Start with the questions from Week 4

Page 1 | R1: slide 2, 4 min. R2: slide 3, 4 min. Check both at slide 4.

This independent lesson replaces the class on **6 November 2026**. We return to the classroom on **13 November**. Keep this one worksheet beside the video. Open Lab 12 and its two-page guide when directed. The solutions are for checking after each attempt.

Planned route: about 42 min of video, 128 min of calculations, Lab work and reflection, plus a 10 min break. No extra required preparation or follow-up assignment. At each pause limit, mark the unresolved step and continue. Bring your question on 13 November.

Week 5 lesson and resources

R. Two kinds of equilibrium need a balance

Bulk sublimation has a separate pure solid phase. While that phase remains, the ideal-gas model gives $P_A = P_{sub}(T)$. Surface adsorption uses an isotherm $q(P_A)$ per mass of adsorbent. In both cases, conserve the total inventory.

R1. At T=300 K, free gas volume V=1 L and Psub=10 kPa, the total volatile amount is nA=0.002 mol. Use R=8.314462618 kPa L mol^{-1} K^{-1}. Calculate ncap=PsubV/(RT), decide whether solid remains, then calculate PA. Add 0.002 mol of ideal, nonadsorbing inert gas at the same T and V. Calculate Ptotal and state whether PA changes.

R2. A candidate Langmuir state has PA=10 kPa, T=300 K, Vg=1 L, ms=0.010 kg, qs=2 mol/kg and b=0.1 kPa^{-1}. The total feed is 0.010 mol. Independently calculate ngas=PAVg/(RT) and nads=ms qs bPA/(1+bPA). Does their sum equal the feed? Explain why a residual amount obtained by subtraction still needs an isotherm check.

What to keep

Keep first attempts and mark corrections separately. Save three completed Lab 12 studies: 12A (350 K, 100 kPa), 12B (350 K, 400 kPa), and 12C (400 K, 100 kPa). At the end, submit the Session 5 exit ticket and feedback once. Exported JSON files remain on your device.

If the Lab does not run, record the message or control that blocked you and keep the hand calculation. Continue at the time limit. An unresolved question is useful evidence for the next class.

Build the quotient and the driving force

Page 2 | A1-A3: slide 8, 10 min. B1: slide 10, 6 min. Check A at slide 9 and B at slide 14.

A. Synthetic $A_2(g) \rightleftharpoons 2A(g)$

Initially $n_{A_2,0}=1$ mol, $n_{A,0}=0$ and no inert gas. Define extent ξ in mol and the dimensionless fraction $f=\xi/(1\ \text{mol})$. This synthetic model assumes one neutral ideal-gas reaction. The standard gas pressure is $p^\circ=100$ kPa.

A1. Complete the mole table in terms of f. Give the feasible interval and show the conserved atom amount $2n_{A_2}+n_A$.

Quantity	A_2	A
Initial amount / mol	1	0
Reaction coefficient ν	-1	$+2$
Amount at extent ξ / mol		
Mole fraction y		

A2. Use $a_i=y_iP/p^\circ$ and $Q=a_A^2/a_{A_2}$. Derive Q in terms of f and P/p°. Explain why Q and P/p° are dimensionless.

A3. At $f=0.50$, calculate the amounts, mole fractions and Q at $P/p^\circ=1$ and 4. Are these necessarily equilibrium states? Verify the atom balance.

B1. Direction before equilibrium

At $T=350$ K, $\Delta_rG^\circ=-4000$ J/mol of reaction. Use $\Delta_rG=\Delta_rG^\circ+RT\ \ln Q$, with $R=8.314462618\ \text{J mol}^{-1}\ \text{K}^{-1}$.

B1. Calculate Δ_rG at $Q=1$ and $Q=10$. For each, state whether increasing or decreasing extent lowers G at fixed T and P.

Calculate K, then calculate composition

Page 3 | B2-B4: slide 13, 10 min. C1-C3: slide 15, 15 min. Checks at slides 14 and 16.

B. Two consistent reference routes at 350 K

All properties are per mole of $A_2 \rightleftharpoons 2A$ as written, on the same ideal-gas standard states. Direct $\Delta rG° = -4.000$ kJ/mol. Reference $\Delta rH° = 50.000$ kJ/mol and $\Delta rS° = 54000/350 = 154.285714$ J mol^{-1} K^{-1}. Use $R = 8.314462618$ J mol^{-1} K^{-1}.

B2. Calculate $\ln K = -\Delta rG°/(RT)$, then K from the direct Gibbs energy. Show the kJ-to-J conversion.

B3. Calculate $\Delta rG° = \Delta rH° - T\Delta rS°$, then $\ln K$ and K. Keep units and the sign explicit.

B4. Explain the expected agreement. Does agreement between consistent synthetic definitions independently validate a real chemical system?

C. Reference equilibrium at 100 kPa

Use $K = 3.9532626$ if your B calculation is unfinished. Set $T = 350$ K and $P = p° = 100$ kPa. $Q = [4f^2/(1-f^2)](P/p°)$. Initial amounts remain 1 mol A_2 and no A.

