$R_{OYGBIV}$ +   $\boxed{\frac{18}{32}}$ 56%

1. Find the oxidation numbers of the underlined element. [6 marks]

(a) $Na_2\underline{S}O_3$  4 ✓

(d) $\underline{P}_2O_5$  5 ✓

(b) $\underline{N}_2O$  1 ✓

(e) $\underline{C}_2O_4{}^{2-}$  3 ✓

**5**

(c) $\underline{Cr}(OH)_3$  3 ✓ -3

(f) $\underline{I}O_3^-$
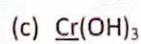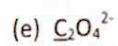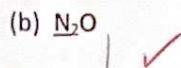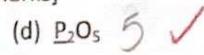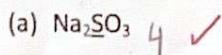
~~+6~~ ✗  $x + 3(-2) = -1$

2. Label the following changes as oxidation, reduction or neither. [4 marks]

(a) $\overset{+4}{N}O_2 \rightarrow \overset{+5}{N}O_3^-$  from lower→higher # = e⁻ loss

reduction ✗  oxidation

(c) $Cr_2O_7{}^{2-} \rightarrow CrO_4{}^{2-}$  LEO

neither ✓  GER

(b) $MgO \rightarrow Mg$

+2 neither ✗ reduction

0

(d) $2I^- \rightarrow I_2$
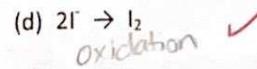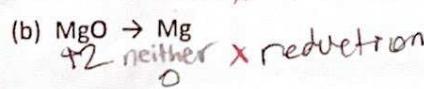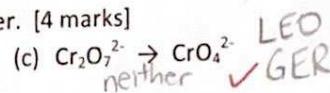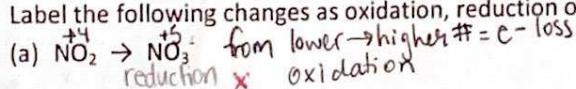
oxidation ✓

3. For the following reaction, $\overset{0}{Ca(s)} + 2\overset{+1\,+5\,-6}{HNO_3(aq)} \rightarrow \overset{0}{H_2(g)} + \overset{+2\,+5\,-2}{Ca(NO_3)_2(aq)}$,

(a) write out the net ionic equation. [3 marks]

$Ca(s) + 2H^+_{NO_3}(aq) \rightarrow H_2(g) + Ca(NO_3)_2(aq)$

$Ca(s) + 2HNO_3(aq) \rightarrow H_2(g) + Ca(NO_3)_2(aq)$

$Ca(s) + 2H^+_{(aq)} + 2NO_3^-_{(aq)} \rightarrow H_2(g) + Ca^{2+}_{(aq)} + 2NO_3^-(aa)$
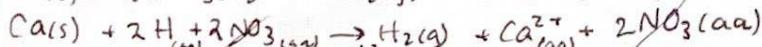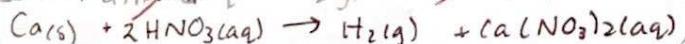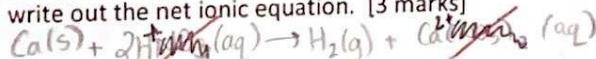
(b) indicate the spectator ion. [1 mark]

$H_2$ ✗ $Ca(s) + 2H^+(aq) \rightarrow H_2(g) + Ca^{2+}(aq) +$
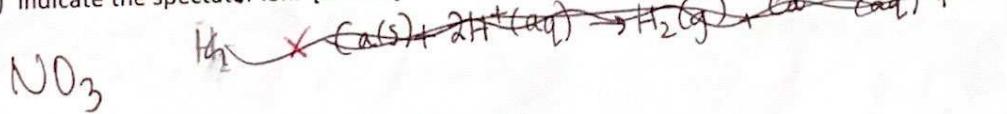
$NO_3$

(c) write out the oxidation half reaction. [2 marks]

$Ca^{(s)} \rightarrow Ca^{2+\,aq}(NO_3)_{2a}$  ✗ $+ 2e^-$
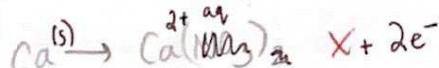
(d) write out the reduction half reaction. [2 marks]

