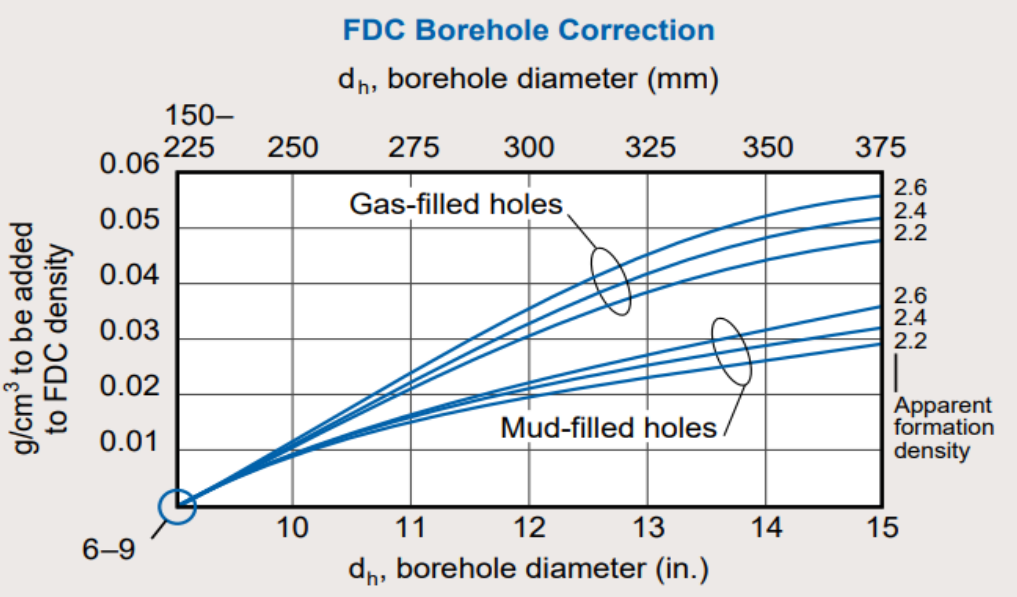


STUDENT NAME:

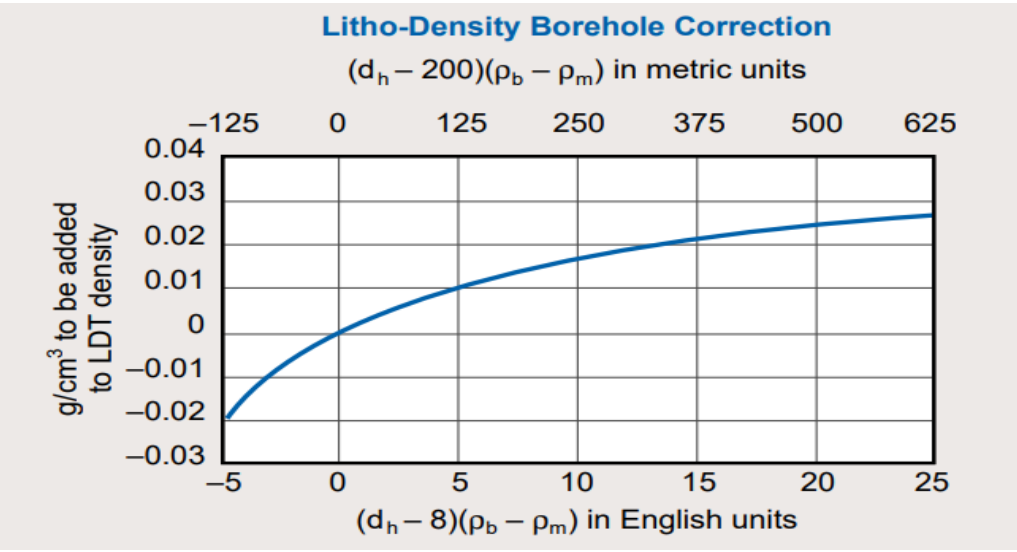
ID NO.:

CHART 2:

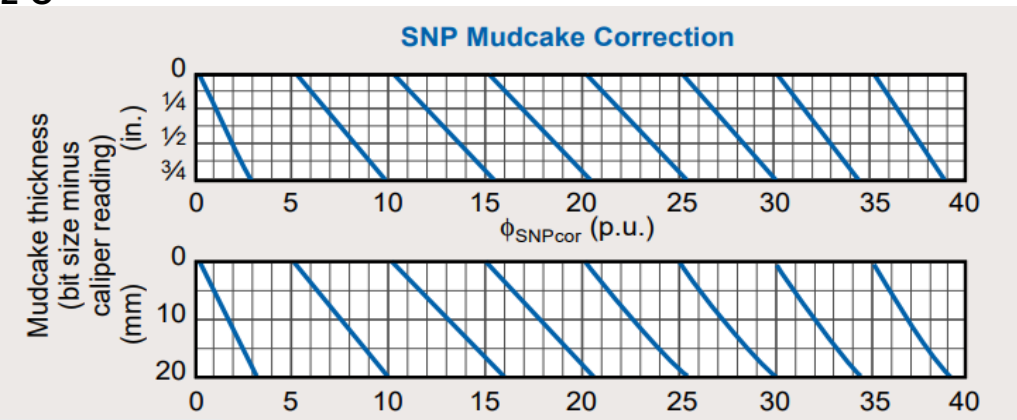
2-A



2-B



2-C

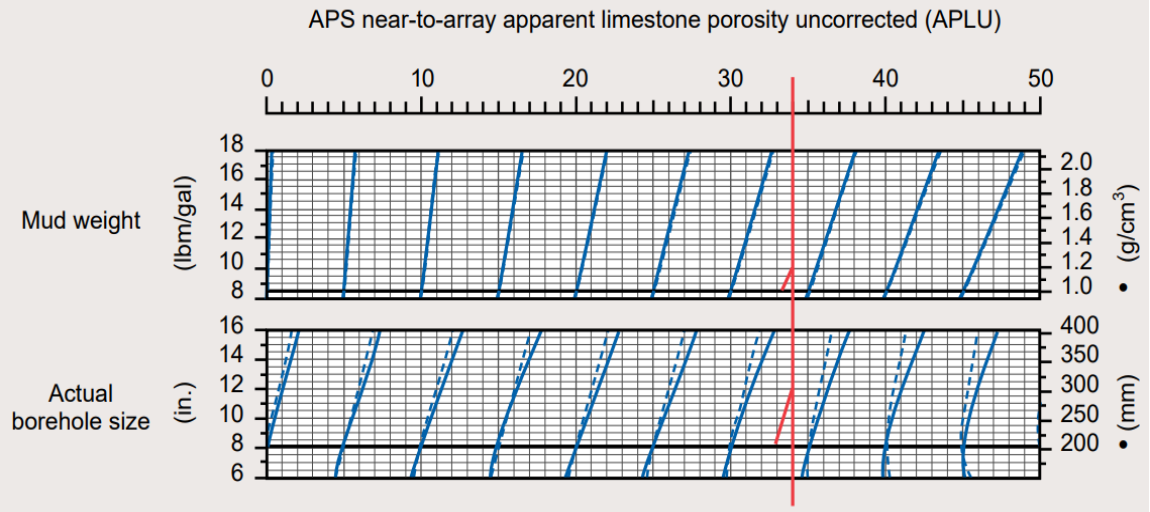


STUDENT NAME:

