

# Dissolved Oxygen Analysis Log Sheet

Institute of Ocean Sciences  
Water Properties Group

Last Updated: July 2015



| Cruise and Analysis Information                                                |                                |  |  |  |  |  | Nisk ID | Nisk Int V | Nisk Int S | Sample ID | Flask 1 | Draw T 1 (°C) | OXY-1 (mL/L) | OXY-1 Comments | Nisk ID | Sample ID | Flask 2 | Draw T 2 (°C) | OXY-2 (mL/L) | OXY-2 Comments |
|--------------------------------------------------------------------------------|--------------------------------|--|--|--|--|--|---------|------------|------------|-----------|---------|---------------|--------------|----------------|---------|-----------|---------|---------------|--------------|----------------|
| Cruise Number:                                                                 | 2016-01                        |  |  |  |  |  | 1       |            |            | 1         | 3056    | 9.1           | 5.642        |                | 1       |           |         |               |              |                |
| Event:                                                                         | 002                            |  |  |  |  |  | 2       |            |            | 2         | 1059    | 9.2           | 5.642        |                | 2       |           |         |               |              |                |
| Station:                                                                       | HARD 59                        |  |  |  |  |  | 3       |            |            | 3         | 2059    | 9.2           | 5.644        |                | 3       |           |         |               |              |                |
| Event Date (Local):                                                            | 9 FEB 16                       |  |  |  |  |  | 4       |            |            | 4         | 2086    | 9.1           | 5.651        |                | 4       |           |         |               |              |                |
| Analysis Date (Local):                                                         | 9 FEB 16                       |  |  |  |  |  | 5       |            |            | 5A        | 3104    | 9.1           | 5.661        |                | 5       | 5B        | 2095    | 9.1           | 5.658        |                |
| Analyst:                                                                       | MB                             |  |  |  |  |  | 6       |            |            | 6         | 3035    | 9.1           | 5.651        |                | 6       |           |         |               |              |                |
| Stdization Date (Local):                                                       | 9 FEB 16                       |  |  |  |  |  | 7       |            |            | 7         | 3088    | 9.1           | 5.659        |                | 7       |           |         |               |              |                |
| KIO <sub>3</sub> N:                                                            | 0 0122010                      |  |  |  |  |  | 8       |            |            | 8         | 2080    | 9.1           | 5.642        |                | 8       |           |         |               |              |                |
| Standard Titer:                                                                | 0.5190                         |  |  |  |  |  | 9       |            |            | 9         | 2075    | 9.1           | 5.657        |                | 9       |           |         |               |              |                |
| Blank Titer:                                                                   | 0.0001                         |  |  |  |  |  | 10      |            |            | 10        | 2085    | 9.1           | 5.655        |                | 10      |           |         |               |              |                |
| THIO N:                                                                        | 0.23500                        |  |  |  |  |  | 11      |            |            | 11        | 2084    | 9.1           | 5.666        |                | 11      |           |         |               |              |                |
| Sample Flask                                                                   | Yes                            |  |  |  |  |  | 12      |            |            | 12        | 3029    | 9.1           | 5.668        |                | 12      |           |         |               |              |                |
| Water Seal?                                                                    | No                             |  |  |  |  |  | 13      |            |            | 13        | 1053    | 9.1           | 5.673        |                | 13      |           |         |               |              |                |
| Reagent Change?                                                                | MnCl <sub>2</sub>              |  |  |  |  |  | 14      |            |            | 14A       | 1002    | 9.1           | 5.671        |                | 14      | 14B       | 1054    | 9.1           | 5.673        |                |
| (Please circle reagent that was changed prior to sampling and standardization) | NaI/NaOH                       |  |  |  |  |  | 15      |            |            | 15        | 639     | 9.2           | 5.663        |                | 15      |           |         |               |              |                |
| NOTE NEW BATCH IN LOG BOOK                                                     | H <sub>2</sub> SO <sub>4</sub> |  |  |  |  |  | 16      |            |            |           |         |               |              |                | 16      |           |         |               |              |                |
|                                                                                | KIO <sub>3</sub>               |  |  |  |  |  | 17      |            |            |           |         |               |              |                | 17      |           |         |               |              |                |
|                                                                                | THIO                           |  |  |  |  |  | 18      |            |            |           |         |               |              |                | 18      |           |         |               |              |                |
| Notes:                                                                         | OCTOPUS                        |  |  |  |  |  | 19      |            |            |           |         |               |              | 19             |         |           |         |               |              |                |
|                                                                                |                                |  |  |  |  |  | 20      |            |            |           |         |               |              | 20             |         |           |         |               |              |                |
|                                                                                |                                |  |  |  |  |  | 21      |            |            |           |         |               |              | 21             |         |           |         |               |              |                |
|                                                                                |                                |  |  |  |  |  | 22      |            |            |           |         |               |              | 22             |         |           |         |               |              |                |
|                                                                                |                                |  |  |  |  |  | 23      |            |            |           |         |               |              | 23             |         |           |         |               |              |                |
|                                                                                |                                |  |  |  |  |  | 24      |            |            |           |         |               |              | 24             |         |           |         |               |              |                |

Bottle integrity: First test the top vent (V) by opening the lower spigot (S) then test the spigot by opening the vent. Mark 'x' in the appropriate column if either fails the integrity check and explain this in the comments column.

# Dissolved Oxygen Analysis Log Sheet

Institute of Ocean Sciences  
Water Properties Group

Last Updated: July 2015



| Cruise and Analysis Information                                                |                                |  |  |  |  |  | Nisk ID | Nisk Int V | Nisk Int S | Sample ID | Flask 1 | Draw T 1 (°C) | OXY-1 (mL/L) | OXY-1 Comments | Nisk ID | Sample ID | Flask 2 | Draw T 2 (°C) | OXY-2 (mL/L) | OXY-2 Comments                   |  |
|--------------------------------------------------------------------------------|--------------------------------|--|--|--|--|--|---------|------------|------------|-----------|---------|---------------|--------------|----------------|---------|-----------|---------|---------------|--------------|----------------------------------|--|
| Cruise Number:                                                                 | 2016-01                        |  |  |  |  |  | 1       |            |            | 16        | 3030    | 9.5           | 3.506        |                | 1       |           |         |               |              |                                  |  |
| Event:                                                                         | 5                              |  |  |  |  |  | 2       |            |            | 17        | 3005    | 9.5           | 3.519        |                | 2       |           |         |               |              |                                  |  |
| Station:                                                                       | JF2                            |  |  |  |  |  | 3       |            |            | 18        | 196     | 9.7           | 4.203        |                | 3       |           |         |               |              |                                  |  |
| Event Date (Local):                                                            | 9 February 2016                |  |  |  |  |  | 4       |            |            | 19        | 456     | 9.4           | 5.36         |                | 4       |           |         |               |              |                                  |  |
| Analysis Date (Local):                                                         | 9 FEB 2016                     |  |  |  |  |  | 5       |            | X          | 20A       | 471     | 9.4           | 5.443        |                | 5       | 20B       | 396     | 9.4           | 5.388        | FLASK NOT FOUND USED 471 INSTEAD |  |
| Analyst:                                                                       | MB                             |  |  |  |  |  | 6       |            |            | 21        | 712     | 9.3           | 5.591        |                | 6       |           |         |               |              |                                  |  |
| Stdization Date (Local):                                                       | 9 FEB 2016                     |  |  |  |  |  | 7       |            |            | 22        | 3073    | 9.3           | 5.712        |                | 7       |           |         |               |              |                                  |  |
| KIO <sub>3</sub> N:                                                            | G 0122010                      |  |  |  |  |  | 8       |            |            | 23        | 3078    | 9.3           | 5.821        |                | 8       |           |         |               |              |                                  |  |
| Standard Titer:                                                                | 0.5190                         |  |  |  |  |  | 9       |            |            | 24        | 3050    | 9.3           | 6.416        |                | 9       |           |         |               |              |                                  |  |
| Blank Titer:                                                                   | 0.0001                         |  |  |  |  |  | 10      |            |            | 25        | 1055    | 9.3           | 6.541        |                | 10      |           |         |               |              |                                  |  |
| THIO N:                                                                        | G 23500                        |  |  |  |  |  | 11      |            |            | 26        | 1406    | 9.3           | 6.482        |                | 11      |           |         |               |              |                                  |  |
| Sample Flask Water Seal?                                                       | Yes                            |  |  |  |  |  | 12      |            |            | 27        | 2089    | 9.3           | 6.484        |                | 12      |           |         |               |              |                                  |  |
|                                                                                | No                             |  |  |  |  |  | 13      |            |            | 28        | 439     | 9.4           | 6.485        |                | 13      |           |         |               |              |                                  |  |
| Reagent Change?                                                                | MnCl <sub>2</sub>              |  |  |  |  |  | 14      |            |            |           |         |               |              |                | 14      |           |         |               |              |                                  |  |
| (Please circle reagent that was changed prior to sampling and standardization) | NaI/NaOH                       |  |  |  |  |  | 15      |            |            |           |         |               |              |                | 15      |           |         |               |              |                                  |  |
| NOTE NEW BATCH IN LOG BOOK                                                     | H <sub>2</sub> SO <sub>4</sub> |  |  |  |  |  | 16      |            |            |           |         |               |              |                | 16      |           |         |               |              |                                  |  |
|                                                                                | KIO <sub>3</sub>               |  |  |  |  |  | 17      |            |            |           |         |               |              |                | 17      |           |         |               |              |                                  |  |
|                                                                                | THIO                           |  |  |  |  |  | 18      |            |            |           |         |               |              |                | 18      |           |         |               |              |                                  |  |
| Notes:                                                                         | DINO                           |  |  |  |  |  | 19      |            |            |           |         |               |              |                | 19      |           |         |               |              |                                  |  |
|                                                                                |                                |  |  |  |  |  | 20      |            |            |           |         |               |              |                | 20      |           |         |               |              |                                  |  |
|                                                                                |                                |  |  |  |  |  | 21      |            |            |           |         |               |              |                | 21      |           |         |               |              |                                  |  |
|                                                                                |                                |  |  |  |  |  | 22      |            |            |           |         |               |              |                | 22      |           |         |               |              |                                  |  |
|                                                                                |                                |  |  |  |  |  | 23      |            |            |           |         |               |              |                | 23      |           |         |               |              |                                  |  |
|                                                                                |                                |  |  |  |  |  | 24      |            |            |           |         |               |              |                | 24      |           |         |               |              |                                  |  |

Bottle integrity: First test the top vent (V) by opening the lower spigot (S) then test the spigot by opening the vent. Mark 'x' in the appropriate column if either fails the integrity check and explain this in the comments column.

