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One-step electrodeposition of Cerium-doped nickel hydroxide nanosheets for effective oxygen generation

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Electronic Supplementary Information (ESI)

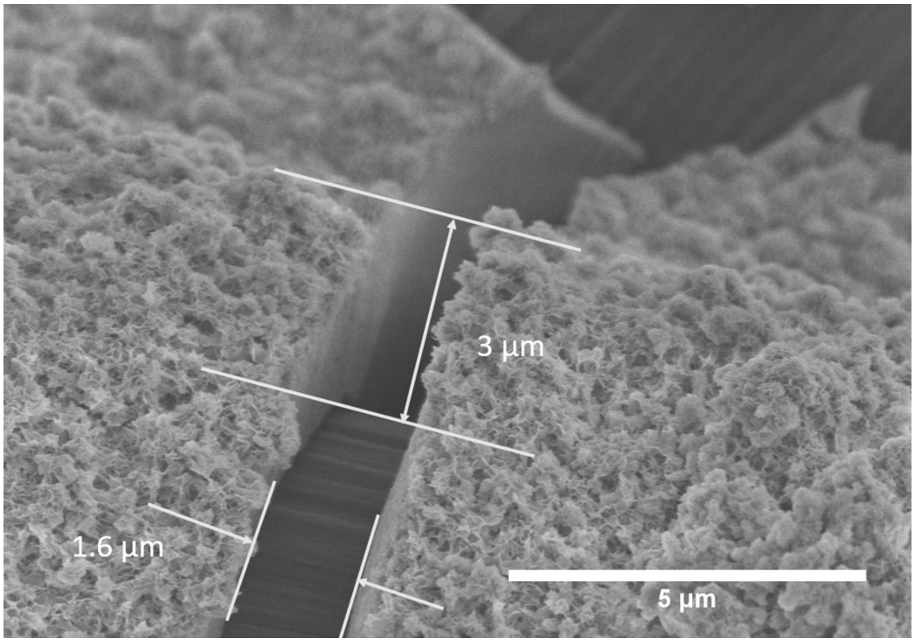
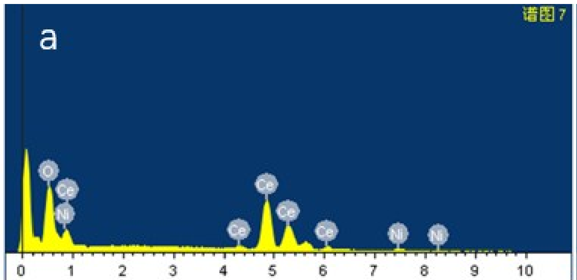
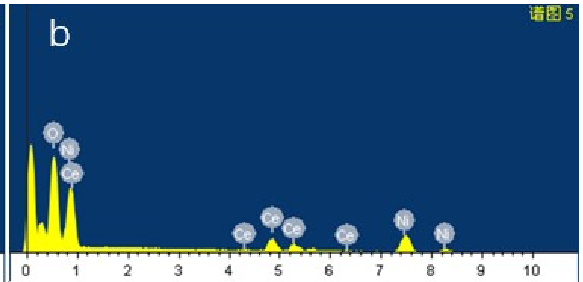


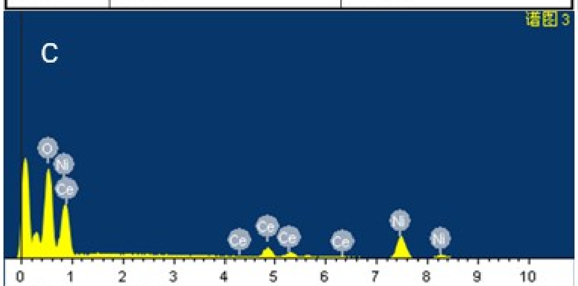
Figure S1. SEM images of $Ni(OH)_2 \cdot 0.75H_2O$-CeO_2 NSs.