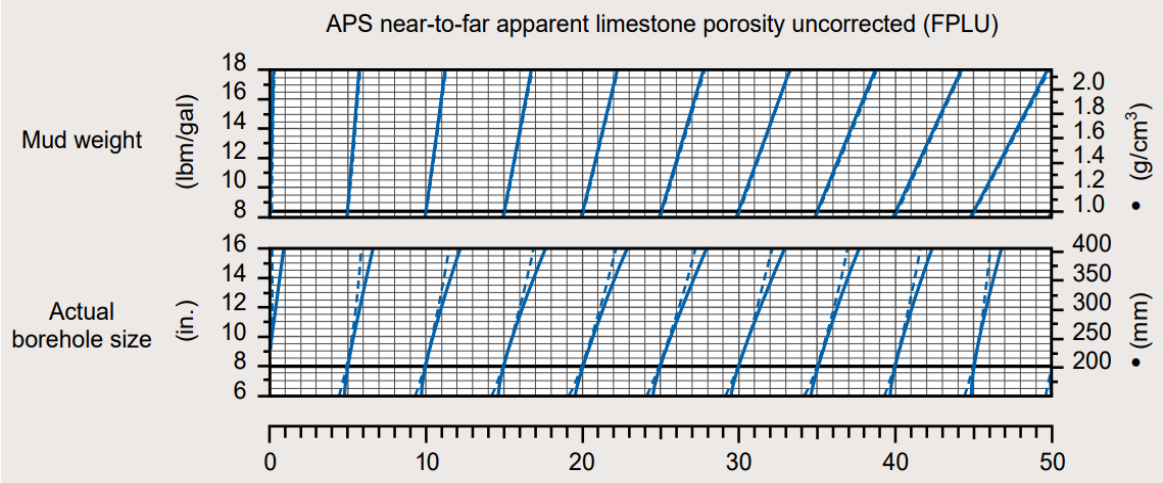
ID NO.:

CHART 3:

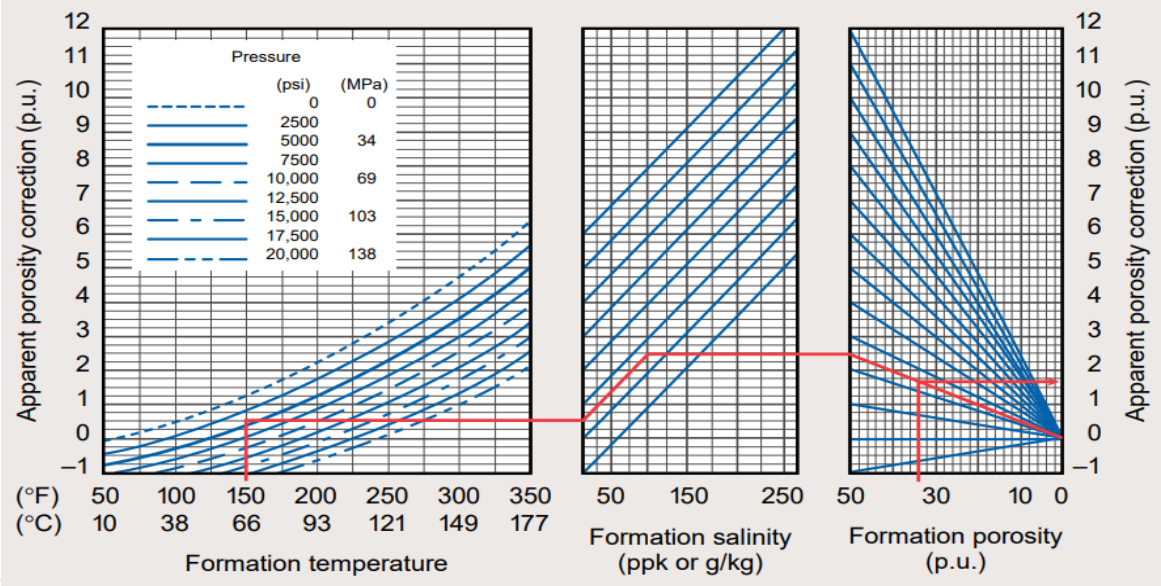
3-A



3-B



3-C



Roll No												

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

END TERM EXAMINATION

Winter Semester: 2021 - 22
Course Code: PET2002
Course Name: Fundamentals of Geophysical Logging Techniques
Program & Sem: B.Tech. & IV Sem

Date: 28th June 2022
Time: 09:30 AM to 12:30 PM
Max Marks: 100
Weightage: 50%

Instructions:

(iv) Read the all questions carefully and answer accordingly.
(v) Question paper consists of 3 parts.
(vi) All the questions are compulsory.
(vii) ***Submit all the charts along with the answer-script for evaluation.***

Part A [Memory Recall Questions]

Answer all the questions. Each question carries EIGHT marks. (4Qx8M = 32M)

1: Choose the correct answer.

(a) Logging devices are categorized according to their depth of _____.

(i) formation
(ii) uninvaded zones
(iii) invaded zones
(iv) investigation

(b) The bed resolution on a long run across a sedimentary series doesn't depends on _____.

(i) thickness of the bed
(ii) mud property
(iii) the contrast between readings in the bed in question and its immediate neighbor
(iv) tool geometry and type of measurements being made

(c) Logging speed is _____ for all types of log.

(i) same
(ii) high
(iii) not same
(iv) low

(d) The factors which limit logging speed are _____.

(i) galvanometer inertia
(ii) cable tension
(iii) None of (i) and (ii)
(iv) Both (i) and (ii)

(e) Mud salinity affects _____.

(i) conductivity
(ii) resistivity
(iii) Both (i) and (ii)
(iv) None of (i) and (ii)

(f) Well Logging companies always specify _____ hole-size for safe passage of the tool.

(i) maximum
(ii) minimum
(iii) Both (i) and (ii)
(iv) average

(g) If only water exists in the formation with ϕ = 30%, then S_w is _____.

(i) 0% (ii) 30%

(iii)70% (iv) 100%

(h) Lithology can be identified using _____.

(i) Gamma Ray Log (ii) Spontaneous Potential Log

(iii) Density Log (iv) All of the above

(C.O.No. 1) [Knowledge]

2: Match the information in Column A and Column B.

Column A	Column B
(a) Formation Factor (F) is expressed as _____.	(i) Archie's Equation
(b) Logging cable fulfills three functions; (a) running-in and pulling out the tool, (b) depth measurement, and (c) _____.	(ii) R_0/R_w
(c) Relation between Porosity and Water Saturation for the Invaded Zone can be expressed as _____.	(iii) conductivity of current through drilling mud
(d) The volume close to the borehole wall in which some or all of the moveable fluids have been displaced by mud filtrate is known as _____ Zone.	(iv) electrical interface between the downhole logging tool and the surface processing and recording unit
(e) The relation of fluid saturation in the uninvaded zone to that in the near borehole invaded zone gives us the measure of _____.	(v) $\emptyset = ((a/S^{wn})*(R_{xo}/R_f))^{1/m}$
(f) First ever log was recorded by the company called _____.	(vi) $\emptyset = ((a/S_i^n)*(R_{mf}/R_i))^{1/m}$
(g) Shales have _____ gamma ray values.	(vii) Mud Displacement
(h) A salt-saturated mud, because of its high conductivity, will contribute a _____ borehole signal to the induction log.	(viii) Invaded
	(ix) movable hydrocarbon index
	(x) Schlumberger
	(xi) Halliburton
	(xii) high

(C.O.No. 2) [Knowledge]

3: Fill in the blank with appropriate single word.

(a) Neutron porosity increases with the increase in shaliness of _____ bearing sandstone.

(b) Borehole enlargement is most commonly observed in _____ and shaly formations.

(c) The common value of matrix density of sand or sandstone is _____ g/cc.

(d) True resistivity of the formation is the resistivity of _____ zone.

(e) The most abundant source of natural radioactivity is the radioactivity isotope of _____.

(f) _____ formation in the borehole decreases the borehole diameter.

(g) The _____ bearing zones in the formation can be identified with the help of higher value with peak in the resistivity log.

(h) R_{xo} value of the formation is the resistivity of the _____ zone.

