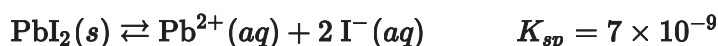


Unit 7 Progress Check: FRQ

1. For parts of the free-response question that require calculations, clearly show the method used and the steps involved in arriving at your answers. You must show your work to receive credit for your answer. Examples and equations may be included in your answers where appropriate.



The dissolution of $\text{PbI}_2(s)$ is represented above.

- (a) Write a mathematical expression that can be used to determine the value of S , the molar solubility of $\text{PbI}_2(s)$. (Do not do any numerical calculations.)



Please respond on separate paper, following directions from your teacher.

- (b) If $\text{PbI}_2(s)$ is dissolved in $1.0 \text{ M NaI}(aq)$, is the maximum possible concentration of $\text{Pb}^{2+}(aq)$ in the solution greater than, less than, or equal to the concentration of $\text{Pb}^{2+}(aq)$ in the solution in part (a)? Explain.



Please respond on separate paper, following directions from your teacher.

Compound	K_{sp}
PbCl_2	2×10^{-5}
PbI_2	7×10^{-9}
$\text{Pb}(\text{IO}_3)_2$	3×10^{-13}

- (c) A table showing K_{sp} values for several lead compounds is given above. A saturated solution of which of the compounds has the greatest molar concentration of $\text{Pb}^{2+}(aq)$? Explain. (Do not do any numerical calculations.)



Please respond on separate paper, following directions from your teacher.

Part (a)

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.



Unit 7 Progress Check: FRQ



0	1
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The response gives the equation $7 \times 10^{-9} = 4S^3$ OR $S = \sqrt[3]{\frac{7 \times 10^{-9}}{4}}$ (or a variation).

Part (b)

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.



0	1	2
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The response meets both of the following two criteria:

- The amount of $\text{Pb}^{2+}(\text{aq})$ that dissolved in the 1.0 M NaI solution is less than the amount of $\text{Pb}^{2+}(\text{aq})$ that dissolved in the original solution.
- The high concentration of $\text{I}^{-}(\text{aq})$ in the solution 1.0 M NaI suppresses the dissolution of $\text{PbI}_2(\text{s})$ because less $\text{Pb}^{2+}(\text{aq})$ can form before the product $[\text{Pb}^{2+}][\text{I}^{-}]$ equals or exceeds the value of K_{sp} .

Part (c)

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.



0	1
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The response indicates that the solution of PbCl_2 has the highest concentration of $\text{Pb}^{2+}(\text{aq})$ because PbCl_2 has the largest K_{sp} .



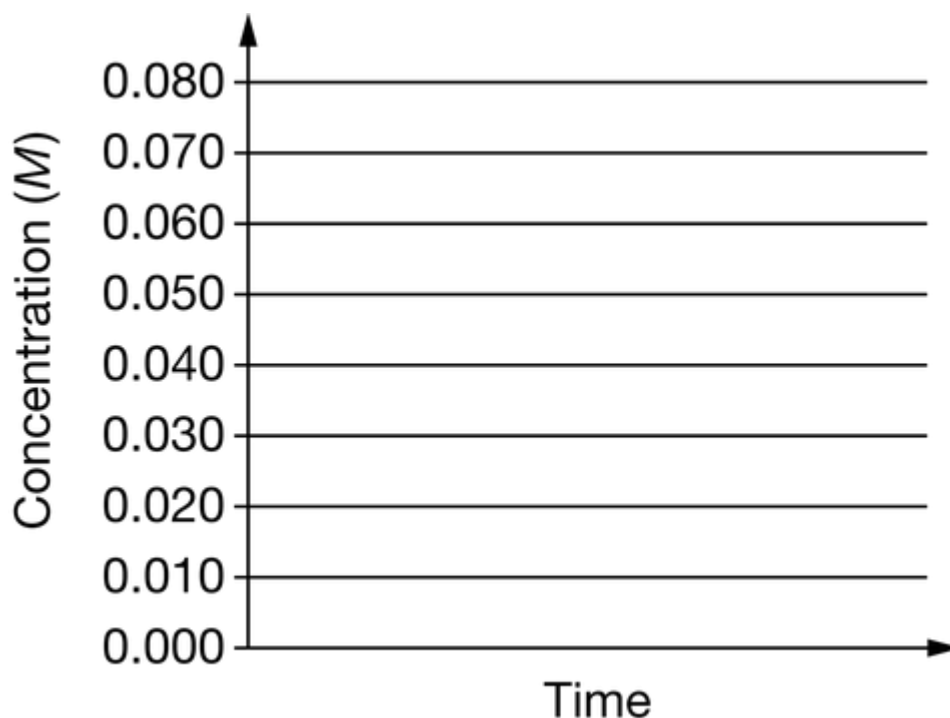
Unit 7 Progress Check: FRQ

2. For parts of the free-response question that require calculations, clearly show the method used and the steps involved in arriving at your answers. You must show your work to receive credit for your answer. Examples and equations may be included in your answers where appropriate.