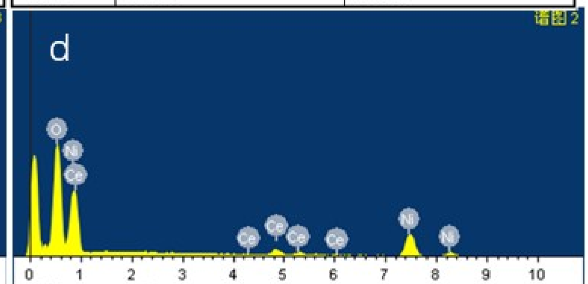
Element	Weight percentage (%)	Atomic percentage (%)
O K	**25.85**	**74.29**
Ni K	**3.03**	**2.37**
Ce L	**71.12**	**23.34**
Total	**100.00**	**100.00**



Element	Weight percentage(%)	Atomic percentage(%)
O K	**42.85**	**78.18**
Ni K	**34.33**	**17.07**
Ce L	**22.81**	**4.75**
Total	**100.00**	**100.00**



Element	Weight percentage (%)	Atomic percentage (%)
O K	**40.71**	**75.00**
Ni K	**42.96**	**21.57**
Ce L	**16.33**	**3.43**
Total	**100.00**	**100.00**



Element	Weight percentage (%)	Atomic percentage (%)
O K	**45.52**	**77.45**
Ni K	**44.43**	**20.60**
Ce L	**10.04**	**1.95**
Total	**100.00**	**100.00**

Figure S2. EDX spectrum and element content of (a) $Ni(OH)_2 \cdot 0.75H_2O$-CeO_2(2.5:1), (b) $Ni(OH)_2 \cdot 0.75H_2O$-CeO_2(10:1), (c) $Ni(OH)_2 \cdot 0.75H_2O$-CeO_2(30:1), and (d) $Ni(OH)_2 \cdot 0.75H_2O$-CeO_2(40:1).

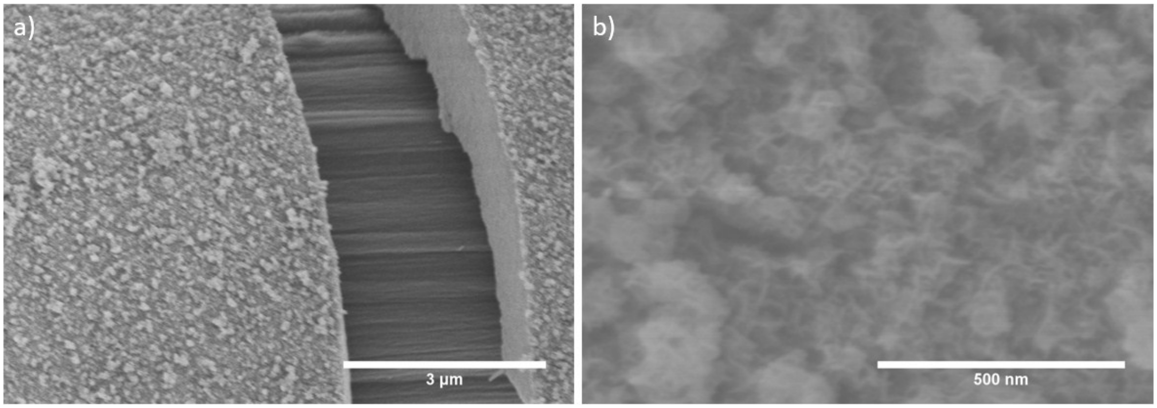


Figure S3. SEM images of $Ni(OH)_2 \cdot 0.75H_2O$ NSs.