(C.O.No. 3) [Knowledge]

4: (a) Discuss the purpose of NMR Logging. [4 Marks]

(b) List down the applications of FMS Logging. [4 Marks]

Part B [Thought Provoking Questions]

Answer all the questions. Each question carries TEN marks. (4Qx10M = 40M)

5: Due to the expense of obtaining core samples, typically only a few wells are cored. There are three types of logging tools that are used to estimate the amount of porosity in rock: the neutron, acoustic velocity (or sonic), and density tool. The neutron tool operates by bombarding the formation with high-energy neutrons and is sensitive mainly to the number of hydrogen atoms in a formation. The sonic or acoustic log measures the travel time of an elastic wave through the formation which derives the velocity of elastic waves through the formation. The density log measures electron density and transforms it into bulk density, porosity is calculated by assuming the matrix density and fluid density.

(a) Suppose the data for Density, Gamma Ray, and Resistivity logs are available. Will it be possible to determine porosity in absence of Neutron Porosity log from available log data? If yes, then write down the equation to be used for determining the porosity of the formation.

(b) Bulk density, matrix density, and fluid density are given as 2.40 g/cc, 2.83 g/cc, and 1.20 g/cc respectively for a formation. Is there any possibility to extract additional information about the same formation? If yes, then determine the additional information.

(c) Identify the appropriate chart from the list of charts (Charts 1 through 10) shared at the end and predict at least one additional information using the same chart and recorded values of bulk density, matrix density, and fluid density. [2M + 4M + 4M]

(C.O.No. 3) [Comprehension]

6: Under some circumstances, the FDC (Compensated Formation Density) log and Litho-Density log must be corrected for borehole size, and the SNP (Sidewall Neutron Porosity) log must be corrected for mudcake thickness. The borehole diameter (d_h), formation density (ρ_b), mud density (ρ_m), SNP apparent porosity (ϕ_{SNP}), caliper log reading in the mudcake, and bit size are recorded as 13 in, 2.20 g/cc 1.50 g/cc, 14 p.u., 7⅝ inch, and 7⅞ inch respectively for a mud-filled borehole.

(a) List down the additional information that can be find out with the help of available data and the Chart No. 5 shared below.

(b) Determine the additional information that can be find out with the help of available data and the Chart No. 5-A and 5-C. [2M + 8M]

(C.O.No. 3) [Comprehension]

7: (a) In log interpretation, the Bottom Hole Temperature (BHT) is taken as the maximum recorded temperature during a logging run or preferably the last of series of runs during the same operation. BHT is the temperature used for the interpretation of logs at total depth. If the BHT at 11000 ft is 200°F (Point A) in shared Chart 1, then list down the information that can be recorded from Point X marked in the same Chart. Submit Chart 1 for evaluation.

(b) The more you increase your concentration, the higher the amount of species that can contribute to conduction. Hence, resistance decreases with increasing concentration. If the resistivity of a water sample is 0.42 ohm-m at 40°C, then find NaCl concentration at 40°C from Chart 2. Suppose the NaCl concentration is kept constant at 67°C, then discuss the information that can be extracted additionally from the same Chart. Submit Chart 2 for evaluation. [4M + 6M]

(C.O.No. 2) [Comprehension]

8: The Formation Resistivity Factor (F_R) is defined as the ratio of the resistivity of the rock saturated with brine (R_o) to the resistivity of the brine (R_w).

(a) Will it be possible to determine F_R for available porosity, cementation factor, and lithology coefficient as 7.5%, 1.8, and 0.95 respectively? If yes, then write down the formula and calculate F_R using the same formula. If no, then write down the process for determining F_R.

(b) Is it possible to determine F_R from any of the available charts (1 through 10)? If yes, then choose the correct chart and determine F_R by plotting the available data. If no, then explain any other method used to determine F_R. [5M + 5M]

(C.O.No. 2) [Comprehension]

Part C [Problem Solving Questions]

Answer both the question. Each question carries FOURTEEN marks. (2Qx14M = 28M)

9: Epithermal neutron detection with borehole-shielded detectors considerably reduces the environmental effects on the APS (Accelerator Porosity Sonde) response and simplifies their correction. The near-to-array porosity measurement (APLU in apparent limestone porosity units) and the near-to-far porosity measurement (FPLU in apparent limestone porosity units) require different mud weight and borehole size corrections, so there are individual sets of correction nomographs for each measurement. Formation temperature, pressure, and salinity effects are, however, the same on each measurement, so there is only one set of nomographs for these corrections. The formation salinity correction is dependent on the amount of salt (NaCl) in the formation. This is a function of both the salinity of fluid in the formation and its volume. The last part of the nomograph, therefore, applies to the correction of a multiplier proportional to the true porosity of the formation. For an openhole well, uncorrected limestone porosity, mud weight, borehole size, borehole temperature, pressure, and formation salinity are recorded as 30 p.u., 14 lbm/gal, 10 inch, 125°F, 5000 psi, and 175 kppm respectively.

(a) List down the corrections that can be determined from the data shared and the Chart No. 6.

(b) Determine corrected values for all the components listed above. [4M + 10M]

(C.O.No. 3) [Application]

10: Cross plots are visual representations of the relationship between two or more variables, and they are used to visually identify or detect anomalies that could be interpreted as the presence of hydrocarbon or other fluids and lithologies.

(a) One of the earliest cross plots is the neutron porosity and bulk density cross plot. This cross plot is used in log analysis for the determination of porosity and lithology from neutron porosity and bulk density. Choose the correct chart from Charts 1 through 10 and identify the lithology based on the given well log data.

Sl. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Neutron Porosity (p.u.)	17	18	18	18	19	19	19	Q9	20	20	20	21	21	21	21
Bulk Density (g/cm^3)	2.64	2.62	2.64	2.66	2.62	2.64	2.70	2.72	2.68	2.70	2.72	2.70	2.72	2.66	2.68

(b) A cross-plot of neutron porosity and sonic transit time can be used to identify lithology. Choose the correct chart from Charts 1 through 10 and identify the lithology based on the given well log data.

Sl. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Neutron Porosity (p.u.)	27	27	28	28	28	29	31	31	32	32	32	32	33	33	33
Sonic Transit Time (µsec/ft))	80	82	81	82	83	84	78	79	80	79	78	77	79	78	80

[7M + 7M]

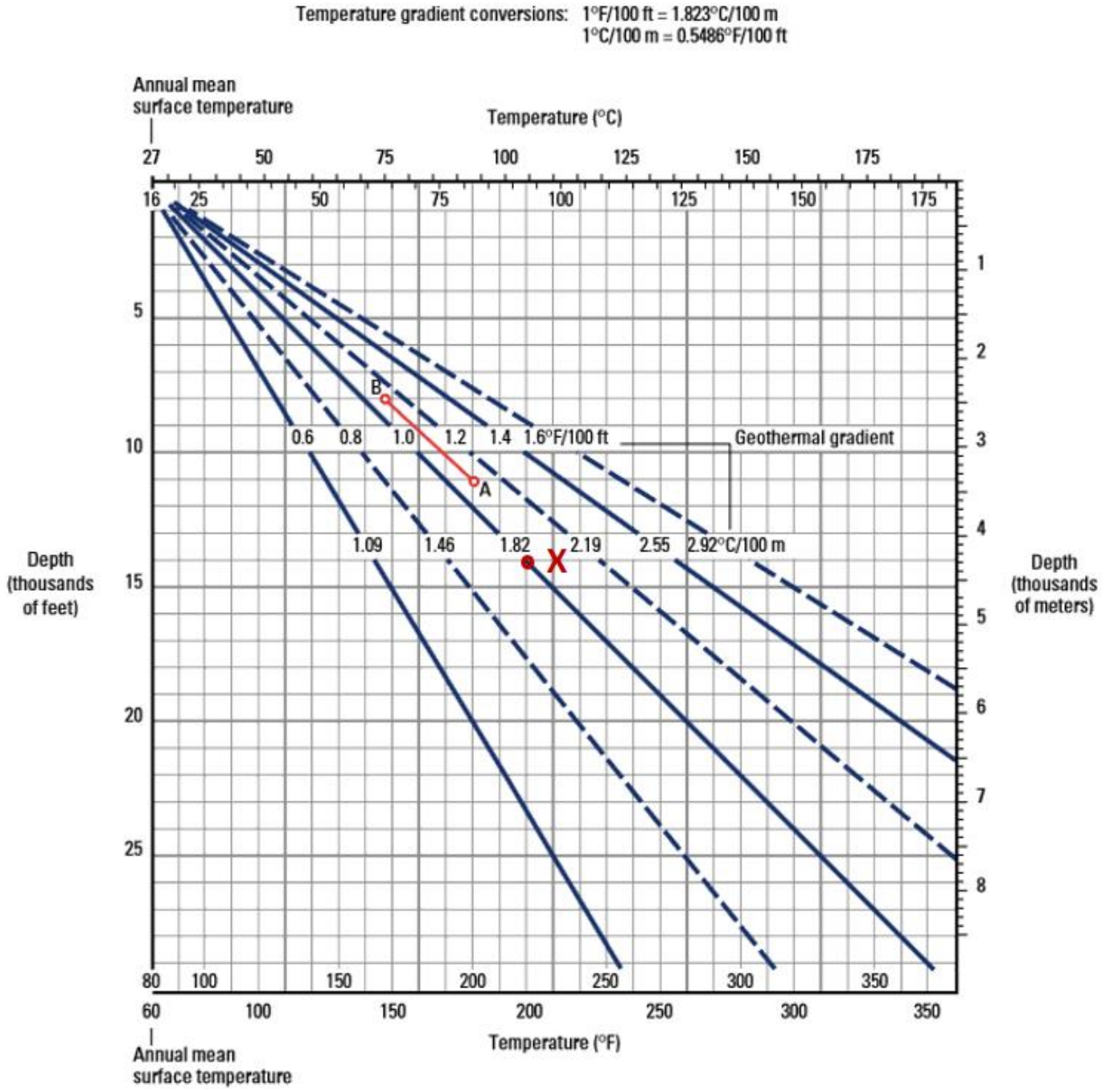
(C.O.No. 5) [Application]