# Dissolved Oxygen Analysis Log Sheet

Institute of Ocean Sciences  
Water Properties Group

Last Updated: July 2015



| Cruise and Analysis Information                                                |    |  |  |        |      |      | Nisk ID | Nisk Int V | Nisk Int S | Sample ID | Flask 1 | Draw T 1 (°C) | OXY-1 (mL/L) | OXY-1 Comments  | Nisk ID | Sample ID | Flask 2 | Draw T 2 (°C) | OXY-2 (mL/L) | OXY-2 Comments |
|--------------------------------------------------------------------------------|----|--|--|--------|------|------|---------|------------|------------|-----------|---------|---------------|--------------|-----------------|---------|-----------|---------|---------------|--------------|----------------|
| Cruise Number: 2016-01                                                         | 1  |  |  | 29A    | 3056 | 11.0 | 5.930   |            |            |           |         |               |              |                 | 1       |           |         |               |              |                |
| Event: 8                                                                       | 2  |  |  | 29B    | 1059 | 11.0 | 5.943   |            |            |           |         |               |              |                 | 2       |           |         |               |              |                |
| Station: P1                                                                    | 3  |  |  | 30     | 2059 | 10.9 | 6.298   |            |            |           |         |               |              | bubble in flask | 3       |           |         |               |              |                |
| Event Date (Local): 2016-02-09                                                 | 4  |  |  | 31     | 2086 | 10.9 | 6.290   |            |            |           |         |               |              |                 | 4       |           |         |               |              |                |
| Analysis Date (Local): 10 FEB 2016                                             | 5  |  |  |        |      |      |         |            |            |           |         |               |              |                 | 5       |           |         |               |              |                |
| Analyst: MB                                                                    | 6  |  |  |        |      |      |         |            |            |           |         |               |              |                 | 6       |           |         |               |              |                |
| Stdization Date (Local): 9 FEB 2016                                            | 7  |  |  |        |      |      |         |            |            |           |         |               |              |                 | 7       |           |         |               |              |                |
| KIO <sub>3</sub> N: 0.0122010                                                  | 8  |  |  |        |      |      |         |            |            |           |         |               |              |                 | 8       |           |         |               |              |                |
| Standard Titer: 0.5190                                                         | 9  |  |  |        |      |      |         |            |            |           |         |               |              |                 | 9       |           |         |               |              |                |
| Blank Titer: 0.0001                                                            | 10 |  |  |        |      |      |         |            |            |           |         |               |              |                 | 10      |           |         |               |              |                |
| THIO N: 0.23500                                                                | 11 |  |  |        |      |      |         |            |            |           |         |               |              |                 | 11      |           |         |               |              |                |
| Sample Flask Yes                                                               | 12 |  |  |        |      |      |         |            |            |           |         |               |              |                 | 12      |           |         |               |              |                |
| Water Seal? No                                                                 | 13 |  |  |        |      |      |         |            |            |           |         |               |              |                 | 13      |           |         |               |              |                |
| Reagent Change? MnCl <sub>2</sub>                                              | 14 |  |  |        |      |      |         |            |            |           |         |               |              |                 | 14      |           |         |               |              |                |
| (Please circle reagent that was changed prior to sampling and standardization) | 15 |  |  |        |      |      |         |            |            |           |         |               |              |                 | 15      |           |         |               |              |                |
| NOTE NEW BATCH IN LOG BOOK                                                     | 16 |  |  |        |      |      |         |            |            |           |         |               |              |                 | 16      |           |         |               |              |                |
|                                                                                | 17 |  |  |        |      |      |         |            |            |           |         |               |              |                 | 17      |           |         |               |              |                |
|                                                                                | 18 |  |  |        |      |      |         |            |            |           |         |               |              |                 | 18      |           |         |               |              |                |
| Notes: octopus box                                                             | 19 |  |  | LOOP A | 3104 | 10.5 | 6.548   |            |            |           |         |               |              | Sample '900'    | 19      |           |         |               |              |                |
|                                                                                | 20 |  |  | LOOP B | 2095 | 10.5 | 6.576   |            |            |           |         |               |              | " '900'         | 20      |           |         |               |              |                |
|                                                                                | 21 |  |  | LOOP A | 3035 | 10.5 | 6.620   |            |            |           |         |               |              | " '901'         | 21      |           |         |               |              |                |
|                                                                                | 22 |  |  | LOOP B | 3088 | 10.6 | 6.458   |            |            |           |         |               |              | " '901'         | 22      |           |         |               |              |                |
|                                                                                | 23 |  |  |        |      |      |         |            |            |           |         |               |              |                 | 23      |           |         |               |              |                |
|                                                                                | 24 |  |  |        |      |      |         |            |            |           |         |               |              |                 | 24      |           |         |               |              |                |

Bottle integrity: First test the top vent (V) by opening the lower spigot (S) then test the spigot by opening the vent. Mark 'x' in the appropriate column if either fails the integrity check and explain this in the comments column.

# Dissolved Oxygen Analysis Log Sheet

Institute of Ocean Sciences  
Water Properties Group

Last Updated: July 2015



| Cruise and Analysis Information                                                |                                | Nisk ID | Nisk Int V | Nisk Int S | Sample ID    | Flask 1 | Draw T1 (°C) | OXY-1 (mL/L)                       | OXY-1 Comments                  | Nisk ID | Sample ID | Flask 2 | Draw T2 (°C) | OXY-2 (mL/L) | OXY-2 Comments |
|--------------------------------------------------------------------------------|--------------------------------|---------|------------|------------|--------------|---------|--------------|------------------------------------|---------------------------------|---------|-----------|---------|--------------|--------------|----------------|
| Cruise Number:                                                                 | 2016-01                        | 1       |            |            | 46A          | 3030    | 10.6         | 4.490                              |                                 | 1       | 46B       | 3005    | 10.6         | 4.484        |                |
| Event:                                                                         | 14                             | 2       |            |            | 47           | 196     | 10.9         | 5.051                              |                                 | 2       |           |         |              |              |                |
| Station:                                                                       | P2                             | 3       |            |            | 48           | 456     | 11.1         | 6.170                              |                                 | 3       |           |         |              |              |                |
| Event Date (Local):                                                            | 9 Dec 2016                     | 4       |            |            | 49           | 471     | 11.1         | 6.167                              |                                 | 4       |           |         |              |              |                |
| Analysis Date (Local):                                                         | 11 FEB 2016                    | 5       |            |            | 50           | 396     | 11.1         | 6.225                              | Flask ID not found put in '471' | 5       |           |         |              |              |                |
| Analyst:                                                                       | ms                             | 6       |            |            | 51           | 712     | 11.1         | 6.319                              |                                 | 6       |           |         |              |              |                |
| Stdization Date (Local):                                                       | 11 FEB 2016                    | 7       |            |            | 52           | 3073    | 11.2         | 6.327                              |                                 | 7       |           |         |              |              | Valve open     |
| KIO <sub>3</sub> N:                                                            | 0.02201                        | 8       |            |            | 53           | 3078    | 11.2         | 6.329                              |                                 | 8       |           |         |              |              |                |
| Standard Titer:                                                                | 0.5190                         | 9       |            |            |              |         |              |                                    |                                 | 9       |           |         |              |              |                |
| Blank Titer:                                                                   | 0.0001                         | 10      |            |            |              |         |              |                                    |                                 | 10      |           |         |              |              |                |
| THIO N:                                                                        | 0.235                          | 11      |            |            |              |         |              |                                    |                                 | 11      |           |         |              |              |                |
| Sample Flask Water Seal?                                                       | Yes                            | 12      |            |            |              |         |              |                                    |                                 | 12      |           |         |              |              |                |
|                                                                                | No                             | 13      |            |            | P2 Loop 3050 | 10.7    | 6.480        | Small bubbles in chem Sample '902' |                                 | 13      |           |         |              |              |                |
| Reagent Change?                                                                | MnCl <sub>2</sub>              | 14      |            |            | P2 Loop 1055 | 10.7    | 6.509        | " Sample '902'                     |                                 | 14      |           |         |              |              |                |
| (Please circle reagent that was changed prior to sampling and standardization) | NaI/NaOH                       | 15      |            |            |              |         |              |                                    |                                 | 15      |           |         |              |              |                |
| NOTE NEW BATCH IN LOG BOOK                                                     | H <sub>2</sub> SO <sub>4</sub> | 16      |            |            |              |         |              |                                    |                                 | 16      |           |         |              |              |                |
|                                                                                | KIO <sub>3</sub>               | 17      |            |            |              |         |              |                                    |                                 | 17      |           |         |              |              |                |
|                                                                                | THIO                           | 18      |            |            | Loop 15 2089 |         | 6.335        | No temp recorded Sample '903'      |                                 | 18      |           |         |              |              |                |
| Notes:                                                                         |                                | 19      |            |            | Loop 15 1406 |         | 6.742        | ↓ Sample '903'                     |                                 | 19      |           |         |              |              |                |
|                                                                                |                                | 20      |            |            |              |         |              |                                    |                                 | 20      |           |         |              |              |                |
|                                                                                |                                | 21      |            |            |              |         |              |                                    |                                 | 21      |           |         |              |              |                |
|                                                                                |                                | 22      |            |            |              |         |              |                                    |                                 | 22      |           |         |              |              |                |
|                                                                                |                                | 23      |            |            |              |         |              |                                    |                                 | 23      |           |         |              |              |                |
|                                                                                |                                | 24      |            |            |              |         |              |                                    |                                 | 24      |           |         |              |              |                |

Bottle integrity: First test the top vent (V) by opening the lower spigot (S) then test the spigot by opening the vent. Mark 'x' in the appropriate column if either fails the integrity check and explain this in the comments column.

