

CHEM 1A - EXAM 2 PRACTICE

Name: _____

This practice exam contains 20 multiple-choice questions worth 3 points each and four written questions worth 10 points each. Choose the best answer for every multiple-choice question. For written questions, show all required work. Final answers must include the correct units and significant figures.

Part I - Multiple Choice (60 points)

1. Balance the complete combustion of propane: $\text{C}_3\text{H}_8 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$. What is the sum of the lowest whole-number coefficients?

- A) 12
- B) 11
- C) 13
- D) 10
- E) 14

2. $\text{Fe}(\text{NO}_3)_3(\text{aq})$ is mixed with $\text{NaOH}(\text{aq})$. Which is the balanced net ionic equation?

- A) $\text{Fe}^{3+}(\text{aq}) + 3 \text{OH}^{-}(\text{aq}) \rightarrow \text{Fe}(\text{OH})_3(\text{s})$
- B) $\text{Fe}^{3+}(\text{aq}) + \text{OH}^{-}(\text{aq}) \rightarrow \text{FeOH}^{2+}(\text{aq})$
- C) $\text{Na}^{+}(\text{aq}) + \text{NO}_3^{-}(\text{aq}) \rightarrow \text{NaNO}_3(\text{s})$
- D) No reaction
- E) $\text{Fe}^{3+}(\text{aq}) + 3 \text{OH}^{-}(\text{aq}) \rightarrow \text{Fe}(\text{OH})_3(\text{aq})$

3. Which statement best classifies $2 \text{C}_2\text{H}_6 + 7 \text{O}_2 \rightarrow 4 \text{CO}_2 + 6 \text{H}_2\text{O}$?

- A) Precipitation only
- B) Neutralization only
- C) Decomposition and precipitation
- D) Combustion and redox
- E) Combustion but not redox

4. Which equation and classification correctly represent a strong-acid/strong-base neutralization?

- A) $\text{Ag}^{+}(\text{aq}) + \text{Cl}^{-}(\text{aq}) \rightarrow \text{AgCl}(\text{s})$; precipitation
- B) $\text{H}^{+}(\text{aq}) + \text{OH}^{-}(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l})$; neutralization
- C) $\text{Zn}(\text{s}) + \text{Cu}^{2+}(\text{aq}) \rightarrow \text{Zn}^{2+}(\text{aq}) + \text{Cu}(\text{s})$; neutralization
- D) $\text{CH}_4(\text{g}) + 2 \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2 \text{H}_2\text{O}(\text{l})$; neutralization
- E) $\text{CaCO}_3(\text{s}) \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$; neutralization

Part I - Multiple Choice (continued)

5. Which name-formula pair is correct?

- A) nitrous acid, HNO_3
- B) hydrosulfuric acid, H_2SO_4
- C) phosphoric acid, H_3PO_3
- D) chlorous acid, HClO_3
- E) chloric acid, HClO_3

6. What is the average oxidation state of sulfur in $\text{S}_2\text{O}_3^{2-}$?

- A) +4
- B) +2
- C) +6
- D) -2
- E) 0

7. In $\text{Cl}_2 + 2 \text{Br}^- \rightarrow 2 \text{Cl}^- + \text{Br}_2$, which statement is correct?

- A) Cl_2 is oxidized and is the reducing agent
- B) Br^- is reduced and is the oxidizing agent
- C) Cl^- is oxidized and is the oxidizing agent
- D) Br^- is oxidized and is the reducing agent
- E) No oxidation states change

8. A cold pack becomes colder as its salt dissolves. Which sign and classification fit the dissolution?

- A) Positive ΔH , endothermic
- B) Negative ΔH , exothermic
- C) Positive ΔH , exothermic
- D) Negative ΔH , endothermic
- E) $\Delta H = 0$ because temperature is not energy

Part I - Multiple Choice (continued)

9. Using bond enthalpies C-H = 413, O=O = 498, C=O in CO_2 = 799, and O-H = 463 kJ/mol, estimate ΔH for $\text{CH}_4 + 2 \text{O}_2 \rightarrow \text{CO}_2 + 2 \text{H}_2\text{O}(\text{g})$.

- A) +802 kJ
- B) -304 kJ
- C) -802 kJ
- D) +3450 kJ
- E) -2648 kJ

10. Given $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$, $\Delta H = -393.5 \text{ kJ}$ and $\text{CO} + 1/2 \text{O}_2 \rightarrow \text{CO}_2$, $\Delta H = -283.0 \text{ kJ}$, find ΔH for $\text{C} + 1/2 \text{O}_2 \rightarrow \text{CO}$.

- A) -676.5 kJ
- B) +110.5 kJ
- C) +676.5 kJ
- D) -393.5 kJ
- E) -110.5 kJ

11. For $\text{N}_2(\text{g}) + 3 \text{H}_2(\text{g}) \rightarrow 2 \text{NH}_3(\text{g})$, $\Delta H = -92.2 \text{ kJ}$. What is the standard enthalpy of formation of $\text{NH}_3(\text{g})$?

