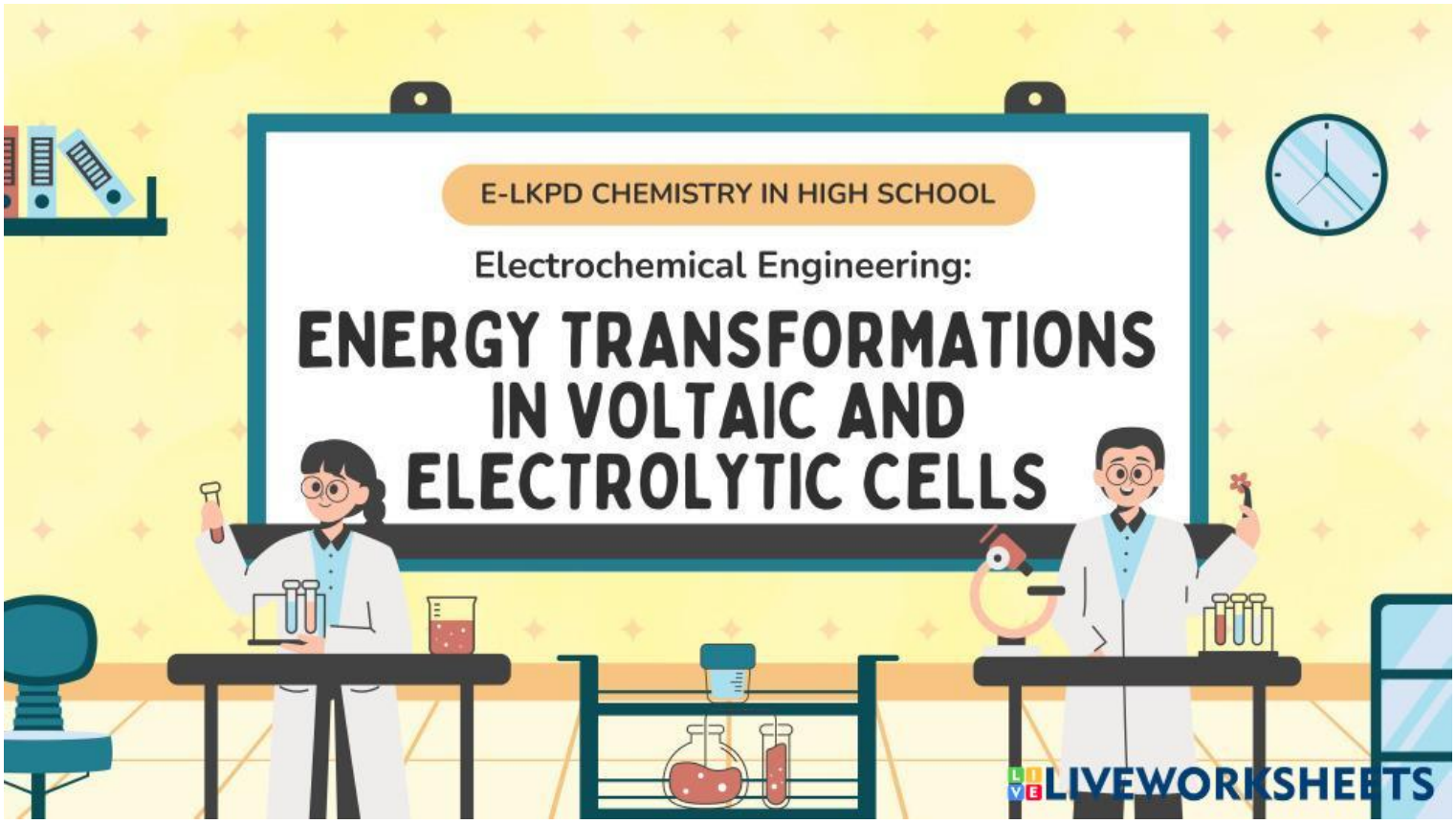
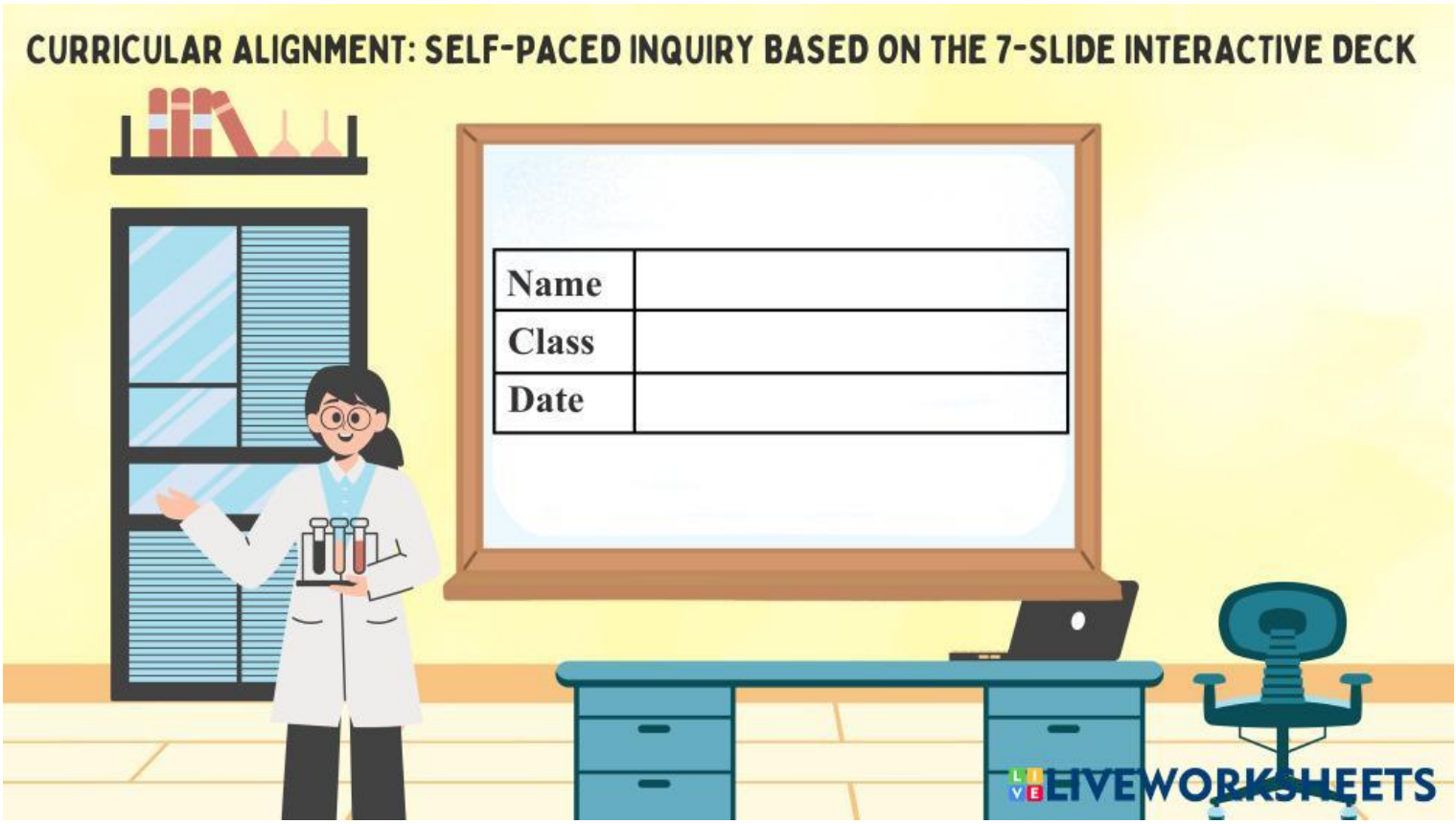