STUDENT NAME: _____

ROLL NO.: _____

Answer To
Q _____

CHART 1: **Related ANSWER should be written in the ANSWER-SCRIPT as well, otherwise the answer will not be evaluated.**



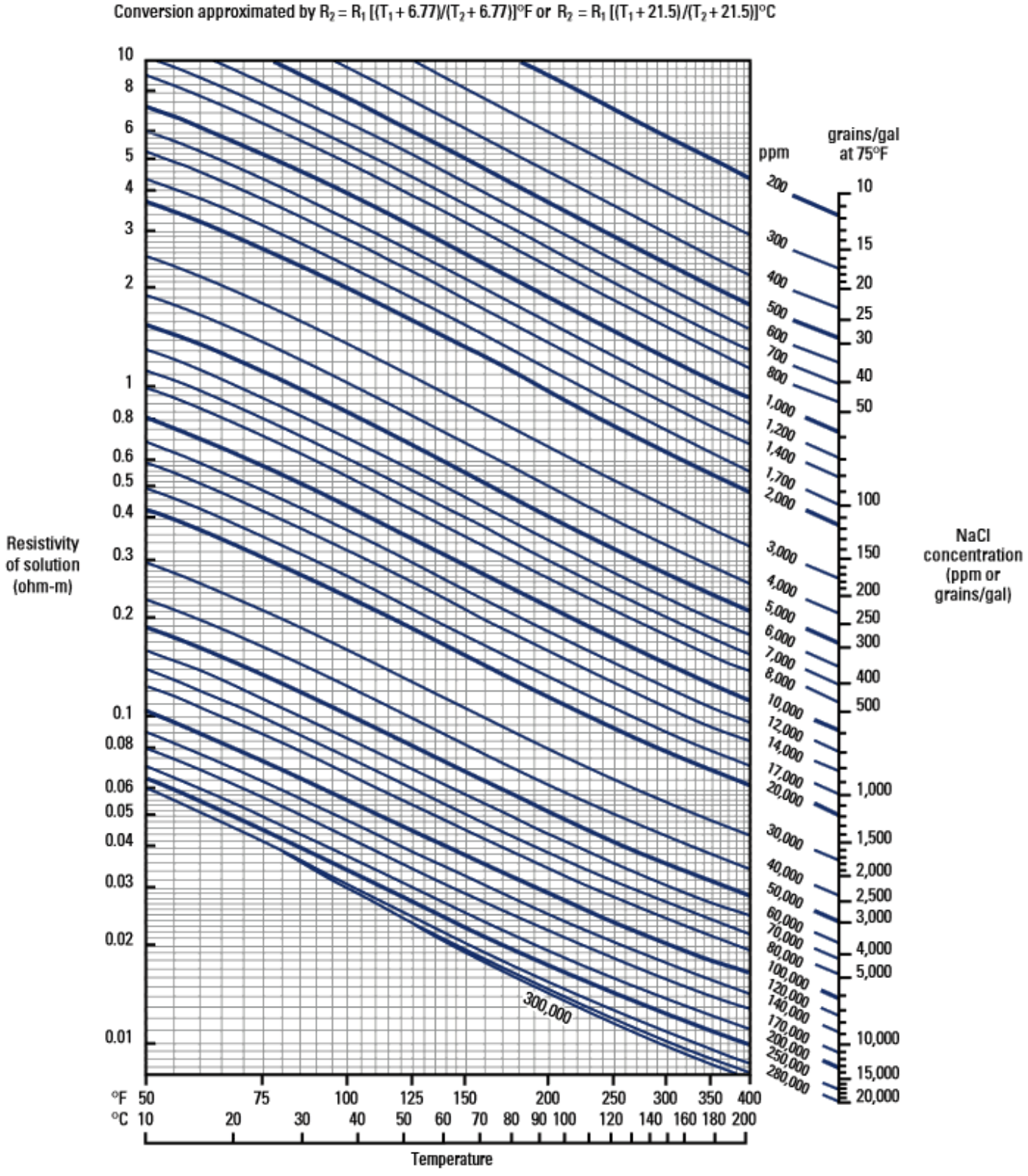
Calculations (if required) and Answer:

STUDENT NAME: _____

ROLL NO.: _____

Answer To
Q _____

CHART 2: **Related ANSWER should be written in the ANSWER-SCRIPT as well, otherwise the answer will not be evaluated.**



