**33. Determine the oxidation number of the underlined element in each of the following chemical formulas. Your answers must include any calculations and/or reasoning in how you derived the oxidation numbers.**

**a. O3**oxidation number: 0.

The oxidation number for an element is always zero, regardless of its subscript.

**b. H3PO4**

oxidation number: +5

The oxidation number of oxygen in a compound is -2, and hydrogen is +1. Therefore, in a neutral compound H3PO4 where the charges are balanced, the oxidation number of P is 0- (-2 \* 4) – 3 = +5

**c. MnO3-**

Oxidation number: +5

The oxidation number of oxygen in a compound is -2. In a compound where the total charges is -1, the oxidation number of Mn is -1 – (-2 \*3) = 5

**d. C2O42-**

Oxidation number: +3

The oxidation number of oxygen in a compound is -2. In a compound where the total charge is -2, the oxidation number of C is (-2 – (-2 \*4))/2 = +3

**34. a. Identify the element oxidized and the element reduced, in this chemical equation:**



Oxidized element: As. Oxidation number changed from +5 to +3

Reduced element: S. Oxidation number changed from -2 to 0

**b. Identify the oxidizing agent and the reducing agent.**

As in H3AsO4 is oxidized, therefore H3AsO4 is the reducing agent.

S in H2S is reduced, therefore H2S is the oxidizing agent.

**c. Justify why this is a redox reaction.**

Yes, this is a redox reaction because the oxidation number of As and S changed.

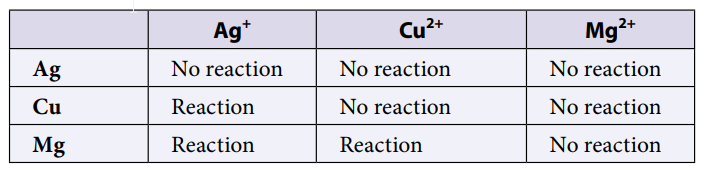
**35. Balance the following redox equation, using half-reaction. All step must be shown in your solutions for full mark to be earned. Assume that the reaction occurs in an aqueous solution.**



|  |  |
| --- | --- |
| Step 1: Identifying half-reactions | Cr2O72- -> Cr3+  NO -> NO3- |
| Step 2: Balance all the elements except hydrogen and oxygen | Cr2O72- -> 2Cr3+  NO -> NO3- |
| Step 3: balance the oxygen atoms by add H2O to the appropriate side | Cr2O72- -> 2Cr3+ + 7H2O  2H2O + NO -> NO3- |
| Step 4: Balance the hydrogen by add H+ | 14H+ + Cr2O72- -> 2Cr3+ + 7H2O  2H2O + NO -> NO3- + 4H+ |
| Step 5: Balance the charges by adding electrons | 12e- + 14H+ + Cr2O72- -> 2Cr3+ + 7H2O + 6e-  2H2O + NO -> NO3- + 4H+ + 3e- |
| Step 6: Multiply one or both half-reactions by a whole number so that the number of electrons gained and lost is equal | 6e- + 14H+ + Cr2O72- -> 2Cr3+ + 7H2O  2H2O + NO -> 3NO3- + 12H+ + 6e- |
| Step 7: Add the half-reaction. Subtract any chemicals that are common to both sides | 6H+ + Cr2O72- + 2NO -> 2Cr3+ + 7H2O + 2NO3- |

**36. Small pieces of silver, copper, and magnesium are placed in solutions that contain one of the following ions: Ag+, Cu2+, and Mg2+. The metal/solution combinations tested are summarized in the following table. Any reaction that occurred followed the pattern**

M(s) + B+(aq) -> B(s) + M+(aq), where M is a general metal and B+ is a general metal ion. Here is the summary of the observations:



**In a column, list the oxidizing agents (those being reduced), with the SOA (strongest oxidizing agent) at the top. In a second column, list the reducing agents (those being oxidized), with the SRA (strongest reducing agent) at the bottom. Label the SOA and the SRA.**

|  |  |
| --- | --- |
| Oxidizing Agents | Reducing Agents |
| Ag+­(SOA) | Mg(SRA) |
| Cu2+ | Cu |
| Mg2+ | Ag |

**37. A water-testing report showed that the water in the drinking fountains in a 50-year-old elementary school contained slightly more than the acceptable level of dissolved lead. Lead levels were highest in the morning and the decreased during the school day.**

**a. Identify a possible source of the lead contamination.**

One possible source of lead is the soldered joints between pipes

**b. Why was the presence of lead a concern?**

Lead is a toxic substance that when consumed, can cause lead poisoning. Symptoms of lead poisoning in children include learning difficulties, loss of appetite, developmental delay, etc.

