Science Olympiad Regional
February 2012

Chem Lab Station 1

KEY

156 pts
Overall Score

Overall Rank

Chem Lab Student Answer Sheet

Team # __**KEY**__

School Name: __**KEY**__

Student Name: __**KEY**__

Student Name: __**KEY**__

Note to graders: All problems are worth 2 points each except problems 13-22 in Station 1 which are worth 1 points each. There is no partial credit for any problem unless otherwise specified or agreed upon by all exam graders. There are 156 possible points: 74 pts from Station 1 and 82 pts from Station 2. If tallying pts by page, there are 16 possible points (pp) on page 1; 18 pp on page 2; 40 pp on page 3; 38 pp on page 4; and 44 pp on page 5.

STATION 1: OXIDATION/REDUCTION

- **Give three (2) points for a data table that contains at least six electrode combinations with reasonable voltages recorded for each combination (-3V to 3V).**
  - **Give two (1) points for 2-5 electrode combinations with reasonable voltages.**
  - **Give no credit for 1 electrode combination, if data is missing, unorganized, or unreasonable. No credit if there isn't at least one mention units.**

2. **$2\ H^+ + 2\ e^- \rightarrow H_2$**

3. **$Fe \rightarrow Fe^{3+} + 3\ e^-$**

4. **$2\ H^+ + 2\ e^- \rightarrow H_2$**

5. **$Zn \rightarrow Zn^{2+} + 2\ e^-$**

6. **Mg, Zn, Fe**

7. **0.00027 Watts (W) or 0.27 mW**

8. **296**

16 pts
Page total

9. $Co^{2+} \rightarrow Co^{3+} + 1e^-$ (oxidation)

10. $ClO_3^- + 6\,H^+ + 6\,e^- \rightarrow Cl^- + 3\,H_2O$ (reduction)

11. $SO_3^{2-} + 2\,OH^- \rightarrow SO_4^{2-} + H_2O + 2\,e^-$ (oxidation)

12. $Pb(OH)_4^{2-} + ClO^- \rightarrow PbO_2 + Cl^- + 2\,OH^- + H_2O$

13. $Cr \rightarrow Cr^{3+} + 3\,e^-$

14. $Cu^{2+} + 2\,e^- \rightarrow Cu$

15. $2\,Cr + 3\,Cu^{2+} \rightarrow 2\,Cr^{3+} + 3\,Cu$

16. Cr

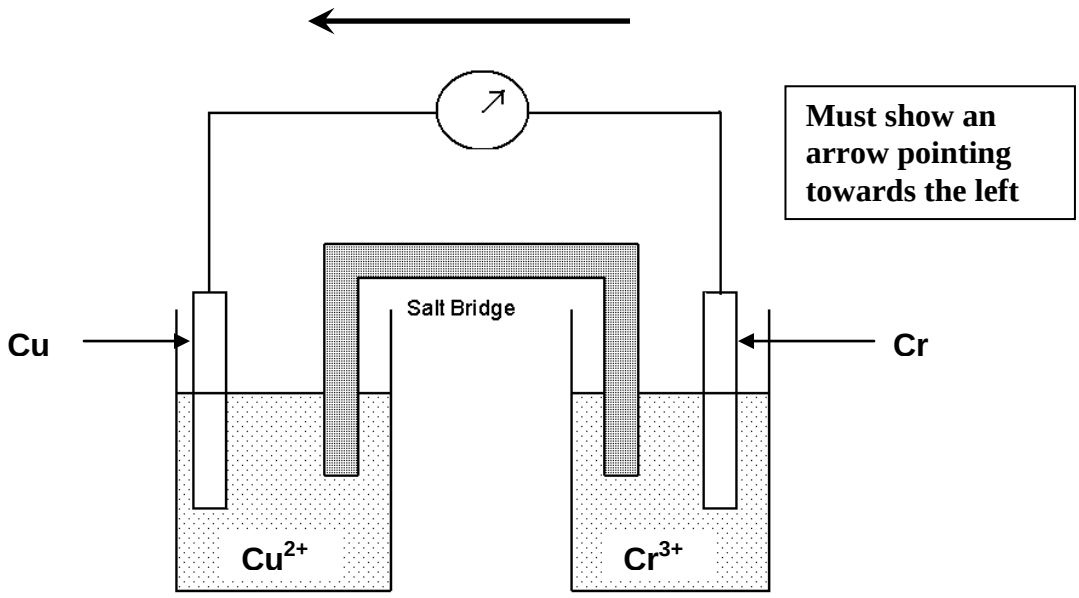
17. Cu^{2+}

18. Cu^{2+}

19. Cr

Note: Problems 13 – 22 in Station 1 are worth 1 point each. There is no partial credit available.

