JENN

Training and Consultancy

The path to enlightened education

SUBJECT: SUBJECT NAME

GRADE 12

2025 SPRING CLASSES

TEACHER
ACTIVITY SOLUTIONS

Topic(s)

1. Electricity
2. Electrochemical Reactions

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ACTIVITY SOLUTIONS

Topic(s)

Electric Circuits

ACTIVITY 1

1.1.1 P = VI √

750 = 240 I √

I = 3,125 I A *(may be rounded to 3,13 A)* √ (3)

1.1.2 Cost = $\frac{cost\ x\ number\ of\ units}{unit}$

Cost = $\frac{R1,20}{unit}$ x (0, 75kW) $\left(\frac{20}{60}h\right)$√

Cost = $\frac{R1,20}{kWh}$ x 0, 25 kWh√

Cost = R0, 30 c√ (3)

1.2.1 Emf is the total energy supplied per coulomb of / unit charge by the cell. √√ (2)

1.2.2 0 V√√ (2)

1.2.3 emf = I(r + R) √

12√ =1, 6 (0, 5 + R) √

R = 7Ω√ (4)

1.2.4 V = IR √ **OR** V = emf – Ir√

V = (1,6)(7)√ = 12 – 16(0, 5) √

V = 11, 2V√ = 11, 2 V√ (3)

1.2.5 $P = \frac{V^2}{r}$√ **OR** P = I^2r √ **OR** P = VI √

P = $\frac{(1,6\ x\ 0,5)^2}{0,5}$ √ | = $(1,6)^2$ (0,5)√ | = (1,6 x 0,5)(1,6)√

P = 1,28 W √ | = 1,28 W√ | = 1,28 W√ (3)

(a) The current increases√ because the resistance of the circuit decreases when a resistor is added in parallel.√ (2)

(b) Increase√√ (2)

(c) Decrease√

When the current increases, the "lost volts" (Ir) increase.
[This means a smaller V_{term} or voltage across the circuit.] √(2)**[26]**

ACTIVITY 2

2.1.1

OPTION 1	OPTION 2	OPTION 3
$P = \frac{V^2}{R}$ ✓ $4 = \frac{V^2}{R} = \frac{(12)^2}{R}$ ✓ R = 36 Ω ✓	P = VI 4 = I(12) I = 0,33…A V = IR ✓ 12 = 0,33R ✓ R = 36,36 Ω ✓	P = V I 4 = I(12) I = 0,33 ..A $P = I^2 R$ ✓ $4 = (0{,}33^2) R$ ✓ R = 36,73 Ω ✓

(3)

2.1.2 Increase ✓ (1)

2.1.3 No change ✓

Same potential difference ✓ (and resistance) (2)

2.2.1 V = IR ✓

5 = I(6)

✓

∴ I = 0,83 A

$V_{\text{"lost"}} = Ir$ **OR** $\varepsilon = I(R + r)$

1 = (0,83)r ✓ 6 = (0,83)(6 + r) ✓

r = 1,20 Ω ✓ r = 1,23 Ω ✓ (4)

2.2.2 Work done ✓ in moving a unit charge ✓ through a cell.

ACCEPT

Energy transferred per unit charge

Work done in moving in 1 C of charge . (2)

2.2.3

OPTION 1

POSITIVE MARKING FROM 9.2.1

$V_{\text{"lost"}} = Ir$

$1,5$ ✓ $= I(1,2)$

$I = 1,25$ A

$V_{||} = I_6R_6$

$4,5 = I_6(6)$ ✓

$I_6 = 0,75$ A

$V_x = IR_x$ ✓ **or** $V = IR$

$4,5 = (1,25 – 0,75)R_x$ ✓

$Rx = 9\ \Omega$ ✓

[17]

ACTIVITY 3

3.1.1 The rate at which (electrical) energy is converted (to other forms) (in a circuit)
The rate at which energy is used/Energy used per second

The rate at which work is done ✓✓(2 or zero) (2)

3.1.2

$P = \frac{V^2}{R}$ $6 = \frac{(16)^2}{R}$ R = 32 Ω✓	$W = \frac{V^2 \Delta t}{R}$ ✓ $8 = \frac{(16)^2(1)}{R}$ R= 32 Ω✓	P = VI 8 = (16)(I) ∴ I = 0,5 A $P = I^2R$✓ $8 = (0,5)^2 R$✓ R = 32 Ω✓	P = VI✓ 8 = (16)(I) ∴ I = 0,5 A V = IR 16 = (0,5)R✓ R = 32 Ω✓

