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

- 2023 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: 12:30~13:45 PM, April 17, 2023

Problem 1.

Provide the full name of each acronym in English:

1-1. IPCC [2 pts.]
1-2. IEA [2 pts.]
1-3. GWP [2 pts.]
1-4. GHG [2 pts.]
1-5. SCAL [2 pts.]

Problem 2.

Sort the following 10 countries in descending order from the 1st rank to the 10th rank based on CO_2 emissions in 2021 (Source: BP Statistical Review of World Energy 2022). [10 pts.]

China, Germany, Japan, India, Indonesia, Iran, Russia, Saudi Arabia, South Korea, USA

Rank	Country	Million Tonnes of CO_2					Growth rate per annum		Share
		2010	…	2019	2020	2021	2021	2011-21	2021
1		8,146		9,810	9,899	10,523	5.8%	1.8%	31.1%
2		5,495		5,029	4,457	4,701	6.6%	-1.3%	13.9%
3		1,652		2,472	2,302	2,553	12.2%	4.0%	7.5%
4		1,527		1,596	1,482	1,581	8.9%	0.1%	4.7%
5		1,198		1,118	1,027	1,054	2.6%	-1.4%	3.1%
6		537		675	678	661	2.6%	2.5%	1.9%
7		783		681	605	623	5.0%	-1.9%	1.9%
8		579		623	578	604	2.8%	-0.2%	1.8%
9		472		580	571	575	1.4%	1.4%	1.7%
10		446		625	545	573	2.4%	2.0%	1.7%
			…						
Total World		31,291	…	34,357	32,284	33,884	5.9%	0.6%	100.0%

Problem 3.

Answer to each question shortly.

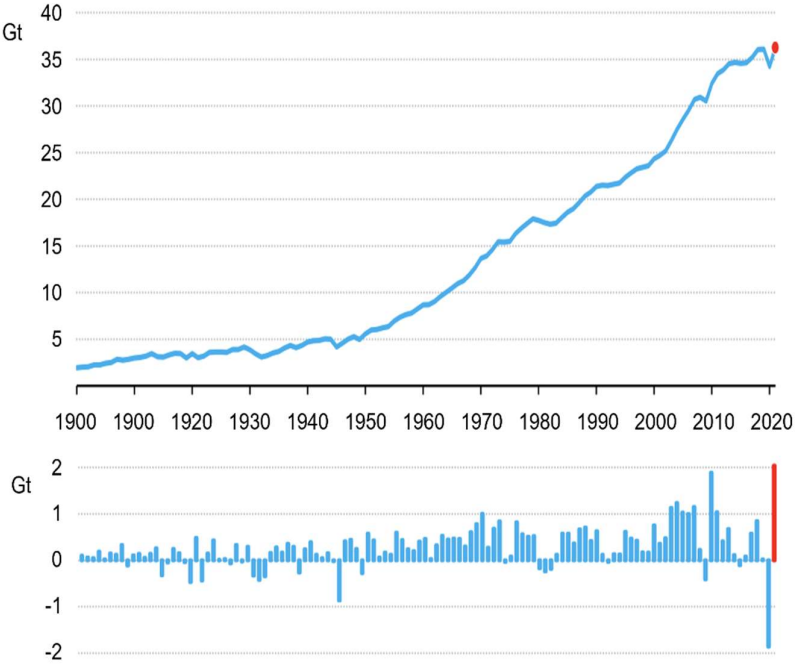
3-1. What is the name of the first large-scale offshore CCS project in the world? [2 pts.]

3-2. What is the name of the only large-scale CCS project utilizing InSAR data in the world? [2 pts.]

3-3. Address the reason why the relationship between the buoyancy force and capillary pressure is important for safe geological carbon storage. [2 pts.]

3-4. What is the main difference between enhanced geothermal system (인공지열발전) and geological carbon storage in terms of pressure maintenance? [2 pts.]