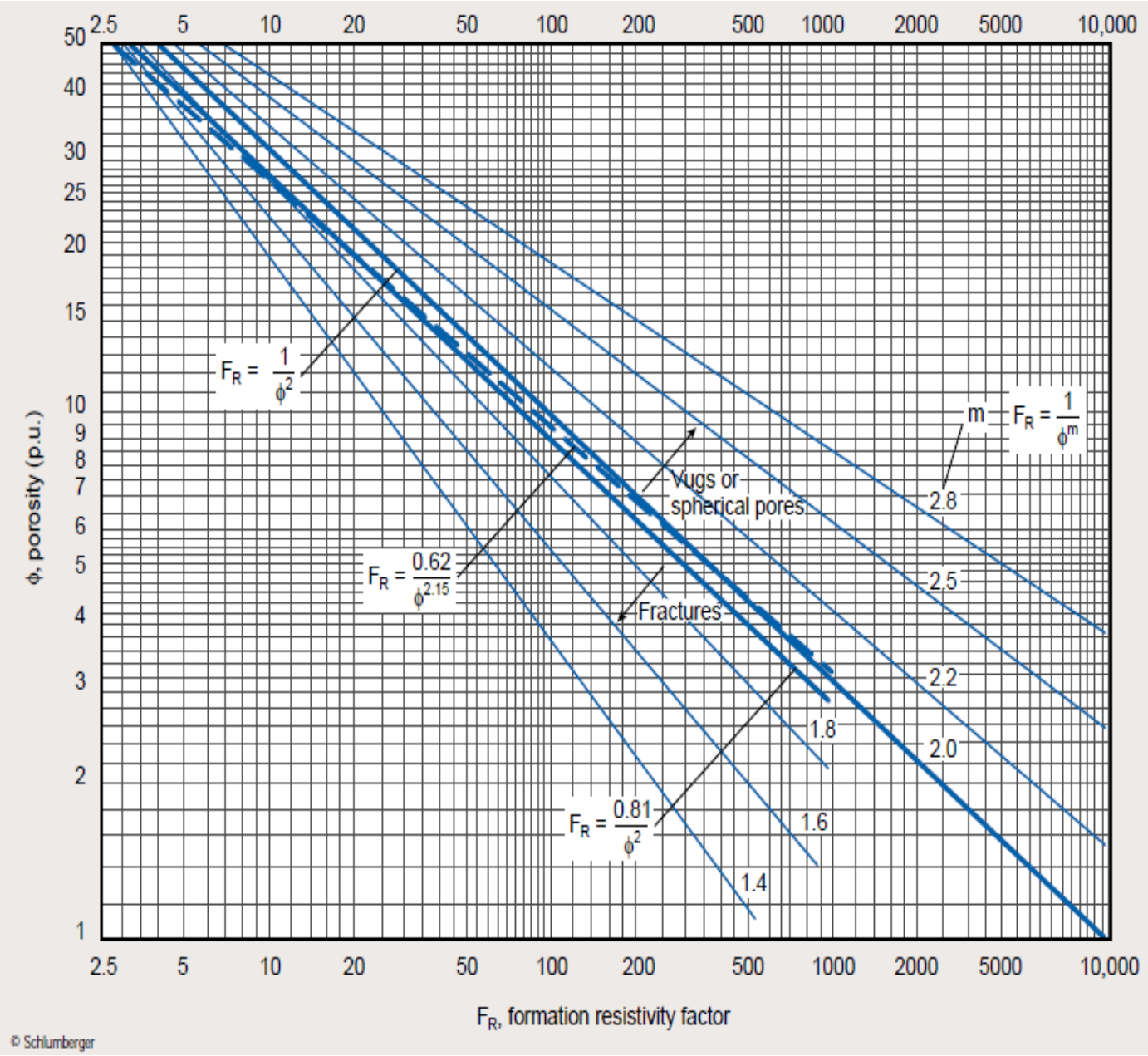
Calculations (if required) and Answer:

STUDENT NAME: _____

ROLL NO.: _____

Answer To
Q _____

CHART 3: **Related ANSWER should be written in the ANSWER-SCRIPT as well, otherwise the answer will not be evaluated.**



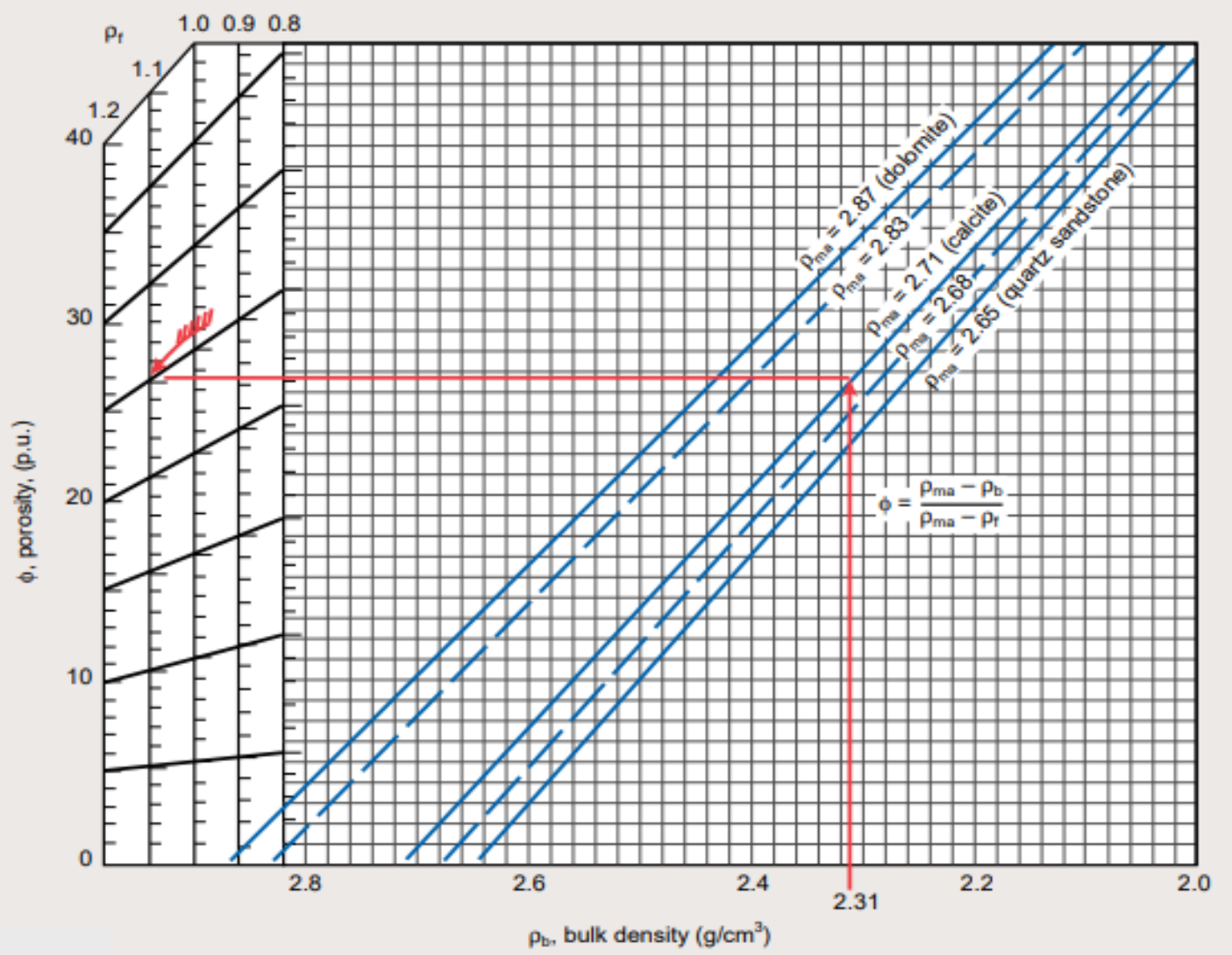
Calculations (if required) and Answer:

STUDENT NAME: _____

ROLL NO.: _____

Answer To
Q _____

CHART 4: **Related ANSWER should be written in the ANSWER-SCRIPT as well, otherwise the answer will not be evaluated.**



Calculations (if required) and Answer:

