Carbon Capture, Utilization, and Storage
(이산화탄소 포집, 활용 및 저장) (38535)

- 2024 Midterm Examination -

Student ID: **Name:**

Notice

- Fill your name below:

  "I, _____, swear I solve all problems by myself in this midterm examination.

  I will take any disadvantages if any dishonesty such as cheating is acted on my solution."

  5 points will be deducted from your total score if you do not fill in your name above.

- **You MUST solve each problem by hand.**

- Submission Deadline: 09:30~10:45 AM, April 14, 2024

Problem 1.
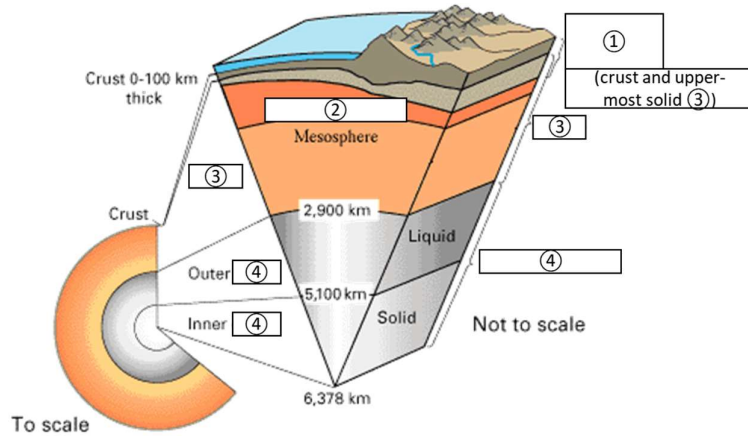
Provide the full name of each acronym:

1-1.   IPCC [2 pts.]
1-2.   BAU [2 pts.]
1-3.   SCAL [2 pts.]
1-4.   TRL [2 pts.]
1-5.   JOGMEC [2 pts.]
1-6.   IRA [2 pts.]

Problem 2.

List the terms corresponding to ①, ②, ③, and ④ in either Korean or English. [8 pts.]

The Earth is made up of layers:

- (①)
  (outside of earth) 65 -100 km thick; rigid, solid rock; includes continental and oceanic crust.

- (②)
  (uppermost ③) 200 km thick; very near melting point; flows gradually under stress.

- (③)
  (beneath ②) 2700 km thick; dense iron and magnesium silicate minerals.

Crust 0-100 km thick

②
Mesosphere

③

Crust

2,900 km

Liquid

Outer ④

5,100 km

Inner ④

Solid

6,378 km

To scale

①
(crust and upper-most solid ③)

③

④

Not to scale

- (④) (centre of earth) 7,000 km diameter; iron and nickel.
- Liquid outer (④) surrounds solid inner (④).

Problem 3.

3-1. Draw a phase diagram of pure CO_2 with its critical point. [3 pts.]

3-2. How much are critical pressure and temperature of pure CO_2? [3 pts.]

3-3. Explain dense phase fluid. [3 pts.]

3-4. Explain supercritical fluid. [3 pts.]

Problem 4.

4-1. In the petroleum industry, the standard conditions are (   ) ˚C and (   ) MPa. [4 pts.]

4-2. Explain why injecting (and storing) supercritical CO_2 is more favored than doing (and storing) gaseous CO_2 in terms of density. [3 pts.]

4-3. What happens if supercritical CO_2 is injected in a target CO_2 storage site? [3 pts.]
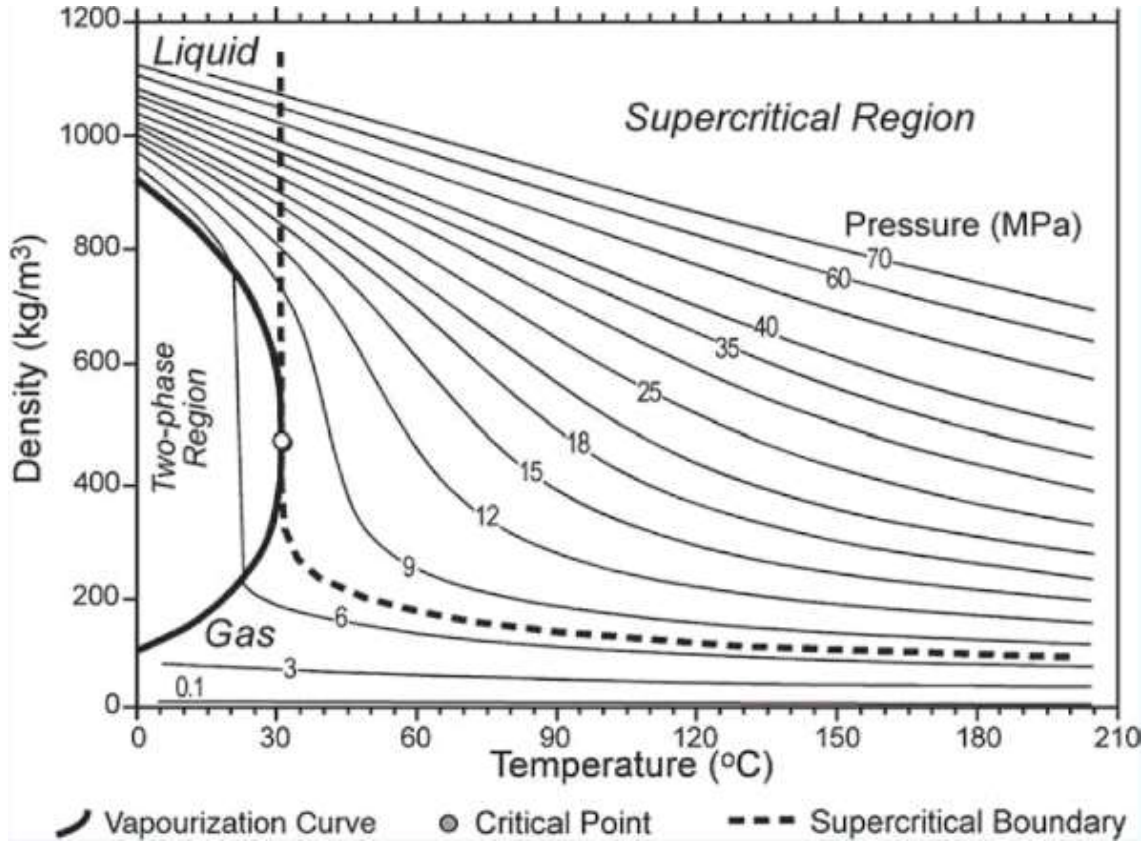
Problem 5.