3-5. According to IEA 2022, global energy-related CO_2 emissions were set to fall nearly 8% in 2020 to their lowest level in a decade. However, the CO_2 emissions rebounded in 2021 to reach their highest every annual level (i.e., 6% increase from 2020 pushed emissions to 36.3 Gt).
The question is, what is the main reason of the decrease of CO_2 emissions in 2020 and rebound of CO_2 emissions in 2021? [2 pts.]



[Figure. CO_2 emissions grew to 36.3 Gt in 2021, a record high (IEA, 2022)]

Problem 4.

4-1. Draw a phase diagram of pure CO_2 with its critical pressure and temperature. [4 pts.]

4-2. Explain dense phase fluid. [3 pts.]

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

Problem 5.

Below table shows greenhouse gas emissions from "A" company in 2020.

CO_2 (ton)	CH_4 (kg)	N_2O (kg)	HFCs (kg)	PFCs (kg)	SF_6 (kg)	GWP (CO2)	GWP (CH4)	GWP (N2O)	GWP (HFCs)	GWP (PFCs)	GWP (SF6)
100,000	380	35	.	.	.	1	21	310	-	-	23,900

5-1. How much is the CO_2 emissions of this company? [3 pts.]

5-2. How much is the CO_2-eq emissions of this company? Round off your answer to the nearest hundredth (당신의 답을 소수점 둘째자리에서 반올림하시오). [3 pts.]

5-3. How much is the carbon (C) emissions of this company? Round off your answer to the nearest hundredth. [4 pts.]

Problem 6.

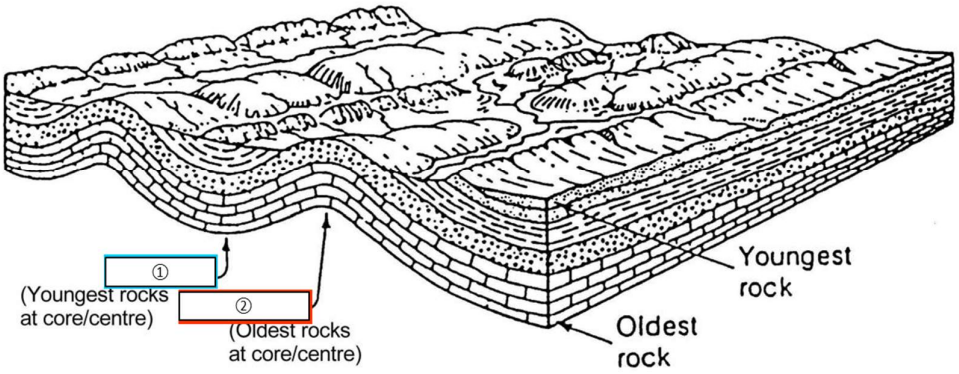
List six conventional options for storing CO_2 in deep underground geological formations for CO_2. [12 pts.]

Problem 7.

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

Problem 8.