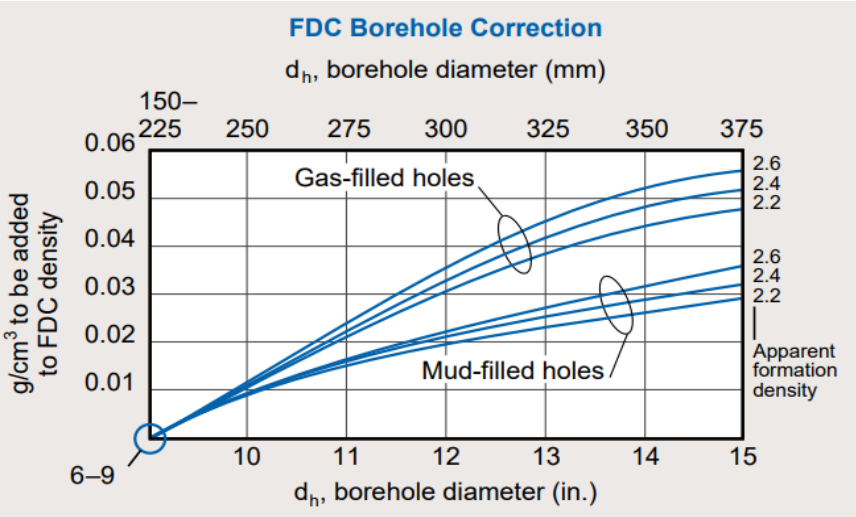
STUDENT NAME: _____

ROLL NO.: _____

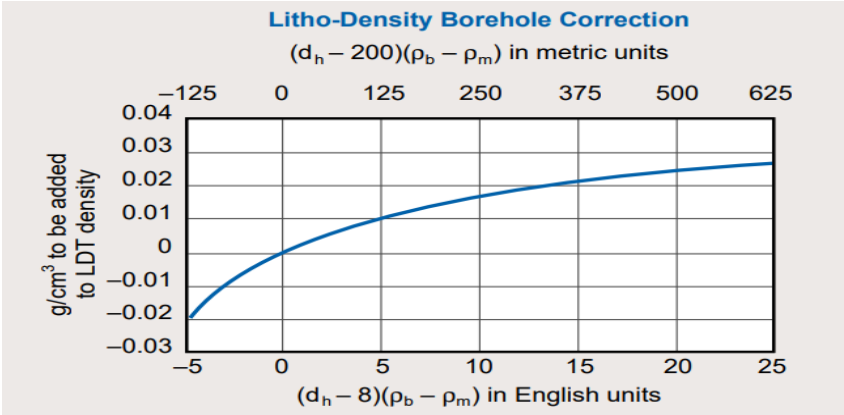
Answer To
Q _____

CHART 5: Related ANSWER should be written in the ANSWER-SCRIPT as well, otherwise the answer will not be evaluated.

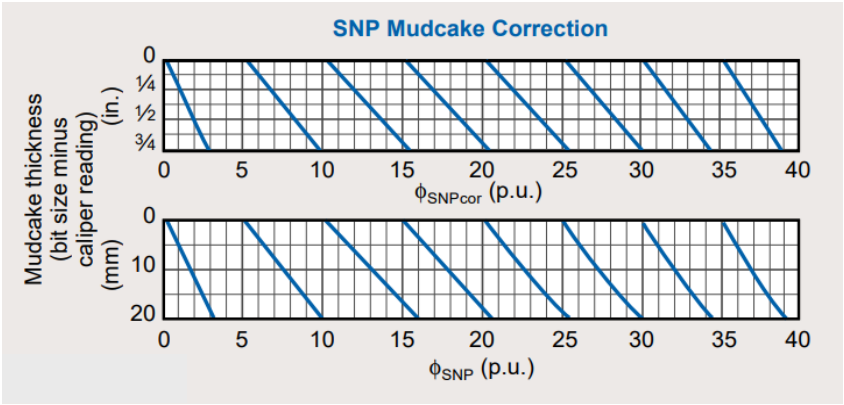
5-A



5-B



5-C



Calculations (if required) and Answer:

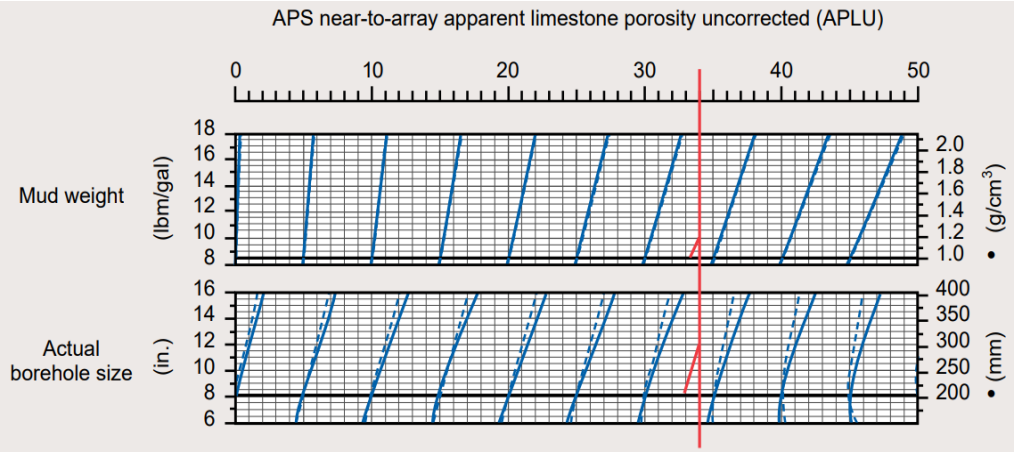
STUDENT NAME: _____

ROLL NO.: _____

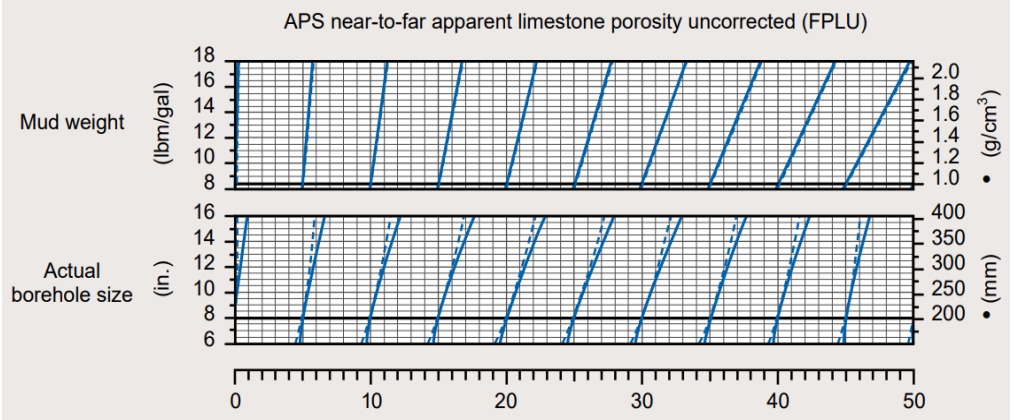
Answer To
Q _____

CHART 6: **Related ANSWER should be written in the ANSWER-SCRIPT as well, otherwise the answer will not be evaluated.**