**c. Why was the amount of lead in the water highest in the sample taken early each morning?**

Since it is possible the lead in the water comes from the solder joints between pipes. In the night when there is minimal water flow, the accumulation of lead is higher than that during the day. Therefore, taking sample in the morning would yield the highest amount of lead in the water.

**d. Closing or renovating the school was not an option. The principal considered two options for supplying the school with fresh, safe drinking water. Identify one advantage and one disadvantage of each of these two options, which follow. In your opinion, which option should she choose? Why?**

**i. Supply bottled water to 500 students and staff each day.**

Advantage: quick access to clean, safe water source.

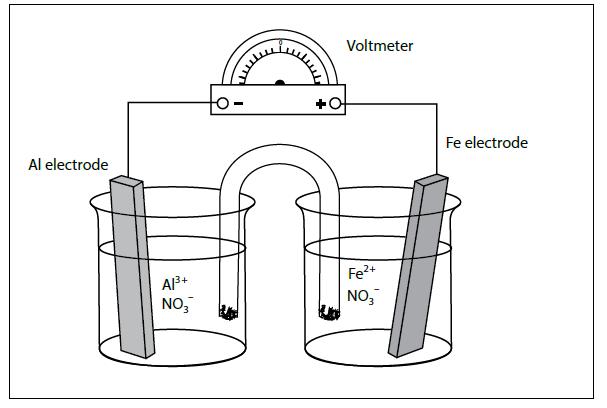
Disadvantage: expensive; creates excess waste

**ii. Have custodians open the taps each morning for about 30 minutes.**

Advantage: less expensive than supplying bottled water

Disadvantage: Wasteful of water resource.

The principal should choose the second option. As convenient as it is to supply bottled water, it also creates a high amount of plastic waste. While keeping the taps running for 30minutes every morning can be wasteful, it effect is not as severe as producing plastic waste. Therefore, the principal should choose the second option and have custodians open the taps each morning for about 30 minutes.

**38. The following figure shows a diagram of an Al/Fe galvanic cell. Use the diagram to answer the questions that follow it.**

**a. Predict the anode half-cell reaction, the cathode half-cell reaction, and the overall cell reaction that occurs as this cell operates.**

Anode(oxidation):

Cathode(reduction):

Overall reaction:

**b. Predict the overall cell potential.**

Cell potential of half reactions:

Overall cell potential:

**c. Describe the direction of ion and electron flow in the diagram.**

Electrons flow from Al electrode to the Fe electrode, through the wire and the voltmeter.

Al3+ ions move towards the salt bridge

NO3- ions move towards the salt bridge

**39. What is the half-reaction for the reduction of oxygen that occurs with the corrosion of iron? Using this reaction, explain why corrosion occurs more slowly in dry climates.**

This half reaction requires both oxygen and water. Therefore, in dry climates when there is less water present in the air, corrosion occur more slowly

**40. Which provides better protection against corrosion: painting a metal or galvanizing a metal? Justify your prediction**

Painting a metal is relatively primitive; the coating can be easily damaged and expose the underlying metal to corrosion. Galvanizing, on the other hand, provides better protection by adding a layer of sacrificial anode coating. The coating is made of materials that oxidizes more readily than the metal being protected, and when it does, forms a protective layer that prevents further corrosion from occurring. Therefore, galvanizing a metal provides better protection against corrosion.

41. **a. Research and write one paragraph describing two advantages of using hydrogen to fuel cars.**

Hydrogen-fueled cars possess many outstanding qualities. Firstly, the quantity of hydrogen fuel is nearly infinite. Hydrogen is the most abundant element in the universe. By using hydrogen as fuel, there is no longer need for conventional fuels such as oil and gas. There will be reduced dependence on oil-producing companies. Consequently, this allows more oil and gas resource to be allocated for other industrial purposes, freeing up more resource. Secondly, compared to conventional fuel such as oil and gas, hydrogen-powered cars are more environmentally friendly. Hydrogen cars are driven by renewable electricity, and no combustion reactions will take place. Therefore, there will be no emission of greenhouse gases like carbon dioxide, which is a significant side product of the combustions taking in place in gasoline engines.