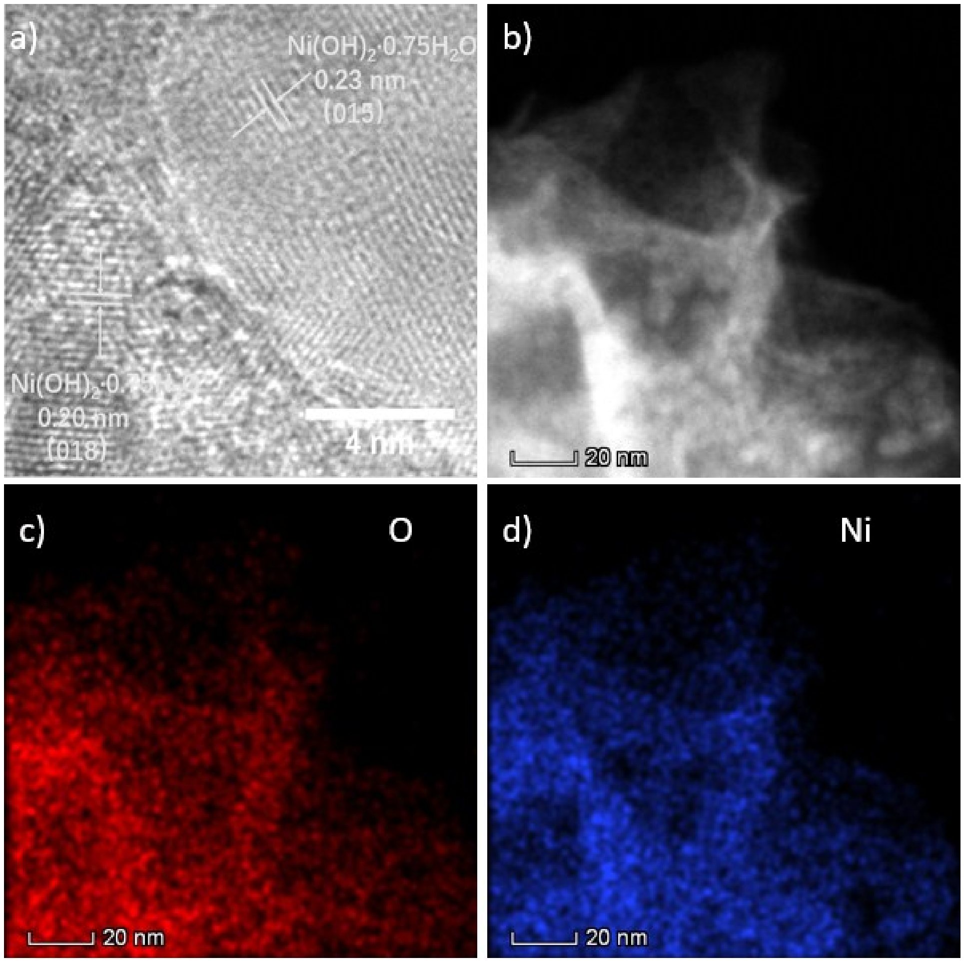


Figure S4. (a) HRTEM images of $Ni(OH)_2{\cdot}0.75H_2O$, (b) Dark-field STEM image of $Ni(OH)_2{\cdot}0.75H_2O$ and corresponding elemental mapping images of (c) O, (d) Ni.

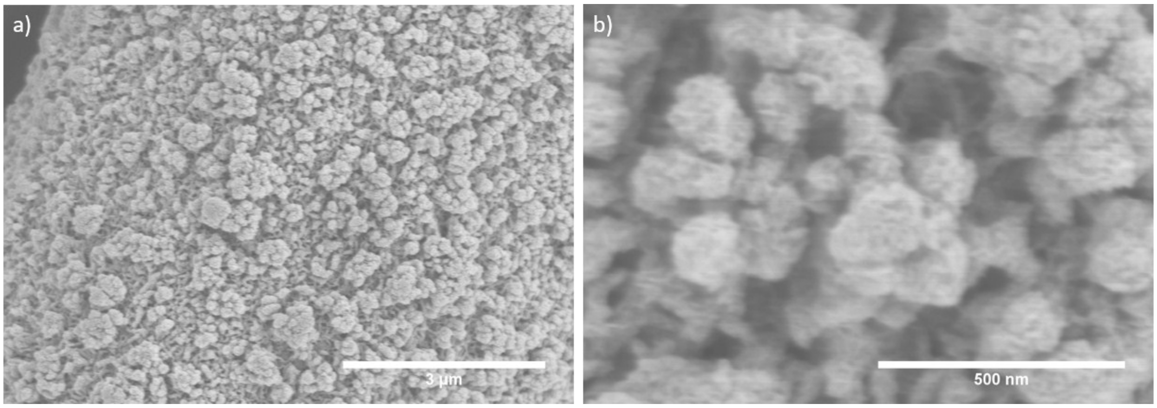
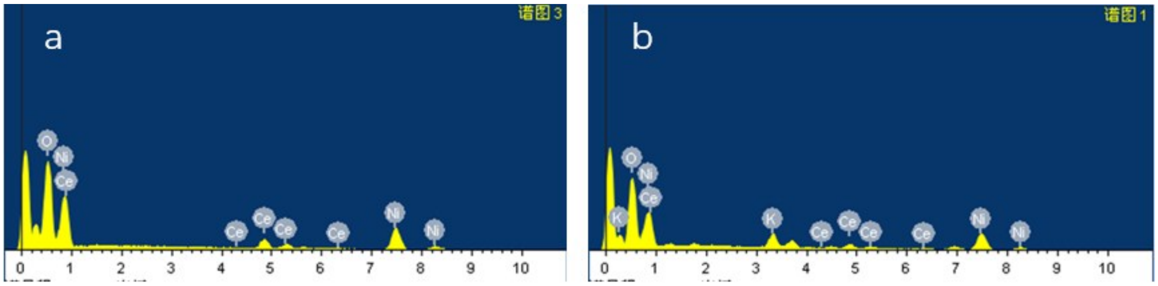