- A) -92.2 kJ/mol
- B) -46.1 kJ/mol
- C) +46.1 kJ/mol
- D) +92.2 kJ/mol
- E) 0 kJ/mol

12. For $2 \text{Al} + 3 \text{Cl}_2 \rightarrow 2 \text{AlCl}_3$, 5.40 g Al reacts with 18.0 g Cl_2 . Molar masses: Al = 26.98, Cl_2 = 70.90, AlCl_3 = 133.33 g/mol. What theoretical mass of AlCl_3 forms?

- A) 26.7 g
- B) 36.0 g
- C) 18.0 g
- D) 22.6 g
- E) 44.1 g

Part I - Multiple Choice (continued)

13. Using the same Al/Cl_2 mixture, approximately how much aluminum remains after reaction?

- A) 0.83 g
- B) 0.00 g
- C) 4.57 g
- D) 1.69 g
- E) 5.40 g

14. If the preceding reaction produces 20.8 g AlCl_3 from a theoretical yield of 22.6 g, what is the percent yield?

- A) 108.7%
- B) 1.80%
- C) 88.0%
- D) 0.920%
- E) 92.0%

15. A calorimeter absorbs 4.80 kJ while its temperature rises 12.0 °C. Its heat capacity is:

- A) 57.6 kJ/°C
- B) 2.50 kJ/°C
- C) 0.400 kJ/°C
- D) 0.250 kJ/°C
- E) 12.0 kJ/°C

16. A 75.0 g metal at 95.0 °C is placed in 100.0 g water at 20.0 °C. The final temperature is 24.0 °C. Water $C_s = 4.184 \text{ J/(g}\cdot\text{°C)}$. Neglecting heat loss, the metal C_s is:

- A) 0.314 J/(g·°C)
- B) 4.18 J/(g·°C)
- C) 1.26 J/(g·°C)
- D) 0.0558 J/(g·°C)
- E) -0.314 J/(g·°C)

Part I - Multiple Choice (continued)

17. A system releases 1.20 kJ of heat and does 0.350 kJ of work on its surroundings. Using $\Delta E = q + w$, what is ΔE ?

- A) -0.850 kJ
- B) +1.55 kJ
- C) -1.55 kJ
- D) +0.850 kJ
- E) -1.20 kJ

18. How much energy is required to melt 36.0 g H_2O at 0°C ? $\Delta H_{\text{fus}} = 6.01 \text{ kJ/mol}$ and molar mass = 18.02 g/mol.

- A) 216 kJ
- B) 3.00 kJ
- C) -12.0 kJ
- D) 0 kJ
- E) 12.0 kJ

19. Evaluate $(4.560 \times 10^{-3} \text{ mol})(3.20 \times 10^0 \text{ g/mol})$ with correct scientific notation and significant figures.

- A) $1.4592 \times 10^{-2} \text{ g}$
- B) $1.46 \times 10^{-2} \text{ g}$
- C) $1.46 \times 10^2 \text{ g}$
- D) 0.014 g
- E) $1.5 \times 10^{-2} \text{ g}$

20. Methane combustion releases 890.3 kJ per mole CH_4 . How much heat is released by burning 8.00 g CH_4 ? Molar mass = 16.05 g/mol.

- A) +444 kJ
- B) $-7.13 \times 10^3 \text{ kJ}$
- C) -111 kJ
- D) -444 kJ
- E) $+7.13 \times 10^3 \text{ kJ}$

Part II - Written Response (40 points)

Show all work. Unsupported answers may not receive full credit.

Written Question 1

Lead(II) nitrate reacts with sulfuric acid. Write the balanced molecular, complete ionic, and net ionic equations.

Balanced molecular equation

Complete ionic equation

Net ionic equation

Written Question 2

Balance the redox reaction in acidic solution: $\text{Cr}_2\text{O}_7^{2-} + \text{Fe}^{2+} \rightarrow \text{Cr}^{3+} + \text{Fe}^{3+}$. Show oxidation states, identify what is oxidized and reduced, and name the oxidizing and reducing agents.

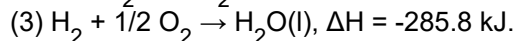
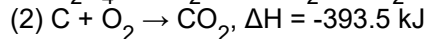
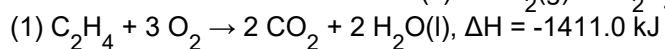
Oxidation states and half-reaction work

Balanced equation

Oxidized / reduced species and both agents

Written Question 3

Use Hess's Law to find ΔH for $2 \text{C(s)} + 2 \text{H}_2\text{(g)} \rightarrow \text{C}_2\text{H}_4\text{(g)}$. Given:



Show every reversal, multiplier, cancellation, and sign. State whether the target reaction is exothermic or endothermic.

Rewritten equations

Cancellation and target equation

Enthalpy calculation and classification

Written Question 4

A 2.35 g fuel sample heats 125.0 g of water from 21.40 °C to 34.85 °C in a calorimeter with $C = 185 \text{ J/}^\circ\text{C}$. Water $C_s = 4.184 \text{ J/(g}\cdot^\circ\text{C)}$. Calculate q for the water, q for the calorimeter, q for the reaction, and kJ released per gram of fuel. State the sign of ΔH and whether the process is endothermic or exothermic. Show every equation, sign, unit, and significant-figure decision.