C1. Set $Q = K$ and rearrange for f^2. Choose the physically feasible positive root, then convert f to ξ in mol.

C2. Calculate nA_2, nA, yA_2 and yA. Keep enough digits for the checks.

C3. Recompute Q from activities. Verify $2nA_2 + nA = 2$ mol of atoms. Explain why conserving total molecular moles would be incorrect for this reaction.

Pressure comparison and Lab 12

Page 4 | C4: slide 17, 8 min. D1: slide 19, 5 min. D2-D4: slide 21, 22 min. Guide p. 1.

C4. A controlled pressure change

C4. Keep T=350 K, p°=100 kPa and the initial inventory. Raise P from 100 to 400 kPa. Predict whether K and ξ change, then calculate ξ and both mole fractions. Explain using Q and Δν=+1.

D. Run the two pressure cases

Open Lab 12: Chemical equilibrium

D1. Before slide 20, reset the synthetic example and use guide p. 1 to check the reference data. Set ΔrCp°=0 (the default is 30) and select the direct Gibbs K source. Identify the evaluation T, reference T, actual P and standard p°.

D2. Run 12A at 350 K and 100 kPa. Compare direct Gibbs with the ΔH°/ΔS° constant-values route, then return to direct Gibbs. **D3.** Change only P to 400 kPa for 12B. Click **Compare K methods** after each change. Record the values below. Complete 12C later in F.

Case	T / K	P / kPa	K	ξ / mol	yA_2 / yA
12A	350	100			
12B	350	400			
12C (F)	400	100			

D4. For 12B, independently calculate Q from the equilibrium mole fractions and verify the atom balance. Label both axes of the Gibbs-energy graph and identify the minimum. Export each study and name it 12A or 12B on your device. Keep one assumption with your comparison.

Read the correct panel. The separate Observed activities panel uses independent input values yA_2=0.2 and yA=0.8. It is not automatically updated to the solver composition. Use **From K to equilibrium composition** for this table and your Q=K check.

At slide 23, take the 10-minute break. If a technical problem prevents a run, record it and retain your hand calculation. Do not invent a Lab result.

Temperature comparison and saved evidence

Page 5 | E1-E3: slide 26, 15 min. F1-F3: slide 29, 19 min. Guide p. 2. Checks at slides 27 and 30.

E. Constant-enthalpy van't Hoff route

Use Tref=350 K, lnKref=1.37454120049, ΔrH°=50000 J/mol and ΔrCp°=0 over 350-400 K. Keep P=p°=100 kPa and the original feed. The approximation assumes consistent reference data, no phase transition and valid constant reaction enthalpy.

$\ln[K(T)/Kref]=(\Delta rH°/R)(1/Tref-1/T)$.

E1. Before calculating, predict the direction of K when temperature rises to 400 K. Calculate the increment in lnK, then lnK(400) and K(400).

E2. Independently use $\Delta rG°(400)=50000-400(54000/350)$ J/mol and $\ln K=-\Delta rG°/(R\cdot 400)$. Explain why this is consistent only under the same thermal assumptions.

E3. At 400 K and P/p°=1, calculate f, ξ, yA_2 and yA. Compare with 12A and check the atom balance.

F. Third Lab case and JSON restore

F1. Follow guide p. 2. For 12C, select van ’t Hoff · constant ΔH°, set T=400 K and P=100 kPa, then recalculate. Keep Tref and supplied Gibbs-data temperatures at 350 K. Complete row 12C on p. 4. Why is the direct Gibbs route unavailable at 400 K?

F2. Export the 12C complete study. Reopen 12A using Restore calculator study JSON. Verify T, P, K source, Cp and initial amounts, then confirm the fresh result matches your 12A record. Record one recovered number and its units.

F3. Write two sentences: why did 12A→12B change composition without changing K, and why did 12A→12C change both? Name one assumption that limits all three predictions.

Close the lesson and retain your evidence

Page 6 | G: slide 32, 10 min. Your required work ends after submission and saving your files.

G. Explain one result and report one difficulty

G1. Prepare your Session 5 explanation: distinguish K from Q and explain how pressure can change composition at fixed K. Give one numerical result or an independent Q/atom-balance check from your work. Include T, P, p°, reaction basis and relevant units.

G2. Record actual study time: _____ minutes. Pace: _____. If a step remains unclear, identify the worksheet item or Lab control and write what you tried. We will discuss questions in the classroom on 13 November.

Submit once

Session 5 exit ticket + feedback

Scan the QR or use the clickable link below. The form is anonymous. It is not an attendance-identification form.

Open the Session 5 form

Use the existing concept, evidence and feedback fields. English or Thai is welcome. Wait for **Response received**. The form is anonymous and does not identify individual attendance. If you already submitted this session, do not send a second entry merely to check the receipt.

Keep for the next class

One completed worksheet with corrections, the 12A/12B/12C complete-study JSON files, one controlled comparison, and one independent numerical check. Your calculator exports are local records, not automatic submissions.

Optional references: custom species, formation-energy detail and nonzero heat-capacity models are outside the required route. No additional preclass reading or after-class assignment is required.

Worked solutions: use after your attempts