# Dissolved Oxygen Analysis Log Sheet

Institute of Ocean Sciences  
Water Properties Group

Last Updated: July 2015



| Cruise and Analysis Information                                                        |    |  |  |       |      |      | Nisk ID | Nisk Int V | Nisk Int S | Sample ID | Flask 1 | Draw T 1 (°C) | OXY-1 (mL/L) | OXY-1 Comments                                        | Nisk ID | Sample ID | Flask 2 | Draw T 2 (°C) | OXY-2 (mL/L) | OXY-2 Comments |
|----------------------------------------------------------------------------------------|----|--|--|-------|------|------|---------|------------|------------|-----------|---------|---------------|--------------|-------------------------------------------------------|---------|-----------|---------|---------------|--------------|----------------|
| Cruise Number: 2016-01                                                                 | 1  |  |  | 99    | 3117 | 4.5  | 0.528   |            |            |           |         |               |              |                                                       | 1       |           |         |               |              |                |
| Event: 19                                                                              | 2  |  |  | 100   | 1408 | 4.5  | 0.393   |            |            |           |         |               |              | Started with this not in sample, aborted & restarted. | 2       |           |         |               |              |                |
| Station: P4                                                                            | 3  |  |  | 101A  | 3009 | 4.7  | 0.398   |            |            |           |         |               |              |                                                       | 3       | 101B      | 2019    | 4.7           | 0.406        |                |
| Event Date (Local): 10/2/2016                                                          | 4  |  |  | 102   | 2040 | 4.8  | 0.287   |            |            |           |         |               |              |                                                       | 4       |           |         |               |              |                |
| Analysis Date (Local): 12FCB2016                                                       | 5  |  |  | 103   | 2032 | 5.6  | 0.253   |            |            |           |         |               |              | Check endpoint, should have over-titrated.            | 5       |           |         |               |              |                |
| Analyst: mb                                                                            | 6  |  |  | 104   | 94   | 5.8  | 0.429   |            |            |           |         |               |              |                                                       | 6       |           |         |               |              |                |
| Stdization Date (Local): 11FCB2016                                                     | 7  |  |  | 105   | 2043 | 6.8  | 1.290   |            |            |           |         |               |              |                                                       | 7       |           |         |               |              |                |
| KIO <sub>3</sub> N: 0.012201                                                           | 8  |  |  | 106   | 3008 | 7.7  | 2.453   |            |            |           |         |               |              |                                                       | 8       |           |         |               |              |                |
| Standard Titer: 0.5185                                                                 | 9  |  |  | 107   | 2047 | 8.1  | 2.801   |            |            |           |         |               |              |                                                       | 9       |           |         |               |              |                |
| Blank Titer: 0.0001                                                                    | 10 |  |  | 108   | 2027 | 8.4  | 3.281   |            |            |           |         |               |              | Over-titrated.                                        | 10      |           |         |               |              |                |
| THIO N: 0.235117                                                                       | 11 |  |  | 109   | 2051 | 8.7  | 3.206   |            |            |           |         |               |              |                                                       | 11      |           |         |               |              |                |
| Sample Flask Water Seal? <input checked="" type="radio"/> Yes <input type="radio"/> No | 12 |  |  | 110   | 3037 | 8.9  | 3.075   |            |            |           |         |               |              | Over-titrated.                                        | 12      |           |         |               |              |                |
| Reagent Change? MnCl <sub>2</sub>                                                      | 13 |  |  | 111   | 2025 | 9.0  | 3.762   |            |            |           |         |               |              |                                                       | 13      |           |         |               |              |                |
| (Please circle reagent that was changed prior to sampling and standardization)         | 14 |  |  | 112   | 2017 | 9.3  | 4.037   |            |            |           |         |               |              |                                                       | 14      |           |         |               |              |                |
| NOTE NEW BATCH IN LOG BOOK                                                             | 15 |  |  | 113A  | 2015 | 10.0 | 6.457   |            |            |           |         |               |              |                                                       | 15      | 113B      | 1465    | 10.1          | 6.458        |                |
|                                                                                        | 16 |  |  | 114   | 3018 | 10.1 | 6.474   |            |            |           |         |               |              |                                                       | 16      |           |         |               |              |                |
|                                                                                        | 17 |  |  | 115   | 1460 | 10.1 | 6.450   |            |            |           |         |               |              |                                                       | 17      |           |         |               |              |                |
|                                                                                        | 18 |  |  | 116   | 2016 | 10.1 | 6.454   |            |            |           |         |               |              |                                                       | 18      |           |         |               |              |                |
| Notes: Shark                                                                           | 19 |  |  | 117   | 2000 | 10.1 | 6.455   |            |            |           |         |               |              |                                                       | 19      |           |         |               |              |                |
|                                                                                        | 20 |  |  |       |      |      |         |            |            |           |         |               |              |                                                       | 20      |           |         |               |              |                |
|                                                                                        | 21 |  |  | LOOPA | 3200 | 9.8  | 6.698   |            |            |           |         |               |              | Sample '904'                                          | 21      | LOOPB     | 3032    | 9.8           | 6.686        | Sample '904'   |
|                                                                                        | 22 |  |  | LOOPA | 3033 | 9.8  | 6.711   |            |            |           |         |               |              | Sample '905'                                          | 22      | LOOPB     | 2007    | 9.8           | 6.592        | Sample '905'   |
|                                                                                        | 23 |  |  |       |      |      |         |            |            |           |         |               |              |                                                       | 23      |           |         |               |              |                |
|                                                                                        | 24 |  |  |       |      |      |         |            |            |           |         |               |              |                                                       | 24      |           |         |               |              |                |

Bottle integrity: First test the top vent (V) by opening the lower spigot (S) then test the spigot by opening the vent. Mark 'x' in the appropriate column if either fails the integrity check and explain this in the comments column.