Draw a graph to compare four primary CO_2 trapping mechanisms in terms of time since cessation of injection (years) and trapping contribution (%) [12 pts.].

Problem 6.

Explain the role of drilling mud (also known as drilling fluid) in brief [6 pts.]
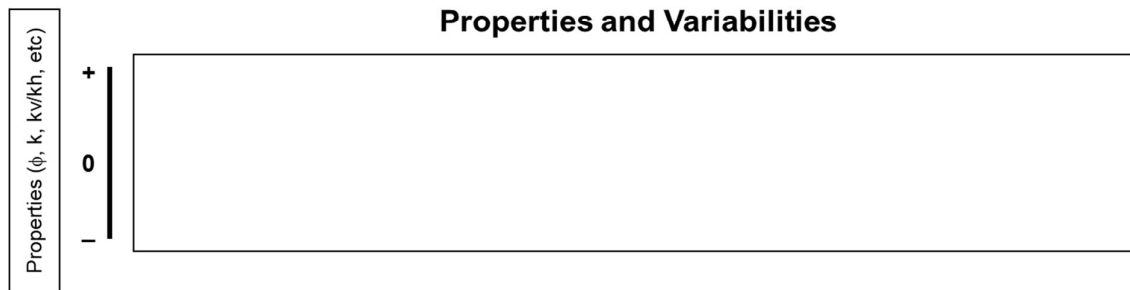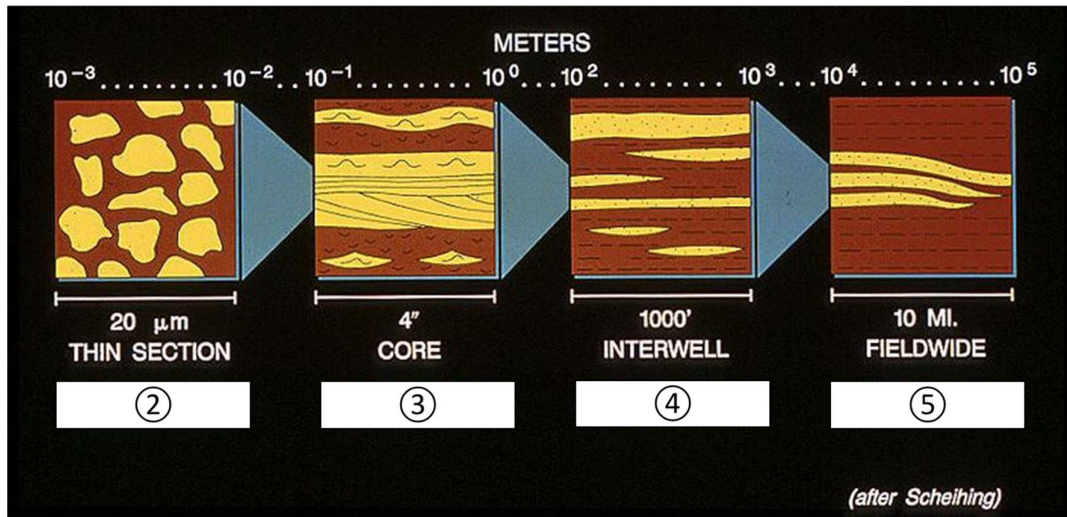
Problem 7.

The figure below illustrates multi-scale effect in reservoir characterization.

10-1. List the terms corresponding to ① to ⑤ in either Korean or English. [10 pts.]

According to Larry Lake (1989), two major issues in reservoir characterization are

(①   ) and scales of (①   ).

10-2. Draw a graph of properties and variabilities in the box below. [5 pts.]