**b. Research and write one paragraph about two technical or logistical problems we face in trying to fuel cars with hydrogen.**

Firstly, although there is a virtually unlimited amount of hydrogen in the universe, pure hydrogen is scarce on Earth or in the atmosphere. This requires hydrogen to be produced. The process that creates pure hydrogen is the extraction of hydrogen from methane, a process which emits natural gas to the atmosphere, increasing environmental risk. Secondly, transporting hydrogen fuel can be expensive and dangerous. Hydrogen reacts readily with the oxygen. A significant amount of energy is released when hydrogen combusts with oxygen. To counter this danger, expensive equipment, and large trucks would have to be used to transport hydrogen. Consequently, the cost and risks associated with transporting hydrogen would increase.

**42. A geothermal system is initially more expensive to set up than a conventional heating and cooling system, but the annual operating costs are much cheaper.**

**a. How many years would it take for the geothermal system to pay for itself? Assume that you are looking to install a new system, and that you can obtain a government grant to do so. Use the costs that were mentioned on the previous page. Show all of your calculations.**

Installation Costs

Geothermal system: $20 000

Conventional system: $3500

Government grant for geothermal installations: $7000

Operating Costs:

Geothermal: $100/month

Conventional: $150/month, plus $400/yr for air conditioning

**b. From an environmental perspective, describe two other advantages of switching to a geothermal system.**

1. Geothermal heating utilizes the natural source of heat that is naturally stored in the earth. Using geothermal heating reduces the use of conventional heating, which is primarily done by burning fossil fuels.

2. Less emission of greenhouse gases and air pollutants

43. A 2.56g sample of anthracene, C14H10, was burned to heat an aluminum calorimeter (mass = 948 g). The calorimeter contained 1.50L of water with an initial temperature of 20.5C and a final temperature of 34.3C.

a. Calculate the molar heat of combustion of anthracene.

Given: mass of anthracene, ma = 2.56g

mass of aluminum, mal = 0.948kg

mass of water = 1.50kg

Tinitial = 20.5◦C

Tfinal = 34.3◦C

Cwater = 4.18J/g◦C

Caluminum = 0.900J/g◦C

The molar heat of the combustion of anthracene is 6.85 \* 106J/mol

b. Write the thermochemical equation, two ways, for the complete combustion of anthracene.

c. If the actual value for ΔH = -7150 kJ/mol, what is the percentage error?

The percentage error is 4%

44. Write the thermochemical equations, two ways, for each of the following situations.

a. When 1 mole of NH4Cl is dissolved in water, 25.0kJ is lost by the water.

b. When acetic acid is neutralized by sodium hydroxide, 76 kJ (per mole of acetic acid) of heat is released.

**45. You have been asked to write an opinion for an environmental magazine about the benefits of purchasing a hybrid vehicle for day-to-day driving. You can use some of the information in the lesson to help get you started, but you will have to do some additional research at a library or at home, on the Internet. You should use at least two sources, which you must list in a properly formatted bibliography. Your answer to this Key Question should be about 500 words long.**

**Your writing should include the following:**

* **An explanation of the operation of a hybrid car, including how it reduces greenhouse gas emissions.**
* **The benefits of hybrid cars**
* **The concerns about hybrid cars**
* **At least three detailed explanations to support your opinion on whether you believe that the benefits outweigh the concerns**
* **At least two sources, which you must list in a properly formatted “references” section**
* **Communication skills, such as proper spelling and full sentences, which will add to your marks**

With the rising concern of environmental stability and resource consumption, automakers have been looking for alternative fueling methods for automobiles. One such solution is the hybrid vehicle. A hybrid vehicle combines the internal combustion engine(ICE) with an electric motor and creates a dual power supply. Together with a power-split transmission, the ICE and the electric motor work together to provide the most fuel-efficient power at appropriate speeds. Hybrid vehicles have many desirable qualities such as environmental friendliness, affordability, and less dependence on fossil fuel.

Take the world’s most popular hybrid vehicle, the Toyota Prius, for example. Therefore, when the speed is below 25KPMH, all power is produced by the electric motors. This is because the ICE does not run efficiently at lower speeds. On the other hand, during normal cruising speed, the vehicle switches power supply from electric motor to gasoline engine, since this is the most efficient range of speed for gasoline engines to operate. When the vehicle undergoes heavy acceleration, the ICE and the electric motor provide power together along the power-split transmission, to provide maximum acceleration. When the vehicle brakes, no power is needed from both the ICE and the electric. When the vehicle is in idle, power is provided by the battery alone to keep the auxiliary systems running. The electric motor draws electricity from the battery, which is continuously charged by the spinning wheels.

When compared with petrol-only vehicles, hybrid cars have certain drawbacks. The biggest drawback is the cost. Hybrid cars are usually more expensive than petrol cars. In general, a hybrid model can cost an additional $5000 to $10000 to their standard model counterparts. For auto buyers, the additional cost can often be an undesirable factor when choosing cars. Another inconvenience of hybrid vehicles is the relatively less power they provide. As the primary source of power, the gasoline engine is smaller than that installed in standard petrol vehicles. Even when combined with the electric motor, which does not possess high power output either, the power of hybrid vehicles pale in comparison with that of petrol vehicles.

However, these deficiencies can be offset by the abundance of benefits hybrid cars have to offer. One of the biggest advantages of hybrid cars over petrol cars is that hybrid cars create less pollution. Petrol vehicles contribute a large part in the emission of greenhouse gases such as carbon dioxide, and other air pollutants. Hybrid vehicles would emit much less of these pollutants and are therefore environmental friendlier. Secondly, despite the disadvantage of the added cost to purchase, hybrid cars are more economical in the long run. In addition to the less use of gasoline, there are many government tax exempts and incentives provided by auto dealers to make hybrid cars more affordable. Finally, the combined power system consumes much less fuel than regular engines and reduce the dependence on fossil fuels. Consequently, this helps to lower the price of gasoline.

In conclusion, although hybrid cars have weaknesses that need improvement, the wealth of benefits outweighs the disadvantages and make hybrid cars an ideal selection. In the current state of environmental issues and energy crisis, hybrid cars are an exemplary representation of future automobiles.

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**46.** **Using Hess’s law, calculate the ΔH value for the following reaction.**

**Use these three reactions:**

|  |  |
| --- | --- |
| Reverse Fe2O3(s) + 3CO(g) -> 2Fe(s) + 3CO2(g) | 2Fe(s) + 3CO2(g) -> Fe2O3(s) + 3CO(g) ΔH = 25.0kJ |
| Multiply 2Fe(s) + 3CO2(g) -> Fe2O3(s) + 3CO(g) by 3 | 6Fe(s) + 9CO2(g) -> 3Fe2O3(s) + 9CO(g) ΔH = 75.0kJ |
| Add the first and second equation | 6Fe(s) + 9CO2(g) + 3Fe2O3(s) + CO(g)-> 3Fe2O3(s) + 9CO(g) + 2Fe3O4(s) + CO2(g)  ΔH = 75.0kJ+(-47.0kJ) = 28.0kJ |
| Cancel out items in both reactants and products | 6Fe(s) + 8CO2(g) -> 8CO(g) + 2Fe3O4(s) ΔH = 28.0kJ |
| Multiply Fe3O4(s) + CO(g) -> 3FeO(s) + CO2(g) by 2 | 2Fe3O4(s) + 2CO(g) -> 6FeO(s) + 2CO2(g)  ΔH = 38.0kJ \*2 = 76.0kJ |
| Add  6Fe(s) + 8CO2(g) -> 8CO(g) + 2Fe3O4(s) ΔH = 28.0kJ  With  2Fe3O4(s) + 2CO(g) -> 6FeO(s) + 2CO(g) ΔH = 76.0kJ | 6Fe(s) + 8CO2(g) + 2Fe3O4(s) + 2CO(g)  ->  8CO(g) + 2Fe3O4(s) + 6FeO(s) + 2CO2(g)  ΔH=28.0kJ + 76.0kJ = 104.0kJ |
| Cancel out items in both reactants and products | 6Fe(s) + 6CO2(g) -> 6FeO(s) + 6CO(g) ΔH = 104.0kJ |
| Divide both sides by 6 | Fe(s) + CO2(g) -> FeO(s) + CO(g) ΔH =17.33kJ |

The ΔH value for Fe(s) + CO2(g) -> FeO(s) + CO(g) is 17.33kJ

**47. Sodium bicarbonate (NaHCO3) is often used in the kitchen to extinguish fires. When heated, it decomposes into sodium carbonate, water vapor, and carbon dioxide. The ΔH for the reaction of 1 mole of sodium bicarbonate is +64.6kJ**

**a. Write a balanced thermochemical equation for this reaction.**

**b. Using the enthalpies of formation, calculate the enthalpy of formation of sodium bicarbonate**