# Dissolved Oxygen Analysis Log Sheet

Institute of Ocean Sciences  
Water Properties Group

Last Updated: July 2015



| Cruise and Analysis Information                                                |  | Nisk ID | Nisk Int V S | Sample ID | Flask 1 | Draw T 1 (°C) | OXY-1 (mL/L) | OXY-1 Comments                                                      | Nisk ID | Sample ID | Flask 2 | Draw T 2 (°C) | OXY-2 (mL/L) | OXY-2 Comments |
|--------------------------------------------------------------------------------|--|---------|--------------|-----------|---------|---------------|--------------|---------------------------------------------------------------------|---------|-----------|---------|---------------|--------------|----------------|
| Cruise Number: 2016-01                                                         |  | 1       |              | 167A      | 708     | 3.9           | 1.354        | dropped 2 magnets in, did not stir well had trouble picking it out. | 1       | 167B      | 3192    | 3.9           | 1.379        |                |
| Event: 28                                                                      |  | 2       |              | 168       | 3040    | 4.2           | 0.648        |                                                                     | 2       |           |         |               |              |                |
| Station: P8                                                                    |  | 3       |              | 169       | 3013    | 4.5           | 0.371        |                                                                     | 3       |           |         |               |              |                |
| Event Date (Local): 10 Feb. 2015                                               |  | 4       |              | 170       | 3025    | 5.0           | 0.254        |                                                                     | 4       |           |         |               |              |                |
| Analysis Date (Local): 12 Feb 2016                                             |  | 5       |              | 171       | 557     | 5.5           | 0.313        |                                                                     | 5       |           |         |               |              |                |
| Analyst: MB                                                                    |  | 6       |              | 172       | 3093    | 5.7           | 0.690        |                                                                     | 6       |           |         |               |              |                |
| Stdization Date (Local): 11 Feb 2016                                           |  | 7       |              | 173       | 3038    | 6.1           | 1.685        | Over-titrated.                                                      | 7       |           |         |               |              |                |
| KIO <sub>3</sub> N: 0.012201                                                   |  | 8       |              | 174       | 575     | 6.5           | 2.737        |                                                                     | 8       |           |         |               |              |                |
| Standard Titer: 0.5185                                                         |  | 9       |              | 175A      | 611     | 7.0           | 3.351        |                                                                     | 9       | 175B      | 510     | 7.1           | 3.346        |                |
| Blank Titer: 0.0001                                                            |  | 10      |              | 176       | 528     | 7.5           | 3.629        |                                                                     | 10      |           |         |               |              |                |
| THIO N: 0.235117                                                               |  | 11      |              | 177       | 2053    | 7.8           | 3.824        |                                                                     | 11      |           |         |               |              |                |
| Sample Flask Water Seal? Yes - see below                                       |  | 12      |              | 178       | 3034    | 8.0           | 3.576        |                                                                     | 12      |           |         |               |              |                |
| Reagent Change? MnCl <sub>2</sub>                                              |  | 13      |              | 179       | 612     | 8.4           | 4.450        |                                                                     | 13      |           |         |               |              |                |
| (Please circle reagent that was changed prior to sampling and standardization) |  | 14      |              | 180       | 2098    | 9.1           | 5.452        |                                                                     | 14      |           |         |               |              |                |
| NOTE NEW BATCH IN LOG BOOK                                                     |  | 15      |              | 181       | 586     | 9.3           | 6.522        |                                                                     | 15      |           |         |               |              |                |
|                                                                                |  | 16      |              | 182       | 2099    | 9.3           | 6.577        |                                                                     | 16      |           |         |               |              |                |
|                                                                                |  | 17      |              | 183       | 3043    | 9.3           | 6.553        |                                                                     | 17      |           |         |               |              |                |
|                                                                                |  | 18      |              | 184A      | 3162    | 9.5           | 6.575        |                                                                     | 18      | 184B      | 3096    | 9.5           | 6.596        |                |
| Notes: BARD,                                                                   |  | 19      |              | 185       | 3175    | 9.5           | 6.586        |                                                                     | 19      |           |         |               |              |                |
| I NOTICED @ ~1815                                                              |  | 20      |              | 186       | 570     | 9.5           | 6.589        |                                                                     | 20      |           |         |               |              |                |
| LOCAL TIME 11 FEB.                                                             |  | 21      |              | 187       | 2097    | 9.5           | 6.596        |                                                                     | 21      |           |         |               |              |                |
| THAT THERE WAS NO                                                              |  | 22      |              |           |         |               |              |                                                                     | 22      |           |         |               |              |                |
| WATER ON TOP, SO 2x SHOOK                                                      |  | 23      |              | LOOP A    | 3161    | 9.2           | 6.826        | Sample '906'                                                        | 23      |           |         |               |              |                |
| + WATER MR                                                                     |  | 24      |              | LOOP B    | 3023    | 9.2           | 6.763        | Sample '906'                                                        | 24      |           |         |               |              |                |

Bottle integrity: First test the top vent (V) by opening the lower spigot (S) then test the spigot by opening the vent. Mark 'x' in the appropriate column if either fails the integrity check and explain this in the comments column.

NO temp? → { LOOP 38 A 3000 Sample '907' 6.966  
 LOOP 38 B 3002 Sample '907' 6.775  
 These are after P12

# Dissolved Oxygen Analysis Log Sheet

Institute of Ocean Sciences  
Water Properties Group

Last Updated: July 2015



| Cruise and Analysis Information                                                |                                | Nisk ID | Nisk Int V | Nisk Int S | Sample ID | Flask 1 | Draw T 1 (°C) | OXY-1 (mL/L) | OXY-1 Comments | Nisk ID | Sample ID | Flask 2 | Draw T 2 (°C) | OXY-2 (mL/L) | OXY-2 Comments |
|--------------------------------------------------------------------------------|--------------------------------|---------|------------|------------|-----------|---------|---------------|--------------|----------------|---------|-----------|---------|---------------|--------------|----------------|
| Cruise Number:                                                                 | 2016-01                        | 1       |            |            | 251       | 569     | 3.5           | 2.298        |                | 1       |           |         |               |              |                |
| Event:                                                                         | 36                             | 2       |            |            | 252A      | 3132    | 7.6           | 2.235        |                | 2       | 252B      | 3129    | 7.6           | 2.238        |                |
| Station:                                                                       | P12                            | 3       |            |            | 253       | 2014    | 3.5           | 2.234        |                | 3       |           |         |               |              |                |
| Event Date (Local):                                                            | 11 Feb 2015                    | 4       |            |            | 254       | 3022    | 3.6           | 1.896        |                | 4       |           |         |               |              |                |
| Analysis Date (Local):                                                         | 13 Feb 2016                    | 5       |            |            | 255       | 3028    | 4.0           | 1.335        |                | 5       |           |         |               |              |                |
| Analyst:                                                                       | MB                             | 6       |            |            | 256       | 3134    | 4.3           | 0.601        |                | 6       |           |         |               |              |                |
| Stdization Date (Local):                                                       | 13 Feb 2016                    | 7       |            |            | 257       | 3133    | 4.8           | 0.348        |                | 7       |           |         |               |              |                |
| KIO <sub>3</sub> N:                                                            | 0.012201                       | 8       |            |            | 258       | 3131    | 5.2           | 0.264        |                | 8       |           |         |               |              |                |
| Standard Titer:                                                                | 0.5185                         | 9       |            |            | 259A      | 3135    | 5.5           | 0.377        |                | 9       | 259B      | 3125    | 5.7           | 0.367        |                |
| Blank Titer:                                                                   | 0.0001                         | 10      |            |            | 260       | 3126    | 6.0           | 0.508        |                | 10      |           |         |               |              |                |
| THIO N:                                                                        | 0.235132                       | 11      |            |            | 261       | 3144    | 6.4           | 1.385        |                | 11      |           |         |               |              |                |
| Sample Flask Water Seal?                                                       | Yes                            | 12      |            |            | 262       | 3147    | 6.9           | 2.089        |                | 12      |           |         |               |              |                |
|                                                                                | No                             | 13      |            |            | 263       | 3150    | 7.3           | 2.576        |                | 13      |           |         |               |              |                |
| Reagent Change?                                                                | MnCl <sub>2</sub>              | 14      |            |            | 264       | 3138    | 7.8           | 3.582        |                | 14      |           |         |               |              |                |
| (Please circle reagent that was changed prior to sampling and standardization) | NaI/NaOH                       | 15      |            |            | 265A      | 3142    | 8.1           | 4.004        |                | 15      | 265B      | 3036    | 8.1           | 3.999        |                |
| NOTE NEW BATCH IN LOG BOOK                                                     | H <sub>2</sub> SO <sub>4</sub> | 16      |            |            | 266       | 3016    | 8.4           | 4.151        |                | 16      |           |         |               |              |                |
|                                                                                | KIO <sub>3</sub>               | 17      |            |            | 267       | 3191    | 8.5           | 4.144        |                | 17      |           |         |               |              |                |
|                                                                                | THIO                           | 18      |            |            | 268       | 3143    | 8.7           | 4.501        |                | 18      |           |         |               |              |                |
| Notes:                                                                         | Bender                         | 19      |            |            | 269       | 3148    | 9.4           | 6.499        |                | 19      |           |         |               |              |                |
|                                                                                |                                | 20      |            |            | 270       | 3145    | 9.4           | 6.533        |                | 20      |           |         |               |              |                |
|                                                                                |                                | 21      |            |            | 271       | 3146    | 9.4           | 6.530        |                | 21      |           |         |               |              |                |
|                                                                                |                                | 22      |            |            | 272       | 3209    | 9.4           | 6.528        |                | 22      |           |         |               |              |                |
|                                                                                |                                | 23      |            |            | 273A      | 3201    | 9.5           | 6.541        |                | 23      | 273B      | 3194    | 9.5           | 6.554        |                |
|                                                                                |                                | 24      |            |            | 274       |         |               |              |                | 24      |           |         |               |              |                |

Bottle integrity: First test the top vent (V) by opening the lower spigot (S) then test the spigot by opening the vent. Mark 'x' in the appropriate column if either fails the integrity check and explain this in the comments column.