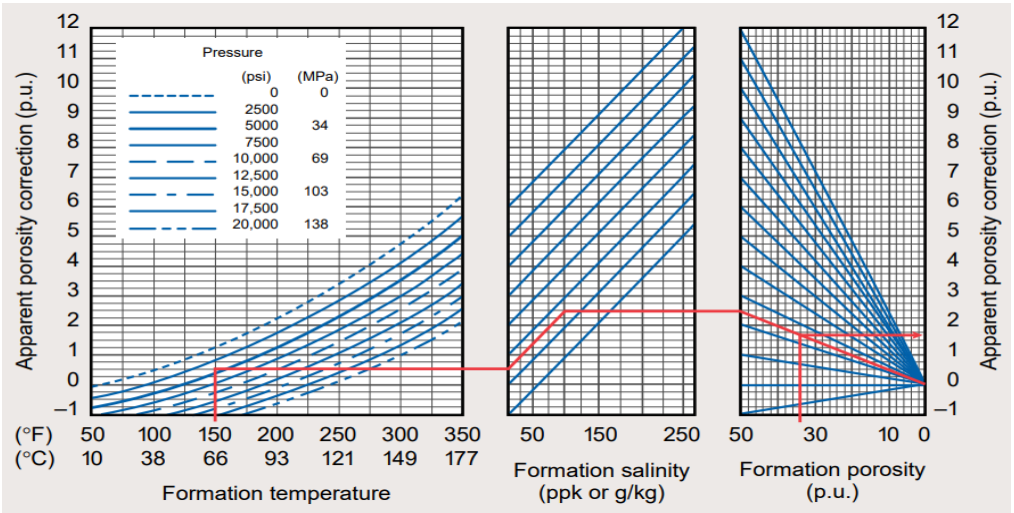
6-A



6-B



6-C



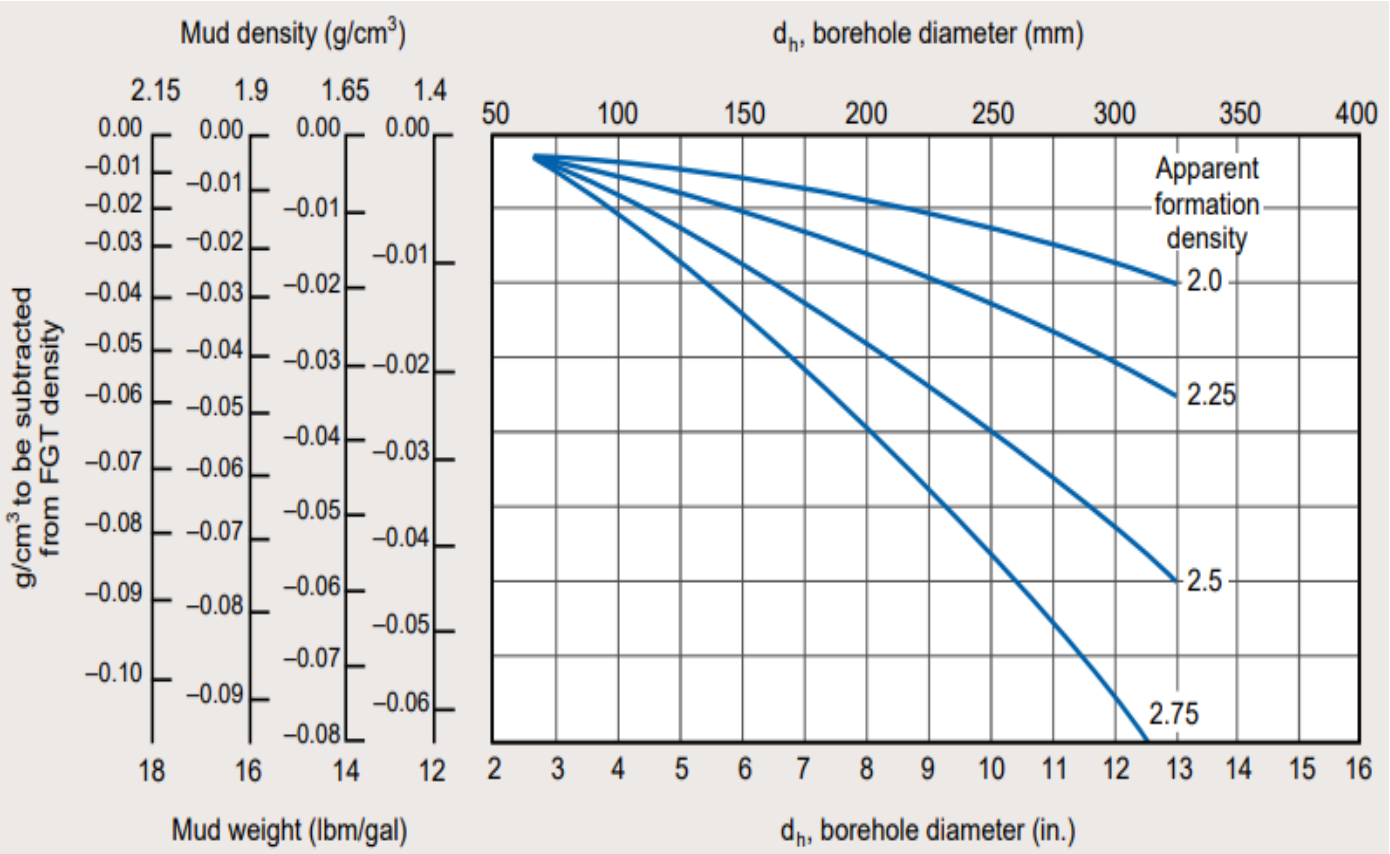
Calculations (if required) and Answer:

STUDENT NAME: _____

ROLL NO.: _____

Answer To
Q _____

CHART 7: Related ANSWER should be written in the ANSWER-SCRIPT as well, otherwise the answer will not be evaluated.



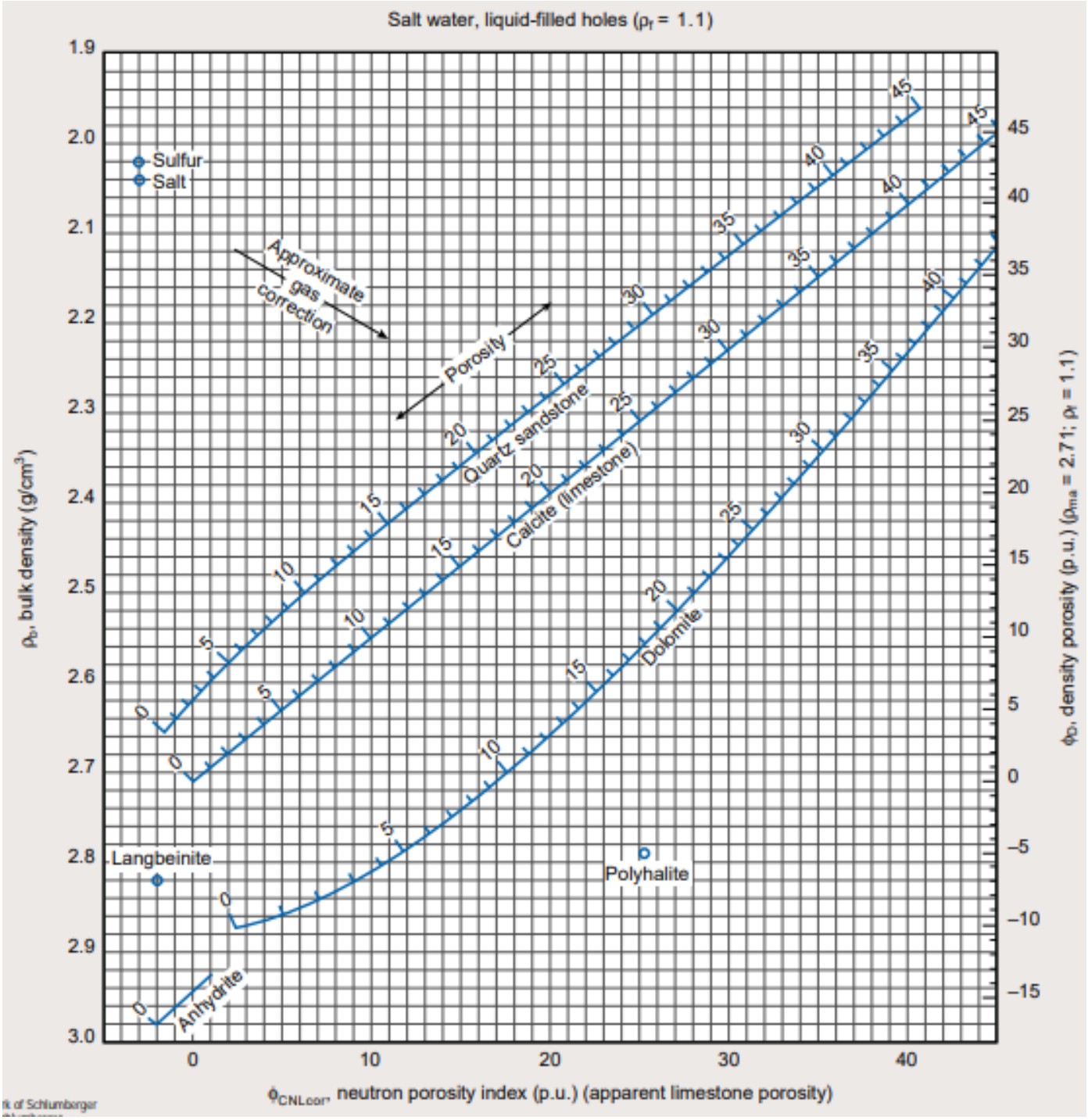
Calculations (if required) and Answer:

STUDENT NAME: _____

ROLL NO.: _____

Answer To
Q _____

CHART 8: **Related ANSWER should be written in the ANSWER-SCRIPT as well, otherwise the answer will not be evaluated.**