(3)

3.1.3

POSITIVE MARKING FROM 10.1.2
OPTION 1

$$\frac{1}{R_{//}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$= \frac{1}{32} + \frac{1}{32}$$

$R_{//} = 16\ \Omega$

$R_{ext} = (R_s + R_{//})$ R_{ext} =
(32 +16) ✓
= 48 Ω
V = IR
OR ✓ any one
ε = I(R + r)
16 = I(48 + 2) ✓
I = 0,32 A ✓

(5)

POSITIVE MARKING FROM 10.1.2
<u>OPTION 2</u>

R_{ext} = (Rs + R//)

$$\frac{1}{R_{//}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$= \frac{1}{32} + \frac{1}{32}$$

$R_{//}$ = 16 Ω

R_{ext} = (32 + 16)✓
= 48 Ω

$$P = I^2R = \frac{V^2}{R}$$

$I^2 = (48 + 2) = \frac{(16)^2}{50}$ ✓

I = 0,32 A ✓

(5)

3.1.4

POSITIVE MARKING FROM 10.1.3
 	
<u>OPTION 1</u>
 	
V = IR
$V = I(R_A+r)$
= 0,32(34) ✓
= 10,88 V
 	
$V_{//}$ = (16 – 10,88) ✓
= 5,12
$\therefore V_C$ = 5,12 ✓
	POSITIVE MARKING FROM 10.1.3
	
	<u>OPTION 2</u>
	
	$\frac{1}{R_1} = \frac{1}{R_1} + \frac{1}{R_2}$ **OR** $R = \frac{R1R2}{(R_1+R_2)}$
	
	$R = \frac{(32)(32)}{64}$
	
	= 16 Ω
	
	$V_{//} = V_C$ ✓
	$V = IR_{//}$
	= (0,32)(16) ✓
	= 5,12 V ✓

POSITIVE MARKING FROM 10.1.3 **<u>OPTION 3</u>** $I_A = I_B + I_C$ = 2 I_B 0,32 = 2I_B✓ I_B = 0,16 A V = 0,16 (32) ✓ = 5,12 V✓	

(3)

3.1.5 **<u>OPTION 1</u>**

The power rating (output voltage) of the bulb is 8 W, 16 V. ✓

$P = \frac{V^2}{R}$

[For a given resistance, power is directly proportional to V^2] ✓

<u>Since the potential difference across light bulb C is less than the operating voltage,</u>✓ <u>the output/power will be less</u>,

<u>OPTION 2</u>

$P = \frac{V^2}{R}$✓

<u>The potential difference across light bulb C is less than the operating voltage</u>. ✓

<u>Thus for the same resistance,</u> ✓ brightness decreases. (3)

OPTION 3

$P = I^2 R$✓
For a given resistance✓, power is directly proportional to I^2 Since current decreases✓, brightness decreases.]

OPTION 4

$P = I^2 R$
In the circuit, the total current in light bulb C is less than the optimum current required. ✓ Thus for the same resistance, ✓ the power will be less✓ hence brightness will decrease.

OPTION 5

$P = IV$✓ [Power is directly proportional/equal to product of V and I. ✓
Since current decreases✓, brightness decreases
OR
The voltage across light bulb C, as well as the current in the bulb are all less✓ than the optimum values✓ hence power is less✓ and brightness is less.

NOTE: No mark if only equation is given.

QUESTION 4

4.1.1 Same length of wires.✓
Same thickness/cross-sectional area of wires. ✓
(2)

4.1.2 Wire **A** (Resistor A)/*Draad A* ✓

$R = \frac{\Delta V}{\Delta I}$ ✓

$R_A = \frac{4,4}{0,4}$ ✓ $= 11\ \Omega$✓

Accept any correct coordinates chosen from the graph *Aanvaar enige korrekte koördinate van die grafiek gekies.*

$R_B = \frac{2,2}{0,4}$ ✓ $= 5,5\ \Omega$✓

$E = I^2 R\Delta t$✓

For the same time and current, the heating in A will be higher because its resistance is higher than that of B. ✓

(8)