LOOP P12 A 3190 9.0 Sample '908' 6.767  
 LOOP P12 B 3198 9.0 Sample '908' 6.867

# Dissolved Oxygen Analysis Log Sheet

Institute of Ocean Sciences  
Water Properties Group

Last Updated: July 2015



| Cruise and Analysis Information |            |            |           |         |               |              |                                         | Cruise and Analysis Information |           |         |               |              |                                                                           |  |  |
|---------------------------------|------------|------------|-----------|---------|---------------|--------------|-----------------------------------------|---------------------------------|-----------|---------|---------------|--------------|---------------------------------------------------------------------------|--|--|
| Nisk ID                         | Nisk Int V | Nisk Int S | Sample ID | Flask 1 | Draw T 1 (°C) | OXY-1 (mL/L) | OXY-1 Comments                          | Nisk ID                         | Sample ID | Flask 2 | Draw T 2 (°C) | OXY-2 (mL/L) | OXY-2 Comments                                                            |  |  |
| 1                               |            |            |           |         |               |              |                                         | 1                               |           |         |               |              |                                                                           |  |  |
| 2                               |            |            |           |         |               |              |                                         | 2                               |           |         |               |              |                                                                           |  |  |
| 3                               |            |            | 294       | 3030    | 9.4           | -            | Flask broken when box slid across deck. | 3                               | 294       | 3005    | 9.3           | 6.60         |                                                                           |  |  |
| 4                               |            |            |           |         |               |              |                                         | 4                               |           |         |               |              |                                                                           |  |  |
| 5                               |            |            | Loop 41   | 176     | 9.0           | 6.798        | Sample '913'                            | 5                               | Loop 41   | 456     | 9.0           | 6.825        | Sample '913'                                                              |  |  |
| 6                               |            |            |           |         |               |              |                                         | 6                               |           |         |               |              |                                                                           |  |  |
| 7                               |            |            | Loop 41   | 471     | 9.0           | 6.761        | Sample '914'                            | 7                               | Loop 41   | 396     | 9.0           | 6.747        | Sample '914' used Flask #471 Since not in Flask #16. Need to change this. |  |  |
| 8                               |            |            |           |         |               |              |                                         | 8                               |           |         |               |              |                                                                           |  |  |
| 9                               |            |            |           |         |               |              |                                         | 9                               |           |         |               |              |                                                                           |  |  |
| 10                              |            |            |           |         |               |              |                                         | 10                              |           |         |               |              |                                                                           |  |  |
| 11                              |            |            |           |         |               |              |                                         | 11                              |           |         |               |              |                                                                           |  |  |
| 12                              |            |            |           |         |               |              |                                         | 12                              |           |         |               |              |                                                                           |  |  |
| 13                              |            |            |           |         |               |              |                                         | 13                              |           |         |               |              |                                                                           |  |  |
| 14                              |            |            |           |         |               |              |                                         | 14                              |           |         |               |              |                                                                           |  |  |
| 15                              |            |            |           |         |               |              |                                         | 15                              |           |         |               |              |                                                                           |  |  |
| 16                              |            |            |           |         |               |              |                                         | 16                              |           |         |               |              |                                                                           |  |  |
| 17                              |            |            |           |         |               |              |                                         | 17                              |           |         |               |              |                                                                           |  |  |
| 18                              |            |            |           |         |               |              |                                         | 18                              |           |         |               |              |                                                                           |  |  |
| 19                              |            |            |           |         |               |              |                                         | 19                              |           |         |               |              |                                                                           |  |  |
| 20                              |            |            |           |         |               |              |                                         | 20                              |           |         |               |              |                                                                           |  |  |
| 21                              |            |            |           |         |               |              |                                         | 21                              |           |         |               |              |                                                                           |  |  |
| 22                              |            |            |           |         |               |              |                                         | 22                              |           |         |               |              |                                                                           |  |  |
| 23                              |            |            |           |         |               |              |                                         | 23                              |           |         |               |              |                                                                           |  |  |
| 24                              |            |            |           |         |               |              |                                         | 24                              |           |         |               |              |                                                                           |  |  |

**Cruise and Analysis Information**

Cruise Number: 2016-01

Event: 40

Station: P14

Event Date (Local): 12 FEB 2016

Analysis Date (Local): 17 FEB 2016

Analyst: MB

Stdization Date (Local): 13 FEB 2016

KIO<sub>3</sub> N: 0.012201

Standard Titer: 0.5185

Blank Titer: 0.0001

THIO N: 0.235132

Sample Flask Yes

Water Seal? No

Reagent Change? MnCl<sub>2</sub>

(Please circle reagent that was changed prior to sampling and standardization)

NaI/NaOH

H<sub>2</sub>SO<sub>4</sub>

NOTE NEW BATCH IN LOG BOOK

KIO<sub>3</sub>

THIO

**Notes:**

NESSY

Used older 'STD' Date since changed chemical after this STD.

Bottle integrity: First test the top vent (V) by opening the lower spigot (S) then test the spigot by opening the vent. Mark 'x' in the appropriate column if either fails the integrity check and explain this in the comments column.

# Dissolved Oxygen Analysis Log Sheet

Institute of Ocean Sciences

Water Properties Group

Last Updated: July 2015



| Cruise and Analysis Information |            |   |                  |         |               |              |                                                     |         |                  |         |               |              |                |
|---------------------------------|------------|---|------------------|---------|---------------|--------------|-----------------------------------------------------|---------|------------------|---------|---------------|--------------|----------------|
| Nisk ID                         | Nisk Int V | S | Sample ID        | Flask 1 | Draw T 1 (°C) | OXY-1 (mL/L) | OXY-1 Comments                                      | Nisk ID | Sample ID        | Flask 2 | Draw T 2 (°C) | OXY-2 (mL/L) | OXY-2 Comments |
| 1                               |            |   | 340              | 3117    | 3.1           | 2.731        |                                                     | 1       |                  |         |               |              | Valve leaking? |
| 2                               |            |   | 341              | 1408    | 3.0           | 2.675        |                                                     | 2       |                  |         |               |              |                |
| 3                               |            |   | 342              | 3009    | 3.0           | 2.674        |                                                     | 3       |                  |         |               |              |                |
| 4                               |            |   | 343              | 2019    | 3.1           | 2.385        |                                                     | 4       |                  |         |               |              |                |
| 5                               |            |   | 344 <sup>A</sup> | 2032    | 3.3           | 1.904        |                                                     | 5       | 344 <sup>B</sup> | 2040    | 3.5           | 1.903        | Valve loose?   |
| 6                               |            |   | 345              | 94      | 3.5           | 1.347        |                                                     | 6       |                  |         |               |              |                |
| 7                               |            |   | 346              | 2043    | 4.0           | 0.535        |                                                     | 7       |                  |         |               |              |                |
| 8                               |            |   | 347              | 3008    | 4.9           | 0.318        |                                                     | 8       |                  |         |               |              |                |
| 9                               |            |   | 348              | 2047    | 4.7           | 0.268        |                                                     | 9       |                  |         |               |              |                |
| 10                              |            |   | 349              | 2027    | 5.2           | 0.333        |                                                     | 10      |                  |         |               |              |                |
| 11                              |            |   | 350              | 2051    | 5.6           | 0.644        |                                                     | 11      |                  |         |               |              |                |
| 12                              |            |   | 351              | 3037    | 5.9           | 1.642        |                                                     | 12      |                  |         |               |              |                |
| 13                              |            |   | 352 <sup>A</sup> | 2025    | 6.3           | 2.530        |                                                     | 13      | 352 <sup>B</sup> | 2017    | 6.3           | 2.528        |                |
| 14                              |            |   | 353              | 2015    | 6.6           | 3.057        |                                                     | 14      |                  |         |               |              |                |
| 15                              |            |   | 354              | 1465    | 7.3           |              | → forgot acid last sample                           | 15      |                  |         |               |              |                |
| 16                              |            |   | 355 <sup>A</sup> | 3018    | 7.5           | 3.945        |                                                     | 16      | 355 <sup>B</sup> | 1460    | 7.6           | 3.948        |                |
| 17                              |            |   | 356              | 2016    | 7.9           | 4.151        |                                                     | 17      |                  |         |               |              |                |
| 18                              |            |   | 357              | 2000    | 8.1           | 4.547        |                                                     | 18      |                  |         |               |              |                |
| 19                              |            |   | 358              | 3032    | 8.7           | 5.465        |                                                     | 19      |                  |         |               |              |                |
| 20                              |            |   | 359 <sup>A</sup> | 3200    | 9.2           | 6.520        |                                                     | 20      | 359 <sup>B</sup> | 3033    | 9.2           | 6.535        |                |
| 21                              |            |   | 360              | 2007    | 9.2           | 6.876        | late putting in thio bad result should have aborted | 21      |                  |         |               |              |                |
| 22                              |            |   | 361              | 1429    | 9.2           | 6.576        |                                                     | 22      |                  |         |               |              |                |
| 23                              |            |   | 362              | 3020    | 9.2           | 6.575        |                                                     | 23      |                  |         |               |              |                |
| 24                              |            |   | 363              | 3158    | 9.2           | 6.571        |                                                     | 24      |                  |         |               |              |                |

Bottle integrity: First test the top vent (V) by opening the lower spigot (S) then test the spigot by opening the vent. Mark 'x' in the appropriate column if either fails the integrity check and explain this in the comments column.

LOOP P16 A 3116 9.0 Sample '909' 6.767  
 LOOP P16 B 3042 9.0 Sample '909' 6.745  
 NESSY BOX → LOOP SOA 3073 9.0 Sample '910' 6.907  
 LOOP SOA 3078 9.0 Sample '910' 6.843