E-LKPD CHEMISTRY IN HIGH SCHOOL
Electrochemical Engineering:
ENERGY TRANSFORMATIONS IN VOLTAIC AND ELECTROLYTIC CELLS
LIVEWORKSHEETS

CURRICULAR ALIGNMENT: SELF-PACED INQUIRY BASED ON THE 7-SLIDE INTERACTIVE DECK



SECTION 1: REACTION SYSTEM INITIATION

INSTRUCTIONS: DRAW CONNECTING LINES (JOIN WITH ARROWS) FROM EACH COMPARATIVE ASPECT ON THE LEFT TO ITS CORRESPONDING ELECTROCHEMICAL FUNDAMENTAL ON THE RIGHT!

Comparative Aspect	Electrochemical Fundamental
Energy Conversion in Voltaic Cells	Anode connects to the positive terminal (+) of the power source; Cathode connects to the negative terminal (−).
Energy Conversion in Electrolytic Cells	Converts chemical energy from spontaneous redox reactions into electrical current ($E^\circ_{cell} > 0$).
Electrode Polarity in Voltaic Cells	Anode is negatively charged (−) as the electron source; Cathode is positively charged (+) where electrons are consumed.
Electrode Polarity in Electrolytic Cells	Utilizes external direct current (DC) electrical energy to drive non-spontaneous redox reactions ($E^\circ_{cell} \leq 0$).

SECTION 2: ELECTRON TRANSFER PHENOMENON

Instructions: Analyze the submicroscopic mechanism of the standard Daniell Cell (Zn - Cu) and select the correct parameter from each Drop-down Menu!

1. **Zinc metal (Zn) exhibits a greater tendency to lose electrons compared to Copper (Cu). Consequently, the Zn electrode functions as the**
   : Choose:..... and undergoes Choose:.....
2. **The half-reaction occurring at the surface of the zinc electrode is**
   : Choose:..... . As a direct consequence of this reaction, the physical mass of the Zn strip will Choose:.....
3. **Aqueous copper ions (Cu^{2+}) migrate toward the copper electrode to accept electrons. The Cu electrode acts as the strip will increase.**
   : Choose:..... The physical mass of the Cu Choose:.....