Figure S5. (a, b) SEM images of $Ni(OH)_2 \cdot 0.75H_2O$-CeO_2(30:1) NSs subjected to long-term potentiostatic electrolysis.



Element	Weight percentage (%)	Atomic percentage (%)
O K	**40.71**	**75.00**
Ni K	**42.96**	**21.57**
Ce L	**16.33**	**3.43**
Total	**100.00**	**100.00**

Element	Weight percentage (%)	Atomic percentage (%)
O K	**42.52**	**73.98**
K K	**6.05**	**4.32**
Ni K	**41.70**	**19.77**
Ce L	**9.73**	**1.93**
Total	**100.00**	**100.00**

Figure S6. EDX spectrum and element content of (a) $Ni(OH)_2 \cdot 0.75H_2O$-CeO_2(30:1), (b) $Ni(OH)_2 \cdot 0.75H_2O$-CeO_2(30:1) subjected to long-term potentiostatic electrolysis.

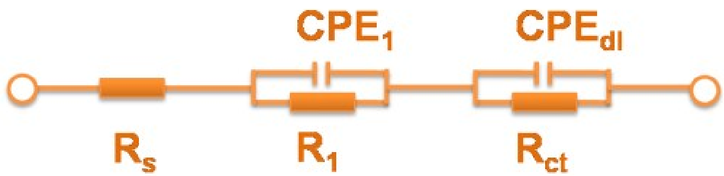


Figure S7. Equivalent circuit used to fit the EIS data. R_0 is series resistance, CPE_1 and R_1 are the constant phase element and the resistance describing electron transport at the substrate/catalyst interface, respectively, CPE_{dl} is the constant phase element of the catalyst/electrolyte interface, and R_{ct} is the charge-transfer resistance at the catalyst/electrolyte interface.