# Dissolved Oxygen Analysis Log Sheet

Institute of Ocean Sciences  
Water Properties Group

Last Updated: July 2015



| Cruise and Analysis Information                                                                                  |    |  |  |             |      |     | Nisk ID | Nisk Int V | Nisk Int S | Sample ID | Flask 1 | Draw T 1 (°C) | OXY-1 (mL/L)          | OXY-1 Comments | Nisk ID | Sample ID   | Flask 2 | Draw T 2 (°C) | OXY-2 (mL/L) | OXY-2 Comments        |
|------------------------------------------------------------------------------------------------------------------|----|--|--|-------------|------|-----|---------|------------|------------|-----------|---------|---------------|-----------------------|----------------|---------|-------------|---------|---------------|--------------|-----------------------|
| Cruise Number: 2016-01                                                                                           | 1  |  |  |             |      |     | 1       |            |            |           |         |               |                       |                | 1       |             |         |               |              |                       |
| Event: 53                                                                                                        | 2  |  |  |             |      |     | 2       |            |            |           |         |               |                       |                | 2       |             |         |               |              |                       |
| Station: P18                                                                                                     | 3  |  |  | 394A        | 3073 | 9.1 | 6.616   |            |            |           |         |               |                       |                | 3       | 394A        | 3078    | 9.1           | 6.615        |                       |
| Event Date (Local): 13 FEB 2016                                                                                  | 4  |  |  | P18 Loop 1A | 3050 | 8.7 | 6.806   |            |            |           |         |               | Sample '915'          |                | 4       | P18 Loop 1A | 1055    | 8.7           | 6.842        | Sample '915'          |
| Analysis Date (Local): 17 FEB 2016                                                                               | 5  |  |  | Loop 54A    | 1460 | ?   | 7.126   |            |            |           |         |               | Sample '916' no temp? |                | 5       | Loop 54B    | 2089    | ?             | 6.839        | Sample '916' no temp? |
| Analyst: MBS                                                                                                     | 6  |  |  |             |      |     |         |            |            |           |         |               |                       |                | 6       |             |         |               |              |                       |
| Standardization Date (Local): 13 FEB 2016                                                                        | 7  |  |  |             |      |     |         |            |            |           |         |               |                       |                | 7       |             |         |               |              |                       |
| KIO <sub>3</sub> N: 0.012201                                                                                     | 8  |  |  |             |      |     |         |            |            |           |         |               |                       |                | 8       |             |         |               |              |                       |
| Standard Titer: 0.5185                                                                                           | 9  |  |  |             |      |     |         |            |            |           |         |               |                       |                | 9       |             |         |               |              |                       |
| Blank Titer: 0.0001                                                                                              | 10 |  |  |             |      |     |         |            |            |           |         |               |                       |                | 10      |             |         |               |              |                       |
| THIO N: 0.235132                                                                                                 | 11 |  |  |             |      |     |         |            |            |           |         |               |                       |                | 11      |             |         |               |              |                       |
| Sample Flask <input checked="" type="checkbox"/> Yes                                                             | 12 |  |  |             |      |     |         |            |            |           |         |               |                       |                | 12      |             |         |               |              |                       |
| Water Seal? <input type="checkbox"/> No                                                                          | 13 |  |  |             |      |     |         |            |            |           |         |               |                       |                | 13      |             |         |               |              |                       |
| Reagent Change? <input type="checkbox"/> MnCl <sub>2</sub>                                                       | 14 |  |  |             |      |     |         |            |            |           |         |               |                       |                | 14      |             |         |               |              |                       |
| (Please circle reagent that was changed prior to sampling and standardization) <input type="checkbox"/> NaI/NaOH | 15 |  |  |             |      |     |         |            |            |           |         |               |                       |                | 15      |             |         |               |              |                       |
| <input type="checkbox"/> H <sub>2</sub> SO <sub>4</sub>                                                          | 16 |  |  |             |      |     |         |            |            |           |         |               |                       |                | 16      |             |         |               |              |                       |
| NOTE NEW BATCH IN LOG BOOK <input type="checkbox"/> KIO <sub>3</sub>                                             | 17 |  |  |             |      |     |         |            |            |           |         |               |                       |                | 17      |             |         |               |              |                       |
| <input type="checkbox"/> THIO                                                                                    | 18 |  |  |             |      |     |         |            |            |           |         |               |                       |                | 18      |             |         |               |              |                       |
| Notes:                                                                                                           | 19 |  |  |             |      |     |         |            |            |           |         |               |                       |                | 19      |             |         |               |              |                       |
| Nessy                                                                                                            | 20 |  |  |             |      |     |         |            |            |           |         |               |                       |                | 20      |             |         |               |              |                       |
| USED older 'STD' date                                                                                            | 21 |  |  |             |      |     |         |            |            |           |         |               |                       |                | 21      |             |         |               |              |                       |
| SINCE change NaOH/NaI                                                                                            | 22 |  |  |             |      |     |         |            |            |           |         |               |                       |                | 22      |             |         |               |              |                       |
| AFTER this STD.                                                                                                  | 23 |  |  |             |      |     |         |            |            |           |         |               |                       |                | 23      |             |         |               |              |                       |
|                                                                                                                  | 24 |  |  |             |      |     |         |            |            |           |         |               |                       |                | 24      |             |         |               |              |                       |

Bottle integrity: First test the top vent (V) by opening the lower spigot (S) then test the spigot by opening the vent. Mark 'x' in the appropriate column if either fails the integrity check and explain this in the comments column.

# Dissolved Oxygen Analysis Log Sheet

Institute of Ocean Sciences  
Water Properties Group

Last Updated: July 2015



| Cruise and Analysis Information                                                |                                | Nisk ID | Nisk Int V | S | Sample ID | Flask 1 | Draw T 1 (°C) | OXY-1 (mL/L) | OXY-1 Comments                              | Nisk ID | Sample ID | Flask 2 | Draw T 2 (°C) | OXY-2 (mL/L) | OXY-2 Comments |
|--------------------------------------------------------------------------------|--------------------------------|---------|------------|---|-----------|---------|---------------|--------------|---------------------------------------------|---------|-----------|---------|---------------|--------------|----------------|
| Cruise Number:                                                                 | 2016-01                        | 1       |            |   | 397       | 3117    | 3.5           | 3.029        | over-titrated, need to adjust voltage (low) | 1       |           |         |               |              |                |
| Event:                                                                         | 57                             | 2       |            |   | 398       | 1408    | 3.5           | 2.828        |                                             | 2       |           |         |               |              |                |
| Station:                                                                       | P20                            | 3       |            |   | 399       | 3009    | 3.4           | 2.837        |                                             | 3       |           |         |               |              |                |
| Event Date (Local):                                                            | 14 FEB 2016                    | 4       |            |   | 400       | 2019    | 3.8           | 2.440        |                                             | 4       |           |         |               |              |                |
| Analysis Date (Local):                                                         | 17 FEB 2016                    | 5       |            |   | 401       | 2032    | 3.8           | 1.891        |                                             | 5       |           |         |               |              |                |
| Analyst:                                                                       | MB                             | 6       |            |   | 402       | 2040    | 4.0           | 1.209        |                                             | 6       |           |         |               |              |                |
| Stdization Date (Local):                                                       | 13 FEB 2016                    | 7       |            |   | 403A      | 94      | 4.4           | 0.483        | bubble in flask                             | 7       | 403B      | 2043    | 4.5           | 0.471        |                |
| KIO <sub>3</sub> N:                                                            | 0.012201                       | 8       |            |   | 404       | 3008    | 4.7           | 0.334        |                                             | 8       |           |         |               |              |                |
| Standard Titer:                                                                | 0.5185                         | 9       |            |   | 405       | 2047    | 5.0           | 0.413        |                                             | 9       |           |         |               |              |                |
| Blank Titer:                                                                   | 0.0001                         | 10      |            |   | 406       | 2027    | 5.4           | 0.534        |                                             | 10      |           |         |               |              |                |
| THIO N:                                                                        | 0.735132                       | 11      |            | X | 407       | 2051    | 5.8           | 0.636        | Over-titrated.                              | 11      |           |         |               |              |                |
| Sampled Flask                                                                  | Yes                            | 12      |            |   | 408       | 3037    | 5.9           | 1.666        |                                             | 12      |           |         |               |              |                |
| Water Seal?                                                                    | No                             | 13      |            |   | 409A      | 2025    | 6.4           | 2.795        |                                             | 13      | 409B      | 2017    | 6.4           | 2.799        |                |
| Reagent Change?                                                                | MnCl <sub>2</sub>              | 14      |            |   | 410       | 2015    | 6.8           | 2.788        |                                             | 14      |           |         |               |              |                |
| (Please circle reagent that was changed prior to sampling and standardization) | NaI/NaOH                       | 15      |            |   | 411       | 1465    | 7.4           | 3.323        |                                             | 15      |           |         |               |              |                |
| NOTE NEW BATCH IN LOG BOOK                                                     | H <sub>2</sub> SO <sub>4</sub> | 16      |            |   | 412A      | 3018    | 7.7           | 3.720        |                                             | 16      | 412B      | 1460    | 7.7           | 3.716        |                |
|                                                                                | KIO <sub>3</sub>               | 17      |            |   | 413       | 2016    | 7.9           | 3.813        |                                             | 17      |           |         |               |              |                |
|                                                                                | THIO                           | 18      |            |   | 414       | 2000    | 8.1           | 4.638        |                                             | 18      |           |         |               |              |                |
| Notes:                                                                         |                                | 19      |            |   | 415       | 3032    | 8.5           | 5.306        |                                             | 19      |           |         |               |              |                |
|                                                                                |                                | 20      |            |   | 416A      | 3000    | 8.7           | 6.549        |                                             | 20      | 416B      | 3033    | 8.7           | 6.570        |                |
|                                                                                |                                | 21      |            |   | 417       | 2007    | 8.7           | 6.623        |                                             | 21      |           |         |               |              |                |
|                                                                                |                                | 22      |            |   | 418       | 1429    | 8.7           | 6.679        |                                             | 22      |           |         |               |              | leaking bottom |
|                                                                                |                                | 23      |            |   | 419       | 3020    | 8.7           | 6.630        |                                             | 23      |           |         |               |              |                |
|                                                                                |                                | 24      |            |   | 420       | 3158    | 8.7           | 6.629        |                                             | 24      |           |         |               |              |                |

Bottle integrity: First test the top vent (V) by opening the lower spigot (S) then test the spigot by opening the vent. Mark 'x' in the appropriate column if either fails the integrity check and explain this in the comments column.