4.2.1

OPTION 1/*OPSIE 1*	OPTION 2/*OPSIE 2*
$I_{5,5\Omega} : I_{11\Omega}$ 2 : 1 $I_{5,5\Omega}$ = (0,2)(2) ✓✓ = 0,4 A✓	V = IR $V_{11\ \Omega}$ = 0,2 x 11 =2,2 V✓ $V_{5,5}$ = V_{11} = 2,2 V✓ $I_{5,5} = \frac{2,2}{5,5}$ = 0,4 A✓ (3)

4.2.2

OPTION 1/OPSIE 1	OPTION 2/*OPSIE 2*
V = IR I_{tot} = (0,4 + 0,2) ✓ = 0,6 A $\frac{1}{R_p}=\frac{1}{R_1}+\frac{1}{R_2}+...$ ✓ $\frac{1}{Rp}=\frac{1}{11}+\frac{1}{5,5}$ ✓ R_P = 3,67 Ω $R_T = R_P + R_A$ = 3,67 + 11✓ =14,67Ω ε = I(R + r) ✓ 9 = 0,6(14,67 +r) ✓ r = 0,33 Ω ✓	I_{tot} = (0,4 + 0,2) ✓ = 0,6 A $V_{ext} = V_{11\ \Omega} + V_{//}$ ✓ = [I_{tot} (R_{11}) + 2,2] = 0,6 (11) ✓ + 2,2 = 8,8V✓ ε = V_{ext} + I_{tot}(r) ✓ 9 = 8,8 + 0,6r✓ r = 0,33 Ω✓

(7)

4.2.3 Decrease ✓ The total resistance increases. ✓ (2)

QUESTION 6

6.1 Temperature ✓ (1)

6.2 $r = 3\ \Omega$ ✓✓ (2)

6.3 **Any correct values from the graph**

OPTION 1	OPTION 3
ε = slope (gradient) of the graph ✓ $\varepsilon = \frac{7{,}5-(-3)}{1{,}5-0}$ ✓ = 7 V ✓	ε = I(R + r) ✓ = 0,5(11 + 3) ✓ ε = 7 V ✓

(3)

[6]

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2025 SPRING CLASSES

ACTIVITY SOLUTIONS

ELECTROCHEMICAL REACTIONS

GALVANIC CELL SOLUTIONS

ACTIVITY 1

1.1 **Chemical** (potential) energy to **electrical** energy.✓✓ (2)

1.2 Aℓ|$A\ell^{3+}$||Ni^{2+}|Ni✓ Anode; Salt bridge;✓ Cathode✓ (3)

(If include 'balancing co-efficients' (**2**Aℓ &**3**Ni) -1)

1.3 9.3.1 Oxidation is loss of electrons✓ (2)
9.3.2 Oxidizing agent is an electron acceptor✓ (2)

1.4 Ni^{2+} ✓ (1)

1.5 E^ocell = E^ocathode – E^oanode ✓ Any Relevant Formula
= –0, 25 – (–1, 66) ✓
E^ocell = 1, 41 V✓ (3)

1.6 1.6.1 Decreases✓ (1)
1.6.2 Decreases (to zero)✓ (1)

1.7 1.7.1 No effect✓ (1)
1.7.2 Decreases✓ (1)
1.7.3 Increases✓ (1)

1.8 1.8.1 $n = \frac{m}{M} = \frac{1,77}{59}$ ✓= **0,03mol**✓ (2)

1.8.2 Aℓ: Ni
2: 3
0, 02: 0, 03 ✓
Mass of Aℓ = n × M
= 0, 02 × 27✓
= 0, 54 g✓ (3)

1.9 3 Mg (s) + $2A\ell^{3+}$(aq) ✓→ 3 Mg^{2+}+ 2Aℓ(s) ✓ Bal✓ (3)

[26]

ACTIVITY 2

2.1 Galvanic✓ (1)

2.2 $Cr_2(SO_4)_3$✓ (1)

2.3 2.3.1 $Cu_2^+ + 2e^- \rightarrow Cu$✓✓ (2)
2.3.2 Cr OR chromium✓ (1)
2.3.3

- The chromium anode will corrode (OR lose mass OR disintegrate) ✓

- The green colour of the electrolyte will intensify (OR darken) ✓ (2)