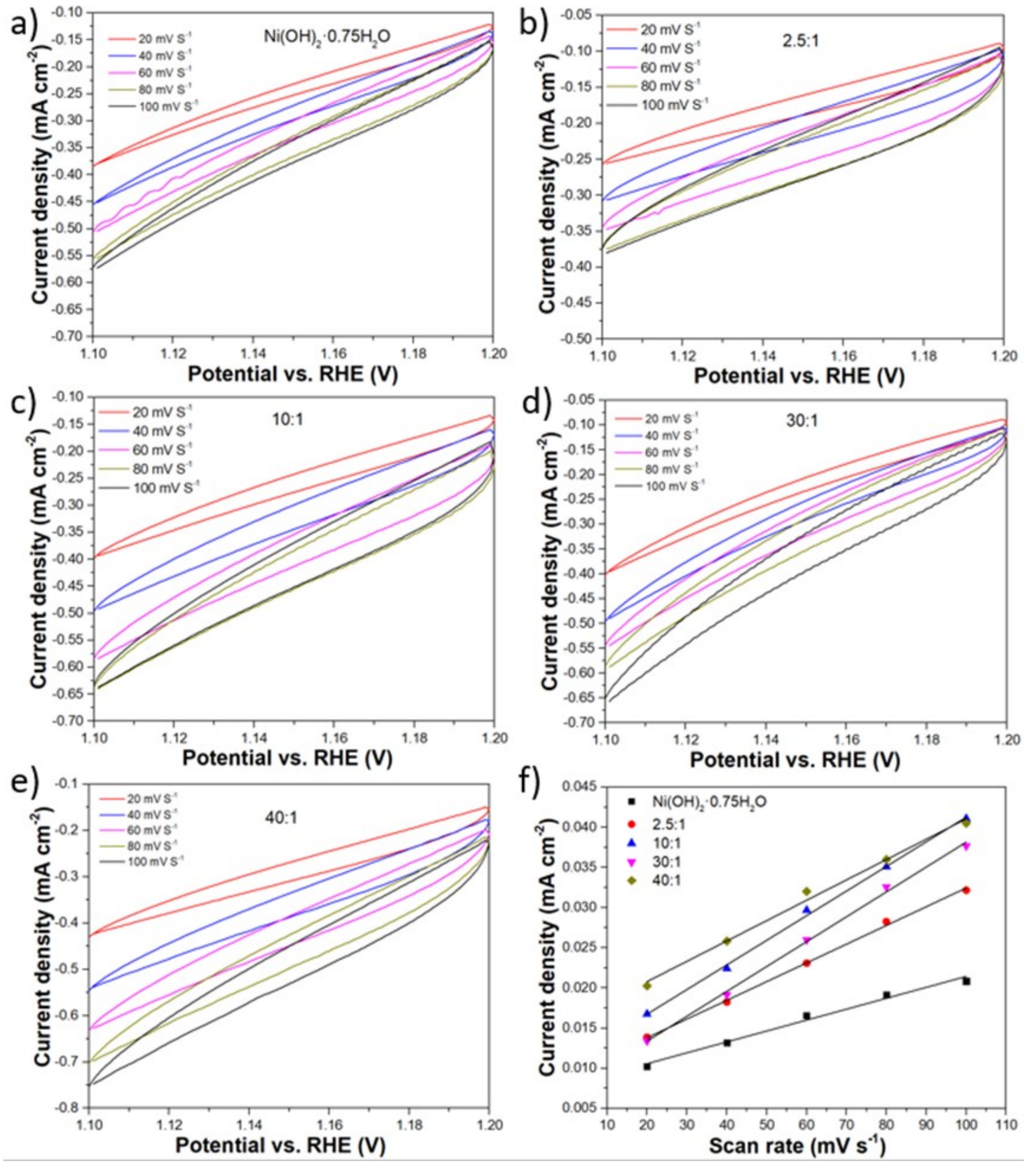


Figure S8. (a, b, c, d, and e) CV of $Ni(OH)_2 \cdot 0.75H_2O$, $Ni(OH)_2 \cdot 0.75H_2O$-CeO_2(2.5:1), $Ni(OH)_2 \cdot 0.75H_2O$-CeO_2(10:1), $Ni(OH)_2 \cdot 0.75H_2O$-CeO_2(30:1), and $Ni(OH)_2 \cdot 0.75H_2O$-CeO_2(40:1) measured with different scan rates. (f) the measured capacitive currents plotted as a function of scan rate.