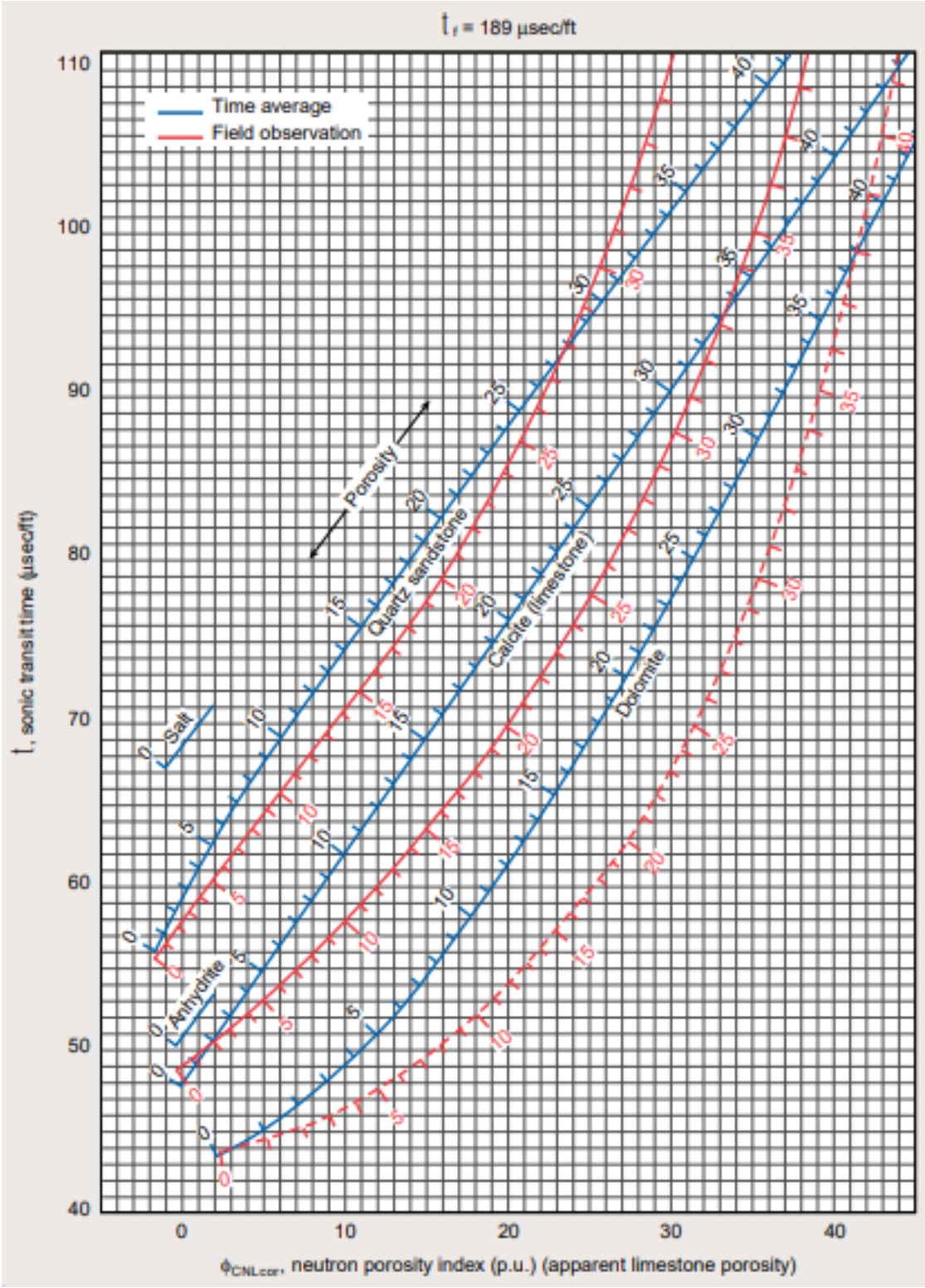
Calculations (if required) and Answer:

STUDENT NAME: _____

ROLL NO.: _____

Answer To
Q _____

CHART 9: Related ANSWER should be written in the ANSWER-SCRIPT as well, otherwise the answer will not be evaluated.



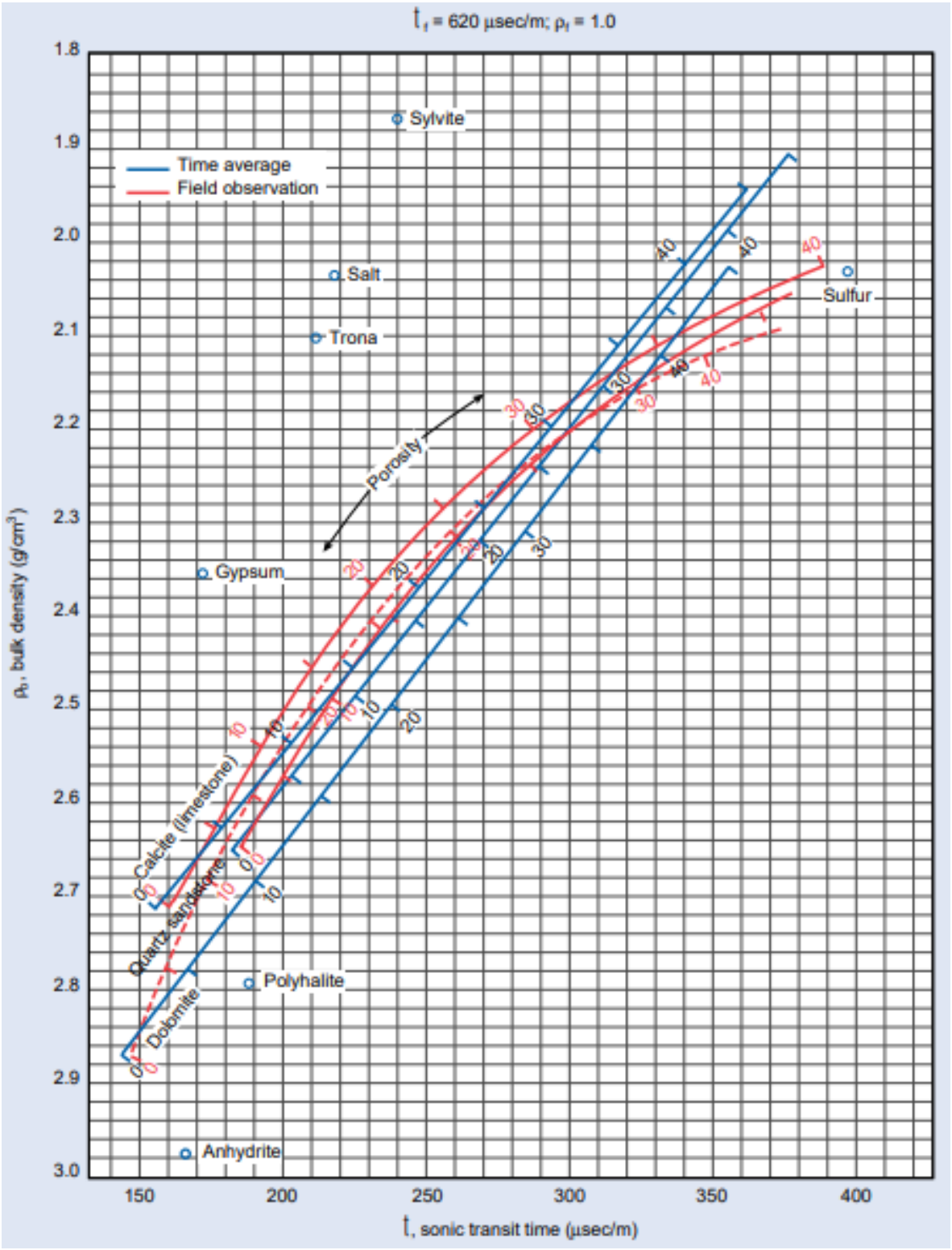
Calculations (if required) and Answer:

STUDENT NAME: _____

ROLL NO.: _____

Answer To
Q _____

<u>CHART 10</u>: Related ANSWER should be written in the ANSWER-SCRIPT as well, otherwise the answer will not be evaluated.



<u>Calculations (if required) and Answer:</u>