Temperature change and q_{water}

$q_{\text{calorimeter}}$

q_{reaction} and energy per gram

Sign, classification, units, and significant figures

CHEM 1A - EXAM 2 PRACTICE

Name: _____

This practice exam contains 20 multiple-choice questions worth 3 points each and four written questions worth 10 points each. Choose the best answer for every multiple-choice question. For written questions, show all required work. Final answers must include the correct units and significant figures.

Part I - Multiple Choice (60 points)

1. Balance $\text{Fe(s)} + \text{O}_2\text{(g)} \rightarrow \text{Fe}_2\text{O}_3\text{(s)}$. What is the sum of the lowest whole-number coefficients?

- A) 7
- B) 8
- C) 6
- D) 9
- E) 10

2. $\text{CaCl}_2\text{(aq)}$ is mixed with $\text{Na}_2\text{CO}_3\text{(aq)}$. Which is the balanced net ionic equation?

- A) $2 \text{Na}^+ + 2 \text{Cl}^- \rightarrow 2 \text{NaCl(s)}$
- B) $\text{Ca}^{2+} + \text{CO}_3^{2-} \rightarrow \text{CaCO}_3\text{(s)}$
- C) $\text{Ca}^{2+} + 2 \text{Cl}^- \rightarrow \text{CaCl}_2\text{(s)}$
- D) No reaction
- E) $\text{Ca}^+ + \text{CO}_3^- \rightarrow \text{CaCO}_3\text{(s)}$

3. Which balanced equation represents an acid-base neutralization?

- A) $\text{H}_2\text{SO}_4 + \text{KOH} \rightarrow \text{KSO}_4 + \text{H}_2\text{O}$
- B) $\text{H}_2\text{SO}_4 + 2 \text{KOH} \rightarrow \text{K}_2\text{SO}_4 + 2 \text{H}_2\text{O}$
- C) $\text{AgNO}_3 + \text{KCl} \rightarrow \text{AgCl} + \text{KNO}_3$
- D) $2 \text{KClO}_3 \rightarrow 2 \text{KCl} + 3 \text{O}_2$
- E) $\text{Zn} + 2 \text{HCl} \rightarrow \text{ZnCl}_2 + \text{H}_2$

4. $\text{C}_2\text{H}_5\text{OH} + 3 \text{O}_2 \rightarrow 2 \text{CO}_2 + 3 \text{H}_2\text{O}$ is best classified as:

- A) precipitation only
- B) neutralization only
- C) combustion and redox
- D) decomposition only
- E) double replacement only

Part I - Multiple Choice (continued)

5. Which mixture forms a precipitate?

- A) $\text{NaNO}_3(\text{aq}) + \text{KCl}(\text{aq})$
- B) $\text{KOH}(\text{aq}) + \text{NaCl}(\text{aq})$
- C) $\text{NH}_4\text{Cl}(\text{aq}) + \text{KNO}_3(\text{aq})$
- D) $\text{AgNO}_3(\text{aq}) + \text{NaCl}(\text{aq})$
- E) $\text{NaClO}_4(\text{aq}) + \text{KNO}_3(\text{aq})$

6. What is the correct name for $\text{HClO}_2(\text{aq})$?

- A) hypochlorous acid
- B) chloric acid
- C) perchloric acid
- D) hydrochloric acid
- E) chlorous acid

7. What is the formula for phosphorous acid?

- A) H_3PO_3
- B) H_3PO_4
- C) HPO_3
- D) H_2PO_4
- E) H_3P^-

8. What is the oxidation state of chromium in $\text{Cr}_2\text{O}_7^{2-}$?

- A) +3
- B) +4
- C) +5
- D) +6
- E) +7

Part I - Multiple Choice (continued)

9. For $\text{Mg(s)} + \text{CuSO}_4\text{(aq)} \rightarrow \text{MgSO}_4\text{(aq)} + \text{Cu(s)}$, which statement is correct?

- A) Mg is reduced and Cu^{2+} is oxidized
- B) Mg is oxidized and Cu^{2+} is reduced
- C) S is oxidized and O is reduced
- D) Both metals are oxidized
- E) No oxidation states change

10. In $\text{Mg(s)} + \text{Cu}^{2+}\text{(aq)} \rightarrow \text{Mg}^{2+}\text{(aq)} + \text{Cu(s)}$, the oxidizing agent is:

- A) Mg(s)
- B) $\text{Mg}^{2+}\text{(aq)}$
- C) Cu(s)
- D) $\text{SO}_4^{2-}\text{(aq)}$
- E) $\text{Cu}^{2+}\text{(aq)}$

11. A reaction has $\Delta H = +84.6 \text{ kJ}$. Which statement is correct?

- A) The reaction releases heat and is exothermic
- B) The surroundings lose heat and the reaction is exothermic
- C) The reaction absorbs heat and is endothermic
- D) Bond formation must be the only process
- E) The reaction has no energy change

12. Which statement about chemical bonds is correct?

- A) Breaking bonds releases energy; forming bonds absorbs energy
- B) