Score:\_\_\_\_\_\_\_/15

Student Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Teacher Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Nickel – Hydrogen Battery WSHS A Secondary Cell: Validation Assessment ‘21**

**Instructions to students:**

1. Answer **ALL** the questions below in the spaces provided.

2. Show full working out for your answers and for calculations express your answer to appropriate number of significant figures.

The major electrode reactions during the **discharge** process of Nickel - Hydrogen battery are listed:

**Cathode:** NiOOH(s) + H2O (l) + e- Ni(OH)2 (s) + OH- (aq)

**Anode**: H2(g) + 2 OH- (aq) 2 H2O (l) + 2e-

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| Q1. Why is it necessary to have energy storage cells such as nickel-hydrogen battery abroad the International Space Station? (1mark)  **The international Space Station gets energy from the Sun when it can, however, sometimes it is in darkness, so cells are needed to store energy that can be used during ‘DARK’ times.** (1 mark) |
| Q2. What is the oxidation number of nickel in: (2 marks)  (a) NiOOH **O. N. of Ni = +3** (1 mk)  (b) Ni(OH)2 **O.N. of Ni = +2** (1 mk) |
| Q3. Write a balanced redox equation for the **recharge** process. Show working out.  (2 marks) |
| Cathode [ Ni(OH)2 (s) + OH- (aq) NiOOH(s) + H2O (l) + e-] x2  Anode [ 2 H2O (l) + 2e-  H2(g) + 2 OH- (aq) ]  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  2 Ni(OH)2 (s) + 2OH- (aq) + 2H2O (l) 2NiOOH(s) + 2H2O + H2 (g)+ 2 OH- (aq)  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  net overall  **2 Ni(OH)2 (s) 2 NiOOH (s) + H2 (g)**    **(2 marks) if the equations are written for recharging and 1 mark if wriiten as discharging.** |
| Q4. The engineers who designed the battery decided that it would be more efficient if the KOH electrolyte was 35.0 % mass/mass (m/m) so that 80.0 mL of the solution has a mass of 88.3 g.  What is the concentration of the electrolyte solution, in mol L-1 . (4 marks)  M(KOH) = 56.108 g/mol  Actual mass (KOH) = (35/100 ) x 88.3 g = 30.90 g (1 mk)    n = m/M = 30.90 / 56.108 = 0.5508 moles (1 mk)  c [ KOH] solution = n / v = 0.5508 mols / 0.0800 L = 6.885 mols L-1(1 mk)  c [ KOH] solution = **6.89 mols L-**1 (1 mk)  minus **(1 mk)** if answer **not** expressed to **3 sig figs**. |
| Q5. Explain how the concentration of the electrolyte changes during the recharging process. (2 marks)  **The concentration of the electrolyte does NOT change.** (1 mk)  **Although OH- ions are consumed at the anode, they are also produced simultaneously at the cathode** (1 mk) |
| Q6. How would the pressure inside the cell change during recharging? (2 marks)    **During recharging H2 gas is produced which increases the pressure** (1mk)  **As more hydrogen frequency gas molecules collisions increase with the container wall thereby increasing the partial pressure of hydrogen gas.**  (1 mk) |
| Q7. State one advantage and one disadvantage of this cell. (2marks)  Advantages: **long life, high energy density, non – hazardous** (1 mk for any)  Disadvantage: **Expensive** (1 mk)  **CHEMISTRY 12 END OF VALIDATION ASSESSMENT 2021** |
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