(after Scheihing)

Properties and Variabilities

Problem 8.

Explain the Northern Lights CCS Project in brief. If appropriate, each statement will gain 1 point up to 5 statements. [5 pts.]
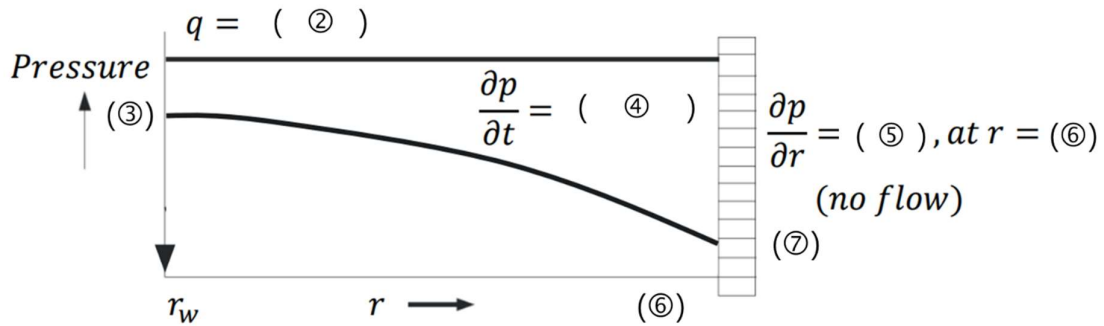
Problem 9.

Below figures compare simulation results of structural trapping (left) and hysteresis trapping (right) where CO_2 has been injected for 1 year and migrated for the subsequent 200 years. Analyze the simulation results based on your engineering knowledge [10 pts].
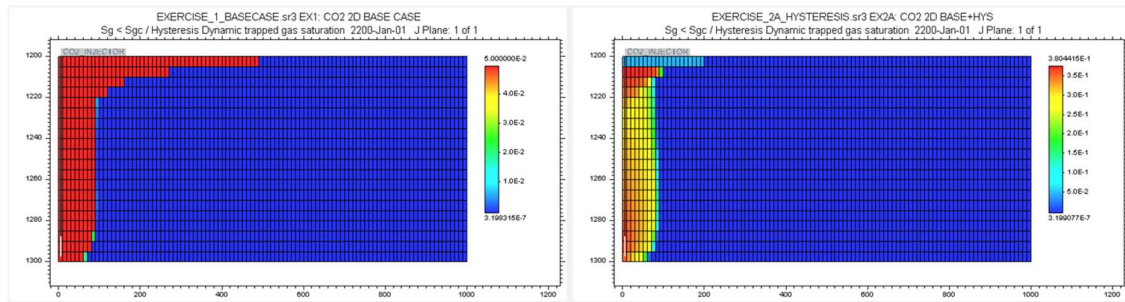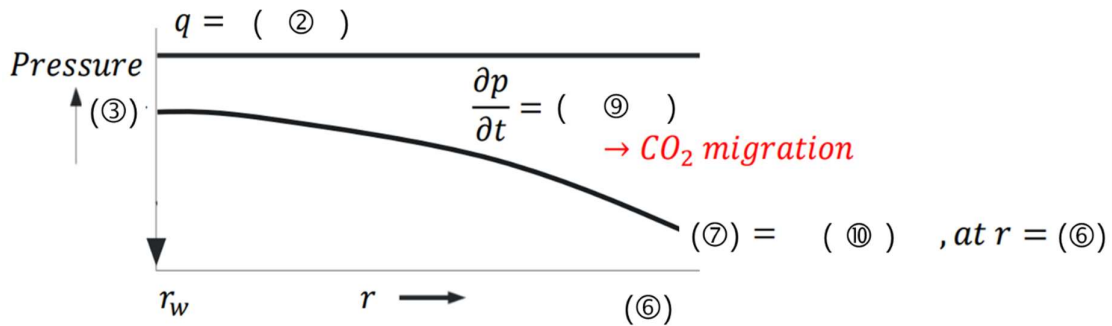
Problem 10.

Fill the ten blanks from ① to ⑩ [10 pts.].

➤ ____①____ system: It is considered that the well is surrounded, at its outer boundary, by a solid "brick wall" which prevents the flow of fluids into the radial cell

$$q = (\ ② \ )$$

Pressure

(③)

$$\frac{\partial p}{\partial t} = (\ ④ \ )$$

$$\frac{\partial p}{\partial r} = (\ ⑤ \ ), at\ r = (⑥)$$

$$(no\ flow)$$

(⑦)

r_w $r \longrightarrow$ $(⑥)$

➤ ____⑧____ system: For a constant rate of injection, fluid from the cell will be exactly balanced by fluid entry across the open boundary

$$q = (\ ② \ )$$

Pressure

(③)

$$\frac{\partial p}{\partial t} = (\ ⑨ \ )$$

$$\rightarrow CO_2\ migration$$

$$(⑦) = (\ ⑩ \ )\ , at\ r = (⑥)$$

r_w $r \longrightarrow$ $(⑥)$

-------------------- This is the End of the Midterm Examination --------------------