P20 LoopA 3116 t= 8.4 Sample '911' 6.961  
P20 LoopB 3042 Sample '911' 6.845  
Loop 58A 439 8.4 Sample '912' 8.341 very fizzy water  
Loop 58B 2065 Sample '912' 8.718

# Dissolved Oxygen Analysis Log Sheet

Institute of Ocean Sciences  
Water Properties Group

Last Updated: July 2015



| Cruise and Analysis Information                                                |    |  |  |      |     |     | Nisk ID | Nisk Int V | Nisk Int S | Sample ID | Flask 1 | Draw T 1 (°C) | OXY-1 (mL/L)                           | OXY-1 Comments | Nisk ID | Sample ID | Flask 2 | Draw T 2 (°C) | OXY-2 (mL/L) | OXY-2 Comments |
|--------------------------------------------------------------------------------|----|--|--|------|-----|-----|---------|------------|------------|-----------|---------|---------------|----------------------------------------|----------------|---------|-----------|---------|---------------|--------------|----------------|
| Cruise Number: 2016-01                                                         | 1  |  |  |      |     |     | 1       |            |            |           |         |               |                                        |                |         |           |         |               |              |                |
| Event: 61                                                                      | 2  |  |  |      |     |     | 2       |            |            |           |         |               |                                        |                |         |           |         |               |              |                |
| Station: P22                                                                   | 3  |  |  |      |     |     | 3       |            |            |           |         |               |                                        |                |         |           |         |               |              |                |
| Event Date (Local): 15 FEB 2016                                                | 4  |  |  |      |     |     | 4       |            |            |           |         |               |                                        |                |         |           |         |               |              |                |
| Analysis Date (Local): 18 FEB 2016                                             | 5  |  |  | 463A | 206 | 8.4 | 5       |            |            |           |         | lost sample   | Flask broken when box slid across deck | 6.719          |         |           |         |               |              |                |
| Analyst: MS                                                                    | 6  |  |  |      |     |     | 6       |            |            |           |         |               |                                        |                |         |           |         |               |              |                |
| Stdization Date (Local): 13 FEB 2016                                           | 7  |  |  |      |     |     | 7       |            |            |           |         |               |                                        |                |         |           |         |               |              |                |
| KIO <sub>3</sub> N: 0.012201                                                   | 8  |  |  |      |     |     | 8       |            |            |           |         |               |                                        |                |         |           |         |               |              |                |
| Standard Titer: 0.5185                                                         | 9  |  |  |      |     |     | 9       |            |            |           |         |               |                                        |                |         |           |         |               |              |                |
| Blank Titer: 0.0001                                                            | 10 |  |  |      |     |     | 10      |            |            |           |         |               |                                        |                |         |           |         |               |              |                |
| THIO N: 0.235132                                                               | 11 |  |  |      |     |     | 11      |            |            |           |         |               |                                        |                |         |           |         |               |              |                |
| Sample Flask (Yes)                                                             | 12 |  |  |      |     |     | 12      |            |            |           |         |               |                                        |                |         |           |         |               |              |                |
| Water Seal? No                                                                 | 13 |  |  |      |     |     | 13      |            |            |           |         |               |                                        |                |         |           |         |               |              |                |
| Reagent Change? MnCl <sub>2</sub>                                              | 14 |  |  |      |     |     | 14      |            |            |           |         |               |                                        |                |         |           |         |               |              |                |
| (Please circle reagent that was changed prior to sampling and standardization) | 15 |  |  |      |     |     | 15      |            |            |           |         |               |                                        |                |         |           |         |               |              |                |
| NOTE NEW BATCH IN LOG BOOK                                                     | 16 |  |  |      |     |     | 16      |            |            |           |         |               |                                        |                |         |           |         |               |              |                |
|                                                                                | 17 |  |  |      |     |     | 17      |            |            |           |         |               |                                        |                |         |           |         |               |              |                |
|                                                                                | 18 |  |  |      |     |     | 18      |            |            |           |         |               |                                        |                |         |           |         |               |              |                |
| Notes: NEST                                                                    | 19 |  |  |      |     |     | 19      |            |            |           |         |               |                                        |                |         |           |         |               |              |                |
|                                                                                | 20 |  |  |      |     |     | 20      |            |            |           |         |               |                                        |                |         |           |         |               |              |                |
|                                                                                | 21 |  |  |      |     |     | 21      |            |            |           |         |               |                                        |                |         |           |         |               |              |                |
|                                                                                | 22 |  |  |      |     |     | 22      |            |            |           |         |               |                                        |                |         |           |         |               |              |                |
|                                                                                | 23 |  |  |      |     |     | 23      |            |            |           |         |               |                                        |                |         |           |         |               |              |                |
|                                                                                | 24 |  |  |      |     |     | 24      |            |            |           |         |               |                                        |                |         |           |         |               |              |                |

Bottle integrity: First test the top vent (V) by opening the lower spigot (S) then test the spigot by opening the vent. Mark 'x' in the appropriate column if either fails the integrity check and explain this in the comments column.

# Dissolved Oxygen Analysis Log Sheet

Institute of Ocean Sciences  
Water Properties Group

\* Note ran loop 64 in the wrong order (reverse) switching the flask #5.

Last Updated: July 2015



| Cruise and Analysis Information                                                |  | Nisk ID | Nisk Int V | Nisk Int S | Sample ID | Flask 1 | Draw T 1 (°C) | OXY-1 (mL/L) | OXY-1 Comments                                              | Nisk ID | Sample ID  | Flask 2 | Draw T 2 (°C) | OXY-2 (mL/L) | OXY-2 Comments                               |
|--------------------------------------------------------------------------------|--|---------|------------|------------|-----------|---------|---------------|--------------|-------------------------------------------------------------|---------|------------|---------|---------------|--------------|----------------------------------------------|
| Cruise Number: 2016-01                                                         |  | 1       |            |            |           |         |               |              |                                                             | 1       |            |         |               |              |                                              |
| Event: 63                                                                      |  | 2       |            |            |           |         |               |              |                                                             | 2       |            |         |               |              |                                              |
| Station: P24                                                                   |  | 3       |            |            |           |         |               |              |                                                             | 3       |            |         |               |              |                                              |
| Event Date (Local): 15 FEB 2016                                                |  | 4       |            |            |           |         |               |              |                                                             | 4       |            |         |               |              |                                              |
| Analysis Date (Local): 18 FEB 2016                                             |  | 5       |            |            |           |         |               |              |                                                             | 5       |            |         |               |              |                                              |
| Analyst: MB                                                                    |  | 6       |            |            |           |         |               |              |                                                             | 6       |            |         |               |              |                                              |
| Stdization Date (Local): 13 FEB 2016                                           |  | 7       |            |            |           |         |               |              |                                                             | 7       |            |         |               |              |                                              |
| KIO <sub>3</sub> N: 0.012201                                                   |  | 8       |            |            |           |         |               |              |                                                             | 8       |            |         |               |              |                                              |
| Standard Titer: 0.5185                                                         |  | 9       |            |            |           |         |               |              |                                                             | 9       |            |         |               |              |                                              |
| Blank Titer: 0.0001                                                            |  | 10      |            |            |           |         |               |              |                                                             | 10      |            |         |               |              |                                              |
| THIO N: 0.235132                                                               |  | 11      |            |            |           |         |               |              |                                                             | 11      |            |         |               |              |                                              |
| Sample Flask Yes                                                               |  | 12      |            |            |           |         |               |              |                                                             | 12      |            |         |               |              |                                              |
| Water Seal? No                                                                 |  | 13      |            |            |           |         |               |              |                                                             | 13      |            |         |               |              |                                              |
| Reagent Change? MnCl <sub>2</sub>                                              |  | 14      |            |            |           |         |               |              |                                                             | 14      |            |         |               |              |                                              |
| (Please circle reagent that was changed prior to sampling and standardization) |  | 15      |            |            |           |         |               |              |                                                             | 15      |            |         |               |              |                                              |
| NOTE NEW BATCH IN LOG BOOK                                                     |  | 16      |            |            | 481A      | 505     | 7.8           | 6.783        |                                                             | 16      | 481B       | 121     | 7.9           | lost sample  | Sample broke when box slid across deck.      |
|                                                                                |  | 17      |            |            | 2055      | 2055    | 7.5           | 7.128        | Sample '917'                                                | 17      | P24 LOOP 6 | 3137    | 7.5           | 6.972        | Sample '917'                                 |
|                                                                                |  | 18      |            |            | 2024      | 3024    | 7.4           | 7.552        | Sample '918' over-titrated. (Used wrong flask #! used 1407) | 18      | 2024       | 1407    | 7.4           | 7.301        | Sample '918' (Used wrong flask #! used 3124) |
| Notes:                                                                         |  | 19      |            |            |           |         |               |              |                                                             | 19      |            |         |               |              |                                              |
| Used old STD date since NaOH/NaI changed after this.                           |  | 20      |            |            |           |         |               |              |                                                             | 20      |            |         |               |              |                                              |
|                                                                                |  | 21      |            |            |           |         |               |              |                                                             | 21      |            |         |               |              |                                              |
|                                                                                |  | 22      |            |            |           |         |               |              | leaking on bottom                                           | 22      |            |         |               |              |                                              |
|                                                                                |  | 23      |            |            |           |         |               |              |                                                             | 23      |            |         |               |              |                                              |
|                                                                                |  | 24      |            |            |           |         |               |              |                                                             | 24      |            |         |               |              |                                              |

Bottle integrity: First test the top vent (V) by opening the lower spigot (S) then test the spigot by opening the vent. Mark 'x' in the appropriate column if either fails the integrity check and explain this in the comments column.