$2HNO_3(aq) \rightarrow H_2(g)$ ✗ $2e^- + 2H^+(aq) \rightarrow H_2(g)$
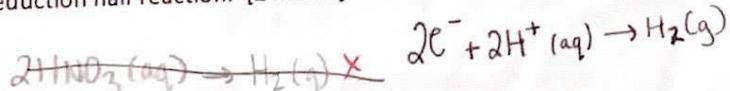
(e) write down the formula of the oxidizing agent. [1 mark]

$HNO_3(aq)$ ✗ $2H^+(aq)$
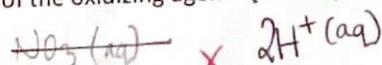
(f) write down the formula of the reducing agent. [1 mark]

$Ca(s)$ ✓
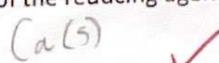
4. Balance the following equation in acidic solution, using the ~~ion-electron~~ method. [6 marks]

ox #

$$CH_3OH + MnO_4^- \rightarrow CH_2O + Mn^{2+}$$
$$-2+1-2+1 \quad 7-2 \quad 1-2 \quad +2$$

$$3CH_3OH + 2MnO_4^- \rightarrow 3CH_2O + 2Mn^{2+}$$

oxidized, 6e⁻ lost    reduction, 9e⁻ gained
$$7 \rightarrow 2$$

4

$$6e^- \times 3 = 18$$
$$9e^- \times 2 = 18$$

$$= 16H^+ + 5CH_3OH + 2MnO_4^- \rightarrow 5CH_2O + 2Mn^{2+} + 8H_2O$$
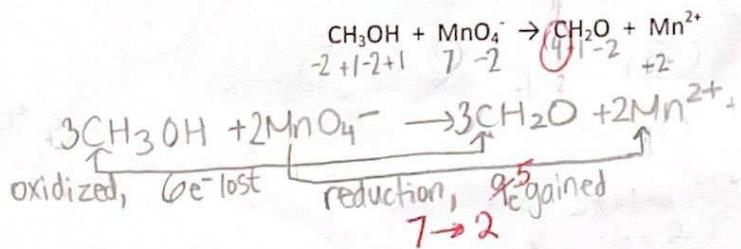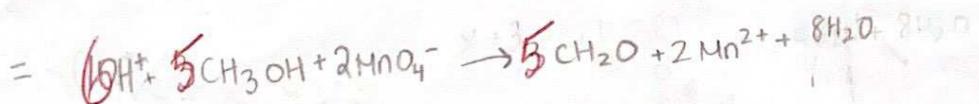
5. Balance the following equation in basic solution, using the ~~oxidation-number~~ method. [6 marks]

ion-e⁻

$$CN^- + IO_3^- \rightarrow CNO^- + I^-$$

$$IO_3^- \rightarrow I^- + 3H_2O$$

$$CN^- \rightarrow CNO^-$$

$$6H^+ + IO_3^- \rightarrow I^- + 3H_2O$$

$$2OH^- + H_2O + CN^- \rightarrow CNO^- + 2H^+ + 2OH^- + 2e^-$$

$$6e^- + 6OH^- + 6H^+ + IO_3^- \rightarrow I^- + 3H_2O + 6OH^-$$

$$\downarrow \times 1 \qquad\qquad \downarrow \times 3$$

$$6e^- + 6OH^- + 6H^+ + IO_3^- \rightarrow I^- + 3H_2O + 6OH^-$$

$$6OH^- + 3H_2O + 3CN^- \rightarrow 3CNO^- + 6H^+ + 6OH^- + 6e^-$$

$$6e^- + 6H_2O + IO_3^- \rightarrow I^- + 3H_2O + 6OH^-$$

$$6OH^- + 3H_2O + 3CN^- \rightarrow 3CNO^- + 6H_2O + 6e^-$$

$$6e^- + 6H_2O + IO_3^- + 6OH^- + 3H_2O + 3CN^- \rightarrow I^- + 3H_2O + 6OH^- + 3CNO^- + 6H_2O + 6e^-$$

$$\boxed{IO_3^- + 3CN^- \rightarrow I^- + 3CNO^-}$$