**Balancing redox reactions in acidic conditions**

For the following reactions use the four steps to write balanced half equations then combine these to give a balanced overall equation. For the equations shown in bold also give the colour and state of all reaction species.

**The four steps:**

1. Balance atoms other than hydrogen and oxygen
2. Add water molecules to balance oxygens
3. Add protons (H+) to balance hydrogen atoms
4. Add electrons to the more positive side to balance charge

**Reactions:**

1. **Cr2O72- + Fe2+ 🡪 Cr3+ + Fe3+**
2. **MnO4- + I- 🡪 Mn2+ + I2**
3. **H2O2 + I- 🡪 I2 + H2O**
4. **H2O2 + MnO4- 🡪 Mn2+ + O2**
5. **Cr2O72- + SO2 🡪 Cr3+ + SO42-**
6. Mn2+ + BiO3- 🡪 MnO4- + Bi3+
7. ClO3- + Cl- 🡪 Cl2 + ClO2
8. P + Cu2+ 🡪 Cu + H2PO4-
9. PH3 + I2 🡪 H3PO2- + I-
10. NO2 🡪 NO3- + NO
11. NO + O2 🡪 NO2
12. Cu + HNO3 🡪 Cu2+ + NO2

**Balancing redox reactions in acidic conditions**

For the following reactions use the four steps to write balanced half equations then combine these to give a balanced overall equation. For the equations shown in bold also give the colour and state of all reaction species.

**The four steps:**

1. Balance atoms other than hydrogen and oxygen
2. Add water molecules to balance oxygens
3. Add protons (H+) to balance hydrogen atoms
4. Add electrons to the more positive side to balance charge

**Reactions:**

1. **Cr2O72- + Fe2+ 🡪 Cr3+ + Fe3+**
2. **MnO4- + I- 🡪 Mn2+ + I2**
3. **H2O2 + I- 🡪 I2 + H2O**
4. **H2O2 + MnO4- 🡪 Mn2+ + O2**
5. **Cr2O72- + SO2 🡪 Cr3+ + SO42-**
6. Mn2+ + BiO3- 🡪 MnO4- + Bi3+
7. ClO3- + Cl- 🡪 Cl2 + ClO2
8. P + Cu2+ 🡪 Cu + H2PO4-
9. PH3 + I2 🡪 H3PO2- + I-
10. NO2 🡪 NO3- + NO
11. NO + O2 🡪 NO2
12. Cu + HNO3 🡪 Cu2+ + NO2