2.4 $3Cu^{2+} + 2Cr \rightarrow 3Cu + 2Cr^{3+}$
LHS ✓
RHS ✓
Balancing✓ (3)

2.5 2.5.1 $E^0_{cell} = E^0_{cathode} - E^0_{anode}$✓
E^0_{cell} = (+0,34) – (-0, 74) ✓
E^0_{cell} = 1, 08V✓ (3)

2.5.2 Stress: an increase in the concentration of Cu^{2+}✓

- Le Châtelier's principle predicts the system will respond in order to decrease the concentration of Cu_2^+
- This would result in the forward reaction being (initially) favoured as the forward reaction consumes Cu_2^+ ✓
- Causing the initial emf to increase ✓ (3)

2.6 2.6.1 KNO_3✓ (1)
2.6.2 Cr^{3+} ions are being produced (OR the concentration of Cr^{3+} ions is increasing) ✓

- This causes anions (e.g. NO_3^- ions) migrating out of the salt bridge into the electrolyte ✓
- and cations (Cr^{3+} ions) migrating into the salt bridge out of the electrolyte ✓
(3)

2.7 Cr(s) | Cr^{3+}(aq, 1 mol·dm^{-3}) || Cu^{2+}(aq, 1 mol·dm^{-3}) | Cu(s) at 25 °C

Oxidation half-cell ✓
Reduction half-cell ✓
Salt bridge ✓
Phase indicators ✓
Conditions✓ (5)
[25]

ACTIVITY 3

3.1 The anode is the electrode where oxidation takes place. ✓✓ (2)

3.2 Nickel since it has gained mass reduction has taken place here. ✓✓ (2)

3.3 $Ni^{2+} + 2e^- \rightarrow Ni$ ✓ ✓ (–1 per error; single arrow)
(No c.o.e. from Question 7.2) (2)

3.4 E°cell = E°cathode – E°anode ✓
0,93 = –0,25 – E°x ✓
E°x = –1,18 V ✓

Therefore, metal X = **Mn** (Manganese) ✓ (4)

3.5 $Mn/Mn^{2+}//Ni^{2+}/Ni$ **OR** $X/X^{2+}//Ni^{2+}/Ni$ anode✓ salt bridge✓ cathode✓ (3)

3.6 7.6.1 A concentrated solution is more conductive, therefore, it lowers the internal resistance and increase the ability of the cell to deliver current. ✓✓ (2)

3.6.1 The **balance between positive and negative ions in the solution** is maintained so that overall, the solution is neutral (uncharged). ✓✓ (2)

3.6.2 K^+ ions are a weak(er) oxidising agent (than Ni^{2+} ions) therefore, they will not be reduced at the cathode. ✓✓
Fe^{3+} ions are a strong(er) oxidising agent (than Ni^{2+} ions) therefore they will be reduced at the cathode. ✓
OR
In the anode half-cell Fe^{3+} ions are a stronger oxidising agent than Mn^{2+} ions, therefore Fe^{3+} ions will be reduced by Mn, which will oxidise. (3)

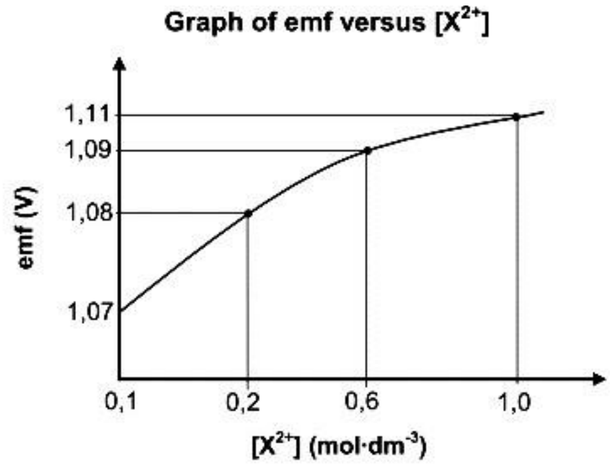
[19]

Activity 4

The electrochemical cell represented by the cell notation below is used to investigate the relationship between the concentration of X^{2+}(aq) and the emf of the cell. The concentration of Zn^{2+}(aq) and the temperature are kept at standard conditions.