Gas	Initial Concentration (M)
H_2	0.030
I_2	0.015
HI	?

Samples of three gases, $H_2(g)$, $I_2(g)$, and $HI(g)$, were combined in a rigid vessel. The initial concentrations of $H_2(g)$ and $I_2(g)$ are given in the table above.

- (a) The original value of the reaction quotient, Q_c , for the reaction of $H_2(g)$ and $I_2(g)$ to form $HI(g)$ (before any reactions take place and before equilibrium is established), was **5.56**. On the following graph, plot the points representing the initial concentrations of all three gases. Label each point with the formula of the gas.

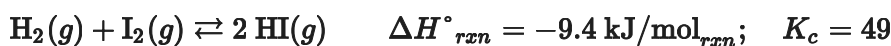


Please respond on separate paper, following directions from your teacher.

Equilibrium was established at a certain temperature according to the following chemical equation.



Unit 7 Progress Check: FRQ



After equilibrium was established, the concentration of $\text{H}_2(g)$ was 0.020 M .

(b) On the graph above, carefully draw three curves, one for each of the three gases, starting from the initial points you drew in part (a). The curves must show how the concentration of each of the three gases changed as equilibrium was established.



Please respond on separate paper, following directions from your teacher.

$\text{H}_2(g)$, $\text{I}_2(g)$, and $\text{HI}(g)$ are at equilibrium at a different temperature in a different vessel.

(c) When the temperature in the vessel is decreased, does the equilibrium shift to the right, favoring the product, or to the left, favoring the reactants? Justify your answer.



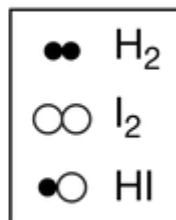
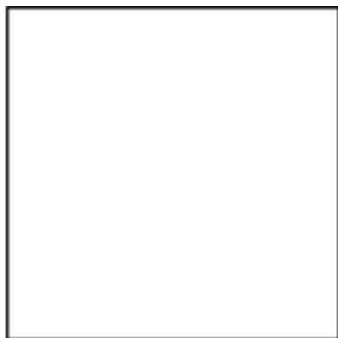
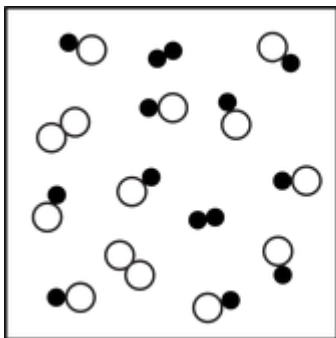
Please respond on separate paper, following directions from your teacher.

(d) Does the value of K_c increase, decrease, or remain the same when the temperature is decreased? Justify your answer based on the expression for K_c and the concentrations of the product and reactants.



Please respond on separate paper, following directions from your teacher.

(e) In the following empty box, draw an appropriate number of each type of molecule to represent a possible new equilibrium at the lower temperature.



Please respond on separate paper, following directions from your teacher.



Unit 7 Progress Check: FRQ

Part (a)

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

✓

0	1	2
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The diagram meets both of the following criteria:

- The partial pressure of H_2 is plotted at 0.030 M at time 0 and the partial pressure of I_2 is plotted at 0.015 M at time 0 , and the points are labeled.
- The partial pressure of HI is plotted at 0.050 M at time 0 , and the point is labeled.

Part (b)

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

✓

0	1	2	3
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The response meets all of the following criteria:

- The curve for H_2 decreases to 0.020 M and levels off.
- The curve for I_2 decreases to 0.005 M and levels off.
- The curve for HI increases to 0.070 M and levels off.

Part (c)

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.



Unit 7 Progress Check: FRQ



0	1
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The response indicates that the system shifts to the right because the forward reaction is exothermic.

Part (d)

Select a point value to view scoring criteria, solutions, and/or examples and to score the response. The response should be consistent with the answer to part (c).



0	1	2
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The response meets both of the following criteria:

- The response indicates that $K_c = \frac{[\text{HI}]^2}{[\text{H}_2][\text{I}_2]}$.
- The response indicates that if $[\text{H}_2]$ and $[\text{I}_2]$ decrease and $[\text{HI}]$ increases, K_c must increase.

Part (e)

Select a point value to view scoring criteria, solutions, and/or examples and to score the response. The response should be consistent with the answer to part (d).



0	1	2
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The response meets both of the following criteria:

- There is one H_2 molecule and one I_2 molecule in the box.
- There are twelve HI molecules in the box.



Unit 7 Progress Check: FRQ
