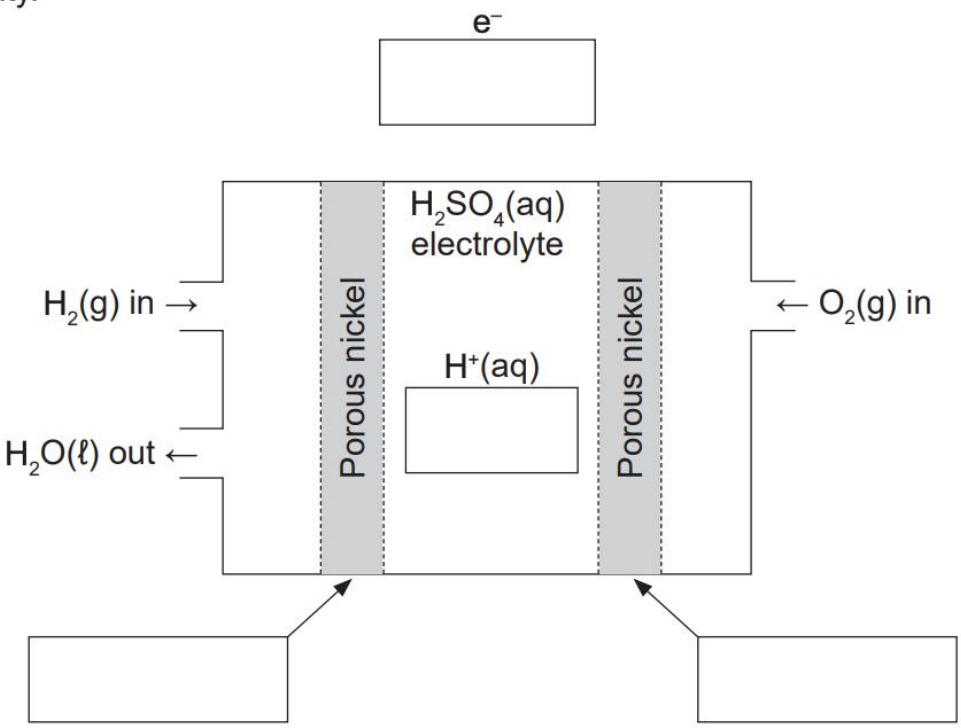
Question 30 **(10 marks)**

Fuel cells, such as the one shown in the diagram below, use gaseous hydrogen and oxygen to produce electricity.



In this particular fuel cell, which uses sulfuric acid as the electrolyte, the hydrogen and oxygen are circulated at very high pressure over porous nickel-platinum electrodes. Operating temperatures range from 25 to 90 °C.

(a) Complete the above diagram by adding labels/arrows to show the:

- anode
- cathode
- direction of electron flow
- direction of hydrogen ion flow. (4 marks)

(b) Write balanced half-equations for the oxidation and reduction reactions and the equation for the overall reaction occurring in this fuel cell. (4 marks)

Oxidation half-reaction	
Reduction half-reaction	
Overall redox reaction	

(c) This fuel cell typically produces 0.7 V, which is significantly less than the predicted value of 1.23 V. State **two** specific conditions of this cell that would account for this observation. (2 marks)

One: _____

_____

Two: _____

_____