20.



21. Copper (cathode)

22. 1.08 V

18 pts
Page total

23. a) $PbO_2 + Pb + 4\,H^+ + 2\,SO_4^{2-} \rightarrow 2\,PbSO_4 + 2\,H_2O$

b) $Pb^0 \rightarrow Pb^{2+} + 2\,e^-$

c) $Pb^{4+} + 2\,e^- \rightarrow Pb^{2+}$

d) $Pb + Pb^{4+} \rightarrow 2\,Pb^{2+}$

e) 12V

f) $2\,PbSO_4 + 2\,H_2O \rightarrow PbO_2 + Pb + 4\,H^+ + 2\,SO_4^{2-}$

g) H_2SO_4 (sulfuric acid)

Note: Each problem (21a, 21b, etc.) is worth 2 points. No partial credit.

24. a) $2\,Ag^+ + Cd \rightarrow 2\,Ag + Cd^{2+}$

b) +0.40 V

c) Anions flow into the cadmium half cell

d) Voltage will INCREASE

e) Voltage will DECREASE

25. B

26. D

27. C

26. B

29. E

30. A

31. C

32. A

40 pts

Page total

All problems are worth 2 pts each. No partial credit unless otherwise specified.

STATION 2: Periodicity

1. Balanced equation #1:

$$CaO + H_2O \rightarrow Ca(OH)_2$$

2. Balanced equation #2:

$$MgO + H_2O \rightarrow Mg(OH)_2$$

3. Balanced equation #3:

$$CO_2 + H_2O \rightarrow H_2CO_3$$

4. Balanced equation #4:

$$SO_2 + H_2O \rightarrow H_2SO_3$$

5. **Ca and Mg are metals; C and S are nonmetals**

6. **Metal oxides in water produce bases; nonmetal oxides in water produce acids**

7. **pH = 13.5** (give credit for any answer between 12.5 and 14.0)

8. **(Dmitri) Mendeleev**

9. **(Henry) Moseley**

10. **Ununoctium**

11. **Groups 3-11** (do not give credit if group 12 is mentioned)

12. **Increases**

13. **Decreases**

14. **Decreases**

15. **Increases**

16. **Decreases**

17. **Increases**

18. **Increases**

19. **Decreases**

38 pts
Page total

20. **Bismuth (Bi)**

21. **Uranium (U)**

22. **Technetium (Tc)**

23. **Hexagonal**

    Cubic

All problems are worth 2 pts each. No partial credit unless otherwise specified

any order, 2 pts. each

24. **London Dispersion Forces** (or Dispersion forces; do not accept Van der Waals Forces)

25. **Chlorine molecules have fewer electrons and/or lower molecular mass than bromine molecules.** (Do not accept Cl has weaker intermolecular forces)

26. **$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^2\ 4s^2$** (give credit if $3d^2\ 4s^2$ are inverted)

27. **$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^2$** (no 4s electrons)

28. **Ti^{3+} has a lone 3d electron that can undergo transitions between split "d" orbitals, releasing photons in the visible region. Sc^{3+} has no "d" electrons (must include full response for credit)**

29. **$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^1$** (give credit if $3d^5\ 4s^1$ are inverted)

30. **Rare Earth Metals**

31. **$2\ Cl^- \rightarrow Cl_2 + 2\ e^-$**

32. **$Na^+ + 1\ e^- \rightarrow Na$**

33. **B**

34. **C**

35. **B**

36. **C**

37. **B**

38. **A**

39. **A**

40. **B**

44 pts
Page total