# Dissolved Oxygen Analysis Log Sheet

Institute of Ocean Sciences  
Water Properties Group

Last Updated: July 2015



| Cruise and Analysis Information |            |            |           |         |               |              |                |         |           |         |               |              |                |
|---------------------------------|------------|------------|-----------|---------|---------------|--------------|----------------|---------|-----------|---------|---------------|--------------|----------------|
| Nisk ID                         | Nisk Int V | Nisk Int S | Sample ID | Flask 1 | Draw T 1 (°C) | OXY-1 (mL/L) | OXY-1 Comments | Nisk ID | Sample ID | Flask 2 | Draw T 2 (°C) | OXY-2 (mL/L) | OXY-2 Comments |
| 1                               |            |            | 514       | 569     | 29            | 3.216        |                | 1       |           |         |               |              |                |
| 2                               |            |            | 515       | 3132    | 28            | 3.167        |                | 2       |           |         |               |              |                |
| 3                               |            |            | 516       | 3129    | 28            | 2.927        |                | 3       |           |         |               |              |                |
| 4                               |            |            | 517       | 2014    | 30            | 2.495        |                | 4       |           |         |               |              |                |
| 5                               |            |            | 518       | 3022    | 33            | 1.919        |                | 5       | 518       | 3022    | 33            | 1.933        |                |
| 6                               |            |            | 519       | 3134    | 34            | 1.225        |                | 6       |           |         |               |              |                |
| 7                               |            |            | 520       | 3133    | 38            | 0.585        |                | 7       |           |         |               |              |                |
| 8                               |            |            | 521       | 3131    | 40            | 0.488        |                | 8       |           |         |               |              |                |
| 9                               |            |            | 522       | 3135    | 45            | 0.492        |                | 9       |           |         |               |              |                |
| 10                              |            |            | 523       | 3125    | 47            | 0.533        |                | 10      |           |         |               |              |                |
| 11                              |            |            | 524       | 3126    | 52            | 0.633        |                | 11      |           |         |               |              |                |
| 12                              |            |            | 525       | 3144    | 55            | 1.302        |                | 12      |           |         |               |              |                |
| 13                              |            |            | 526       | 3147    | 57            | 2.015        |                | 13      |           |         |               |              |                |
| 14                              |            |            | 527       | 3150    | 58            | 2.465        |                | 14      | 527       | 3138    | 59            | 2.461        |                |
| 15                              |            |            | 528       | 3142    | 61            | 3.009        |                | 15      |           |         |               |              |                |
| 16                              |            |            | 529       | 3036    | 62            | 3.334        |                | 16      |           |         |               |              |                |
| 17                              |            |            | 530       | 3016    | 65            | 3.609        |                | 17      |           |         |               |              |                |
| 18                              |            |            | 531       | 3191    | 65            | 4.795        |                | 18      |           |         |               |              |                |
| 19                              |            |            | 532       | 3143    | 72            | 6.583        | Leaky bottom   | 19      |           |         |               |              |                |
| 20                              |            |            | 533       | 3148    | 73            | 6.769        |                | 20      | 533       | 3145    | 73            | 6.775        |                |
| 21                              |            |            | 534       | 3146    | 73            | 6.784        |                | 21      |           |         |               |              |                |
| 22                              |            |            | 535       | 3209    | 73            | 6.781        | Leaky bottom   | 22      |           |         |               |              |                |
| 23                              |            |            | 536       | 3201    | 72            | 6.795        |                | 23      |           |         |               |              |                |
| 24                              |            |            | 537       | 3194    | 74            | 6.783        |                | 24      | 537       | 3190    | 74            | 6.784        |                |

Bottle integrity: First test the top vent (V) by opening the lower spigot (S) then test the spigot by opening the vent. Mark 'x' in the appropriate column if either fails the integrity check and explain this in the comments column.

P26 Loop A @ 5m 3198 ~ 7.0 Sample '919' 7.045 Loop 71 A 1223 Sample '920' ~ 7.0 7.571  
P26 Loop B 3193 ~ 7.0 Sample '919' 7.135 Loop 71 B 1175 Sample '920' ~ 7.0 7.185  
(Temp taken ~ 30 min after)

LOOPS → HEADING HOME

| Dissolved Oxygen Analysis Log Sheet                                            |  |         |              |           |         |               |              |                                                                       |         | Last Updated: July 2015                                                             |         |               |              |                |                            |
|--------------------------------------------------------------------------------|--|---------|--------------|-----------|---------|---------------|--------------|-----------------------------------------------------------------------|---------|-------------------------------------------------------------------------------------|---------|---------------|--------------|----------------|----------------------------|
| Institute of Ocean Sciences<br>Water Properties Group                          |  |         |              |           |         |               |              |                                                                       |         |  |         |               |              |                |                            |
| Cruise and Analysis Information                                                |  | Nisk ID | Nisk Int V S | Sample ID | Flask 1 | Draw T 1 (°C) | OXY-1 (mL/L) | OXY-1 Comments                                                        | Nisk ID | Sample ID                                                                           | Flask 2 | Draw T 2 (°C) | OXY-2 (mL/L) | OXY-2 Comments |                            |
| Cruise Number: 2016-01                                                         |  | 1       |              | Loop 770  | 2056    | 6.8           | 7.217        | Sample '921'                                                          | 1       | Loop 770                                                                            | 2068    | 6.8           | 7.173        | Sample '921'   | NESSY                      |
| Event: 78 → 95                                                                 |  | 2       |              |           |         |               |              |                                                                       | 2       |                                                                                     |         |               |              |                |                            |
| Station: Loops                                                                 |  | 3       |              | Loop 822  | 3081    | 8.3           | 6.765        | Sample '922'                                                          | 3       | Loop 822                                                                            | 3079    | 8.3           | 6.876        | Sample '922'   | NESSY                      |
| Event Date (Local): 17 FEB → 20 FEB 2016                                       |  | 4       |              |           |         |               |              |                                                                       | 4       |                                                                                     |         |               |              |                |                            |
| Analysis Date (Local): 19 FEB 2016 - 20 FEB                                    |  | 5       |              | Loop 770  | 3005    | 7.1           | 6.954        | Sample '923'                                                          | 5       | Loop 770                                                                            | 196     | 7.2           | 7.023        | Sample '923'   |                            |
| Analyst: m3                                                                    |  | 6       |              |           |         |               |              |                                                                       | 6       |                                                                                     |         |               |              |                |                            |
| Stdization Date (Local): 19 FEB 2016                                           |  | 7       |              | Loop 866  | 1471    | 8.6           | 6.840        | Sample '924'                                                          | 7       | Loop 866                                                                            | 456     | 8.6           | 6.921        | Sample '924'   |                            |
| KIO <sub>3</sub> N: 0.612201                                                   |  | 8       |              |           |         |               |              |                                                                       | 8       |                                                                                     |         |               |              |                |                            |
| Standard Titer: 0.5186                                                         |  | 9       |              | Loop 820  | 3073    | 8.9           | 6.850        | Sample '925'                                                          | 9       | Loop 820                                                                            | 3078    | 8.9           | 6.741        | Sample '925'   |                            |
| Blank Titer: 0.0002                                                            |  | 10      |              |           |         |               |              |                                                                       | 10      |                                                                                     |         |               |              |                |                            |
| THIO N: 0.2351164                                                              |  | 11      |              | Loop 911  | 1406    | 8.9           | BAD          | Sample '926' Left large bubble in this line when flushing bad result! | 11      | Loop 911                                                                            | 396     | 8.9           | 6.543        | Sample '926'   | FLASK ID MISSING Used 1406 |
| Sample Flask Water Seal? Yes                                                   |  | 12      |              |           |         |               |              |                                                                       | 12      |                                                                                     |         |               |              |                |                            |
| Reagent Change? MnCl <sub>2</sub>                                              |  | 13      |              | Loop 933  | 3005    | 9.5           | 6.777        | Sample '927'                                                          | 13      | Loop 933                                                                            | 196     | 9.5           | 6.761        | Sample '927'   | IN BOX FREE 09501          |
| (Please circle reagent that was changed prior to sampling and standardization) |  | 14      |              |           |         |               |              |                                                                       | 14      |                                                                                     |         |               |              |                |                            |
| NOTE NEW BATCH IN LOG BOOK                                                     |  | 15      |              | Loop 951  | 2025    | 10.0          | 6.530        | Sample '928'                                                          | 15      | Loop 951                                                                            | 2017    | 10.0          | 6.645        | Sample '928'   |                            |
|                                                                                |  | 16      |              |           |         |               |              |                                                                       | 16      |                                                                                     |         |               |              |                |                            |
|                                                                                |  | 17      |              |           |         |               |              |                                                                       | 17      |                                                                                     |         |               |              |                |                            |
|                                                                                |  | 18      |              |           |         |               |              |                                                                       | 18      |                                                                                     |         |               |              |                |                            |
|                                                                                |  | 19      |              |           |         |               |              |                                                                       | 19      |                                                                                     |         |               |              |                |                            |
|                                                                                |  | 20      |              |           |         |               |              |                                                                       | 20      |                                                                                     |         |               |              |                |                            |
|                                                                                |  | 21      |              |           |         |               |              |                                                                       | 21      |                                                                                     |         |               |              |                |                            |
|                                                                                |  | 22      |              |           |         |               |              |                                                                       | 22      |                                                                                     |         |               |              |                |                            |
|                                                                                |  | 23      |              |           |         |               |              |                                                                       | 23      |                                                                                     |         |               |              |                |                            |
|                                                                                |  | 24      |              |           |         |               |              |                                                                       | 24      |                                                                                     |         |               |              |                |                            |

Bottle integrity: First test the top vent (V) by opening the lower spigot (S) then test the spigot by opening the vent. Mark 'x' in the appropriate column if either fails the integrity check and explain this in the comments column.