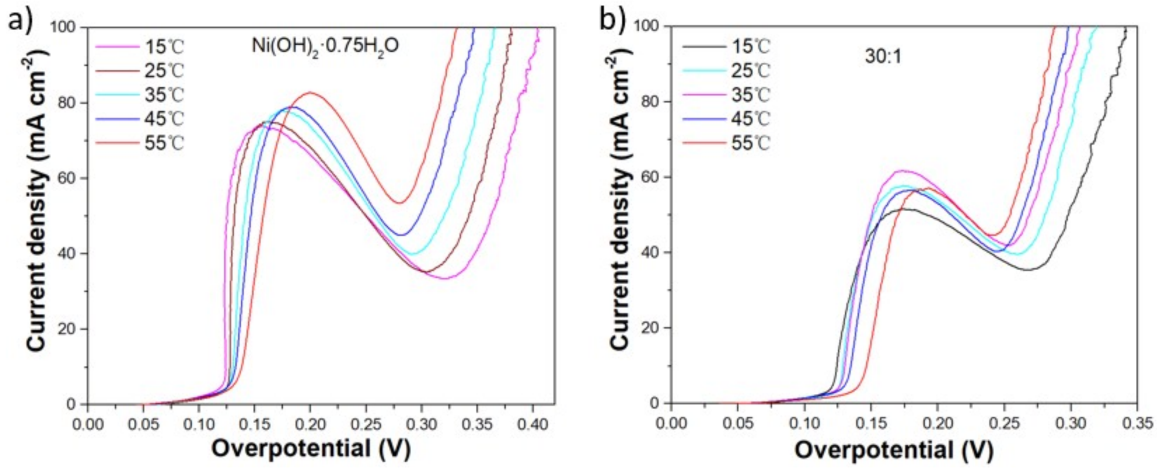


Figure S9. Temperature dependent polarization curves of (a) $Ni(OH)_2 \cdot 0.75H_2O$ and (b) $Ni(OH)_2 \cdot 0.75H_2O$-CeO_2(30:1).

Table S1. Composition determined by ICP of synthesized catalysts.

Method: Weigh a certain amount of sample, add 10ml of aqua regia, heat the plate to heat digestion at about 200 degrees, add aqua regia when steaming dry, the general digestion time is 3-4 h, then filter out the carbon fiber paper. Dilute the solution and determine the volume, and then perform ICP analysis.

Sample(3 cm^2)	The sample quantity(g)	Volume of digestion liquid(mL)	Concentration of Ni in digestion liquid(mg/L)	Concentration of Ce in digestion liquid(mg/L)	Dilution ratio	Atomic ratio of Ni:Ce	Mass loading (mg cm^{-2})
$Ni(OH)_2 \cdot 0.75H_2O$-CeO_2 NSs (2.5:1)	0.0834	25	2.89	6.29	100	1.1:1	6.8
$Ni(OH)_2 \cdot 0.75H_2O$-CeO_2 NSs (10:1)	0.0728	25	1.62	1.70	100	2.27:1	4.2
$Ni(OH)_2 \cdot 0.75H_2O$-CeO_2 NSs (30:1)	0.0782	25	3.05	2.80	100	2.6:1	7.5
$Ni(OH)_2 \cdot 0.75H_2O$-CeO_2 NSs (40:1)	0.0796	25	2.80	1.63	100	4.1:1	5.9
$Ni(OH)_2 \cdot 0.75H_2O$ NSs	0.0815	25	3.53	0	100	---	5.3

Table S2. Performance of typical reported cerium doped OER electrocatalysts in alkaline media.

Electrocatalysts	**η_{10} (mV)**	**η_{20} (mV)**	**η_{100} (mV)**	**Tafel slope (mV dec^{-1})**	**Electrolyte (M KOH)**
$Ni(OH)_2 \cdot 0.75H_2O$-CeO_2 (This work)			320	126	1.0
$CeO_2/CoSe_2$[1]	288	324		41	0.1
Ce-NiO-E[2]	382			118.7	1.0
Ce-NiO-L[2]	426			131.6	1.0
Ni_4Ce_1-CP[3]	220			81.9	1.0
$NiFeO_xH_y$[4]	207			25	1.0
$NiFeO_xH_y$/G[4]	177			22	1.0
$NiCeO_x$–Au[5]	290			-	1.0
CeO_2/FeOOH HLNTs-NF[6]			330	92.3	1.0
CoO_x(Ce)[7]	229	261	302	63.7	1.0

Table S3. Values of equivalent circuit elements resulted from fitting of EIS data.

Sample	R_s (Ω)	Q_1 (F cm^{-2} S^{n-1})	n_1	R_1 (Ω)	Q_{dl} (F cm^{-2} S^{n-1})	n_{dl}	R_{ct} (Ω)
$Ni(OH)_2{\cdot}0.75H_2O$	2.844	0.6394	0.9857	4.828	0.7936	0.3966	1.317
2.5:1	2.674	0.1635	0.6863	3.631	0.0468	0.3325	1.177
10:1	3.133	0.749	0.793	1.784	0.4334	0.1924	0.928
30:1	2.853	0.7328	0.9598	1.678	0.6619	0.3177	0.8654
40:1	3.395	0.6881	0.9581	2.383	0.294	0.4829	0.948

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