HL Paper 3 Section A Experimental work (9)

Manganese is above zinc in the activity series. The total electromotive force (EMF) produced by connecting a $Zn(s)/Zn^{2+}(aq)$ half-cell to a $Mn(s)/Mn^{2+}(aq)$ half-cell operating under standard conditions is 0.42 V.

(a) Draw a clearly labelled diagram showing the apparatus and chemicals you could use in a school laboratory to confirm this information Your diagram should also show the direction of flow of electrons in the external circuit. (Upload your answer as an image or as a pdf file). ***[3]***

(b) You are provided with a piece of cobalt and a molar aqueous solution of cobalt nitrate, $Co(NO_3)_2$. Describe how you could determine practically without using a voltmeter whether the standard electrode potential for the $Co(s)/Co^{2+}(aq)$ half-cell is more negative or more positive than either or both of the two half-cells used in **(a)**. ***[2]***

(c) When a voltmeter is used the potential difference between a $Co(s)/Co^{2+}(aq)$ half-cell and a $Mn(s)/Mn^{2+}(aq)$ half-cell is found to be 0.90 V and the potential difference between a $Co(s)/Co^{2+}(aq)$ half-cell and a $Zn(s)/Zn^{2+}(aq)$ half-cell is found to be 0.48 V.
Determine the standard electrode potential of the $Co(s)/Co^{2+}(aq)$ half-cell using information given in Section 24 of the data booklet. ***[1]***