$Zn(s) \mid Zn^{2+}(aq) \mid\mid X^{2+}(aq) \mid X(s)$

The graph shows the results obtained :



4.1 For this investigation, write down the:

4.1.1 Dependent variable (1)

Answer: *Emf* ✓

4.1.2 Name of an instrument needed to measure the emf of the cell (1)

Answer: *Voltmeter/Multimeter* ✓

4.1.3 Name of the component of the cell that ensures electrical neutrality (1)

Answer: *Salt bridge* ✓

4.1.4 Values of TWO standard conditions needed to ensure that the standard emf is obtained (2)

Answer: *Temperature: 25 °C / 298 K* ✓ *AND Concentration: 1 mol·dm^{-3}* ✓

4.2 Write down the conclusion that can be drawn from the results. (2)

Answer: *Example - Emf increases as concentration increases.*

<u>*Marking criteria*</u>

- *Dependent and independent variables correctly identified.* ✓
- *Relationship between the independent and dependent variables correctly stated.* ✓

4.3 Identify electrode **X** with the aid of a calculation. (5)

Answer: *E^0 cell = E^0 reduction - E^0 oxidation*✓ ∴1,11 ✓ = EX/ X^{2+} - (- 0,76) ✓

∴$E^{\theta}_{X/X^{2+}}$= 0,35 (V) ✓ X = Copper / Cu ✓

4.4 Write down the overall (net) cell reaction that takes place when this cell is in operation. (3)

Answer: Cu^{2+}(aq) + Zn(s) ✓ → Zn^{2+}(aq) + Cu(s) ✓ Bal. ✓ (3)

[15]

ELECTROLYTIC CELLS

QUESTION 1

1.1 Electro-refining / Electro-winning / Electrolytic refinement. ✓ (1)

1.2 $Cu^{2+} + 2e^{-} \rightarrow Cu$ ✓✓ (2)

1.3 1.3.1 Cu is a stronger reducing agent than water thus will be preferentially oxidised. ✓✓ (2)

OR

Cu has a lower reduction potential than water, this preferentially oxidised

NOT ACCEPTING: H_2O is a stronger oxidising agent

Referring to position on table

Will not be spontaneous due to the "C"

1.3.2 Fe and Zn have a more negative half cell potential compared to potential difference (0,34V) applied. ✓

Fe and Zn will thus be oxidised. ✓

Au and Ag have a more positive half cell potential compared to the potential difference – cannot be oxidised. ✓

(3)

ACCEPT: Fe and Zn half cell potential less than 0,34V, Au and Ag half cell potential greater than 0,34 – thus Zn and Fe will be oxidised

Fe and Zn are stronger reducing agents than Au and Ag, therefore it takes lower voltages for them to oxidise. The applied potential of 0,34V is sufficient for Fe and Zn to be oxidised (insufficient for Ag and Auto oxidise)

1.3.3 Fe^{2+} and Zn^{2+} are weaker oxidising agents than Cu^{2+}. ✓✓ OR

Cu^{2+} is a stronger oxidising agent than Fe^{2+} and Zn^{2+}
(2)

1.3.4 $Cu^{2+} + Cu \longrightarrow Cu + Cu^{2+}$ ✓✓

OR

$CuSO_4$ + Cu

$\longrightarrow$ Cu + $CuSO_4$

OR

Cu (impure) → Cu (pure) (2)

[11]

ACTIVITY 2

2.1 2.1.1 Electrolyte√ (1)

2.1.2 Electrolytic (cell)√ (1)

2.2 A to B √ (1)

2.3 2.3.1 B√ (1)

2.3.2 A√ (1)

2.4 Decreases√

Copper (Cu) is oxidized to Cu^{2+}/Oxidation takes place at A/Electrons are lost.√
(2)

2.5.1 Electroplating✓ (1)

2.5.2 Cathode✓ (1)

2.5.3 Ag^+ is a much stronger ✓oxidizing agent than water ✓meaning Ag^+ will be reduced predominantly ✓ (3)

2.5.4 Silver✓ (1)

[13]

ACTIVITY 3

3.1 A solution that conducts electricity through the movement of ions. ✓✓ (2)

3.2 $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$ ✓✓ (2)

3.3 Chlorine gas / $C\ell_2$ ✓ (1)

3.4 H_2O is a stronger oxidising agent ✓ than Na^+ and will be reduced ✓ to H2 (2)

[7]