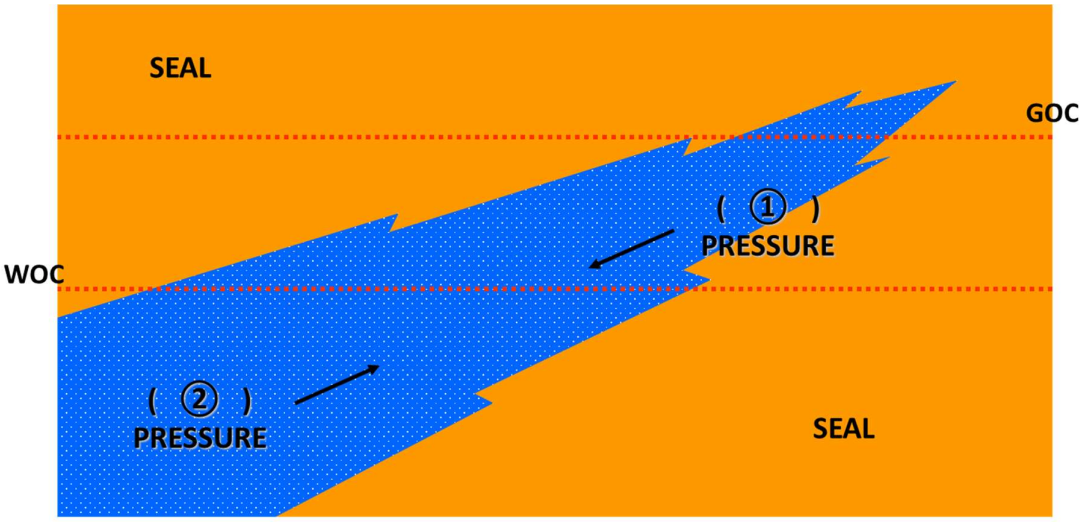
8-1. Fill the two blanks ① and ② [4 pts.].



Ductile deformation results in FOLDS (습곡).

Concave upwards folds are called (①).
Convex upwards folds are called (②).

8-2. Fill the two blanks ① and ② [4 pts.].



UPWARD MIGRATION OF HYDROCARBONS IS DRIVEN BY (②)

(DENSITY DIFFERENCE BETWEEN WATER AND HYDROCARBON)

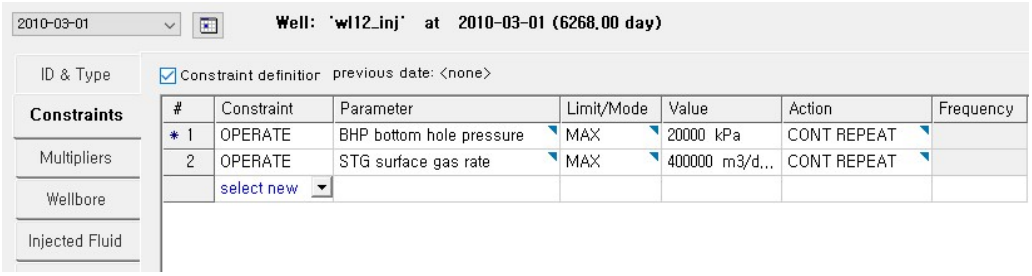
(②) PRESSURE IS OPPOSED BY (①) PRESSURE (DISPLACEMENT PRESSURE OF LARGEST PORE THROAT)

Problem 9.

This figure was captured from the Lecture Note RE2.2 Scenarios of Prediction: Gas Injection.

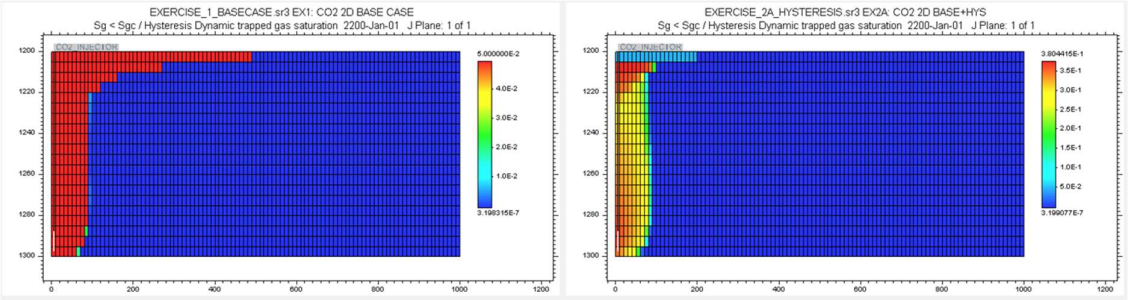
9-1. Describe the operating constraints of this gas injection well 'wl12_inj'. [4 pts.]

9-2. What would happen if any operating constraint is violated? [4 pts.]



Problem 10.

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].



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