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4. **Electrons travel spontaneously through the external circuit (conducting wire) from the** : Choose:..... electrode.

5. **Without a salt bridge, a positive charge accumulation of Zn^{2+} occurs in the anode compartment, alongside a deficit of positive ions in the cathode compartment. The salt bridge (KNO_3) maintains electrical neutrality by migrating nitrate anions (NO_3^-) toward the**: Choose: ..... compartment and potassium cations (K^+) toward the Choose:..... compartment.

SECTION 3: INTERACTIVE REDOX SIMULATION

Instructions: Analyze the submicroscopic mechanism of the standard Daniell Cell (Zn - Cu) and select the correct parameter from each Drop-down Menu!

Standard Reduction Potential Reference Data (25°C, 1 M):

- $Mg^{2+}(aq) + 2e^- \rightarrow Mg(s)$ $E^\circ = -2.37$ V
- $Fe^{2+}(aq) + 2e^- \rightarrow Fe(s)$ $E^\circ = -0.44$ V
- $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ $E^\circ = +0.34$ V
- $Ag^{+}(aq) + e^- \rightarrow Ag(s)$ $E^\circ = +0.80$ V

Spontaneity Equation: $E^\circ cell = E^\circ Reduction\ (cathode) - E^\circ Oxidation\ (anode)$

THE QUESTION IN NEXT SLIDE

Instructions: Analyze the submicroscopic mechanism of the standard Daniell Cell (Zn - Cu) and select the correct parameter from each Drop-down Menu!

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Cell Notation System	Cathode (+)	Anode (−)	Calculated Ecell∘ (Type Value)	Spontaneity (Drag & Drop)	Electron Flow (Drag & Drop)
System A: Mg | Mg2+ // Cu2+ | Cu	Cu	Mg	+0.34−(−2.37)= [ ] V	[ ]	[ ]
System B: Fe | Fe2+ // Ag+ | Ag	Ag	Fe	+0.80−(−0.44)= [ ] V	[ ]	[ ]
System C: Cu | Cu2+ // Fe2+ | Fe	Fe	Cu	−0.44−(+0.34)= [ ] V	[ ]	[ ]

You can Drag From Here

+2.71 +1.24 -0.78

SPONTANEOUS NON-SPONTANEOUS From Fe to Ag

SPONTANEOUS From Mg to Cu Requires External Power

SECTION 4: FARADAIC KINETIC ANALYSIS

Instructions: Complete the quantitative and mechanistic analysis for the electroplating of an iron spoon (F) with silver (Ag) using an aqueous AgNO3 electrolyte and a pure silver anode!

1. Electrode Reaction Identification:

- The substrate to be coated (Iron spoon, Fe) must be connected to the negative terminal ([ ]).

Reduction half-reaction forming silver deposit: [ ]

- The plating metal (Silver bar, Ag) must be connected to the positive terminal ([ ]).

Oxidation half-reaction dissolving silver ions: [ ]

2. Faraday's First Law Calculation:

An electroplating circuit operates with a constant current of I=5.0I = 5.0 A for a duration of t=t = 1,930 seconds. Given the molar mass of silver ArA_r Ag = 108 g/mol and valence charge n=1n = 1:

Formula: $$w = \frac{A_r \cdot I \cdot t}{n \cdot 96,500}$$

Numerical Substitution: $$w = \frac{108 \cdot 5.0 \cdot 1,930}{1 \cdot 96,500}$$

Theoretical mass of silver deposited: [ ] grams.

SECTION 5: POTENTIAL EQUILIBRIUM SYNTHESIS

Instructions: Evaluate each conceptual statement below by selecting [T] (True) or [F] (False) based on electrochemical principles!

No	Conceptual Synthesis Statement	Cognitive Evaluation
1	Across all electrochemical cells (both Voltaic and Electrolytic), Oxidation invariably occurs at the Anode, while Reduction invariably occurs at the Cathode.	[ ]
2	A positive standard cell potential (Ecell >0) signifies that the net redox reaction is thermodynamically favorable and generates electrical work spontaneously.	[ ]
3	During the electrolysis of aqueous solutions using inert electrodes (Pt/C), active metal cations from Group IA, IIA, Al, Mn are reduced at the cathode to form solid metal deposits.	[ ] (Water is reduced instead)
4	The further left a metal is positioned in the Activity Series (e.g., Li, K, Ba, Ca, Na, Mg), the more readily it loses electrons, functioning as a stronger reducing agent.	[ ]
5	Cathodic protection of underground steel pipelines using a sacrificial magnesium (Mg) anode works because the reduction potential of magnesium is more positive than that of iron (Fe).	[ ] (Mg is more negative/easily oxidized)