1   Let us assume that the following reaction is in a state of equilibrium.

$$2 \, HI_{(g)} \leftrightarrow I_{2(g)} + H_{2(g)}$$
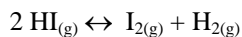
Which mathematical expression best explains the relation between the concentration of the reactants and the concentration of the products at equilibrium?
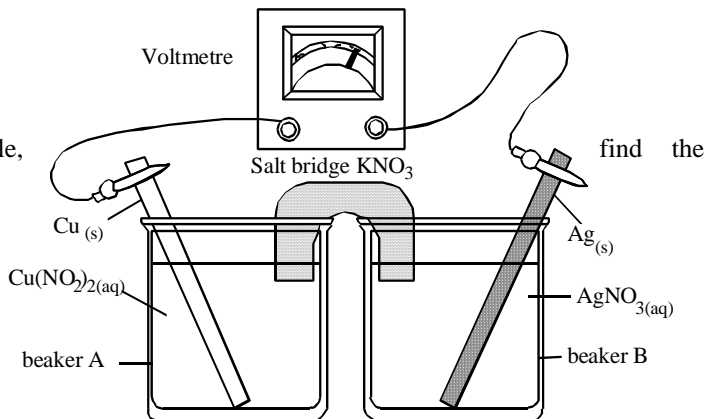
A) $\dfrac{[H_2] \bullet [I_2]}{[HI]^2}$ C) $\dfrac{[H_2] \bullet [I_2]}{[2 \, HI]}$

B) $\dfrac{[H_2] + [I_2]}{[HI]^2}$ D) $\dfrac{[HI]^2}{[H_2] + [I_2]}$

3   Below is a diagram of an electrochemical cell.

Using the data in the standard reduction potential table, find the oxidation-reduction potential for this cell.

4   A glass flask is filled with air at a pressure of 102 kPa and a temperature of 20.0°C. The thin glass tube extending horizontally from the flask is sealed with a plug of mercury (the plug is used to measure the change in volume of the air in the flask). The volume of the air in the flask is 515 cm^3.

The flask is immersed in warm water. The mercury plug moves along the horizontal tube. It eventually stops moving and indicates that the volume of the trapped air has increased by 15 cm^3.
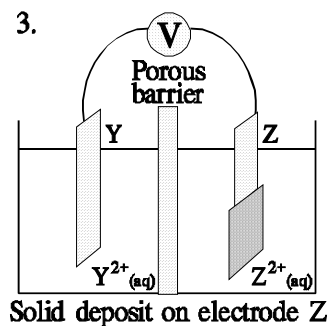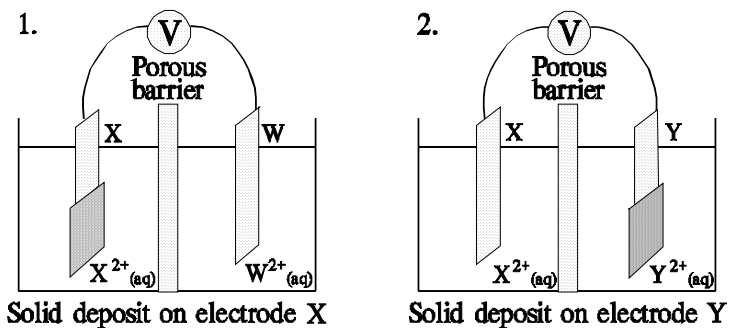
What was the temperature of the warm water that the flask was placed in?
(see choices on next page)
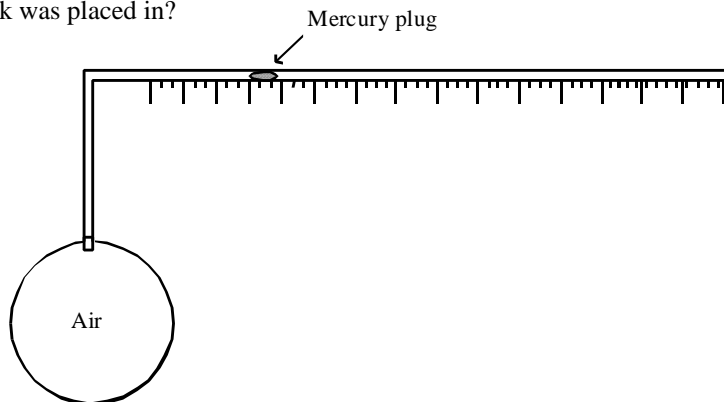
A)   33.0°C

B)   28.5°C

C)   24.3°C

D)   20.6°C

---

5 In pairs, two different metal plates are immersed in their respective ions, as shown below. You observe solid forming on one of the electrodes.

From the preceding illustrations, which combination of electrodes will produce the largest electrical potential?

1.
Porous barrier
X
W
$X^{2+}_{(aq)}$
$W^{2+}_{(aq)}$
Solid deposit on electrode X

2.
Porous barrier
X
Y
$X^{2+}_{(aq)}$
$Y^{2+}_{(aq)}$
Solid deposit on electrode Y

3.
Porous barrier
Y
Z
$Y^{2+}_{(aq)}$
$Z^{2+}_{(aq)}$
Solid deposit on electrode Z

A)   W - Y   C)   X - Z

B)   W – Z   D)   Y – Z

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6 A student wishes to compare the strength of several acids supplied by the Laboratory Technician. From the information given in the table below, classify the acids in order from weakest to strongest.

ACID	CONCENTRATION (mol/L)	pH
HX	0.10	2.1
HY	0.0010	3.1
HZ	0.10	3.1

7 | A cell has electrodes made of a strip of copper and a strip of aluminum immersed respectively in a solution of copper nitrate, $Cu(NO_3)_2$ and a solution of aluminum nitrate, $Al(NO_3)_3$ as shown below.

$Cu_{(s)}$ (V) $Al_{(s)}$

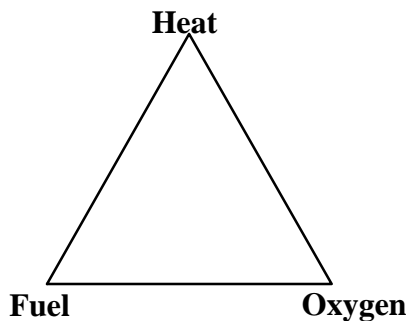Cu $(NO_3)_2$ Al $(NO_3)_3$
1 mol/L   1 mol/L
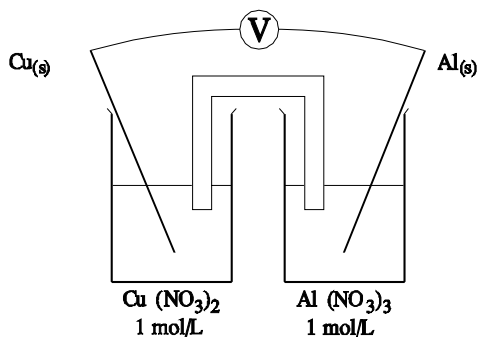
On the diagram,

- indicate :

1)   the direction of the electron flow;
2)   the formulas of the ions in each of the solutions;
3)   the direction of motion of the ions.

- calculate the potential difference of the cell.

8 |

Heat

Fuel   **Oxygen**

Any measure used to extinguish a fire usually tries to reduce or eliminate one or more of the three components of the fire triangle.

Two of the most common substances used to extinguish fires are water and carbon dioxide.

A)   Which component of the fire triangle does water reduce or eliminate?

B)   Which component of the fire triangle does carbon dioxide reduce or eliminate?

9 **Problem**

During an experiment, you are asked to **qualitatively** compare the strength of two different acids of known concentrations.

Concentrations of acid X = 2×10^{-2} mol/L
Concentrations of acid Y = 2×10^{-3} mol/L

Experiment

You decide to measure the pH of the two acids and you obtain the following results :

100 mL of acid X (2×10^{-2} mol/L) with 10 drops of universal indicator has the same color as 100 mL of acid Y (2×10^{-3} mol/L) with 10 drops of the same indicator.

Using the results obtained, compare the strengths of the two acids.

10 Tim is heating oil in a deep fryer so he can cook some french fries. The telephone rings and he forgets about the oil he is heating. His telephone conversation ends abruptly when he realizes the oil has caught on fire. He reacts quickly and puts the cover on the pot.

Why did Tim place the cover on the pot?

A) To reduce the temperature of the oil below the temperature at which ignition occurs, thereby ending combustion

B) To increase the pressure on the oil, thereby putting out the fire

C) To prevent a required reactant from contacting the oil, thereby ending combustion

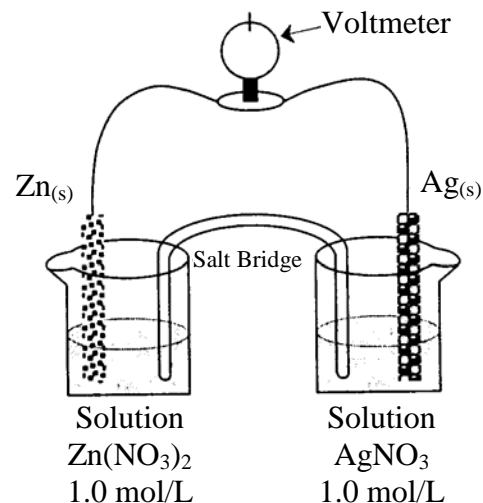D) To prevent a required product from escaping the pot, thereby ending combustion

11 A voltaic cell is illustrated below.

Using the sheet of standard reduction potentials, provide the following information:

- the net redox equation
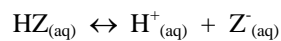- the standard cell potential for this cell

Show all your work.

Voltmeter

$Zn_{(s)}$

$Ag_{(s)}$

Salt Bridge

Solution
Zn(NO$_3$)$_2$
1.0 mol/L

Solution
AgNO$_3$
1.0 mol/L

12 An unknown acid, $HZ_{(aq)}$, has an equilibrium concentration of 1.0×10^{-2} mol/L.

The concentration of H^+ ions in the solution is 1.0×10^{-3} mol/L.

If the dissociation is as shown below, what is the $\mathbf{K_a}$ value of this acid?

$$HZ_{(aq)} \leftrightarrow H^+_{(aq)} + Z^-_{(aq)}$$

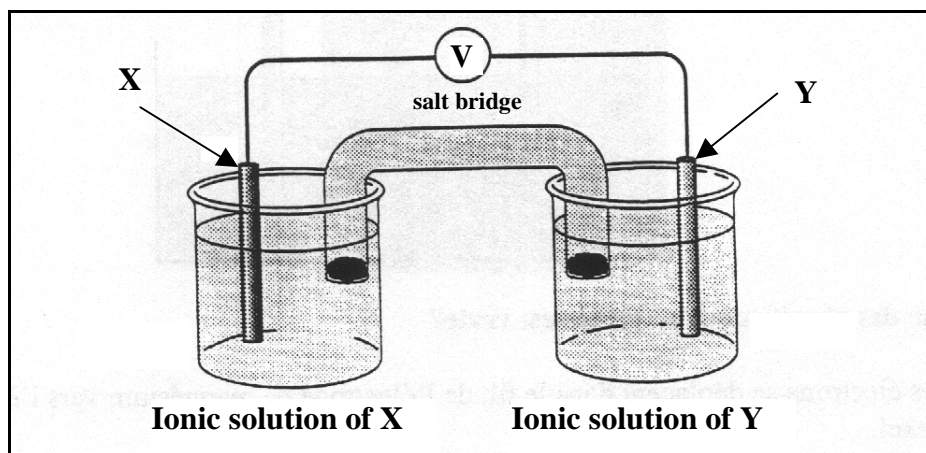A) 1.0×10^{-7} C) 1.0×10^{-5}

B) 1.0×10^{-6} D) 1.0×10^{-4}

13 As part of a lab exam, a student was asked to set up an electrochemical cell in order to obtain a maximum voltage.

The student has a choice of the following electrodes:

    Silver(Ag)
    Cobalt (Co)
    Lead (Pb)
    Magnesium (Mg)

1.   Write the balanced redox equation for the cell that will produce the maximum voltage.

2.   Determine the cell potential, $E°$.

3.   What would be the reducing agent?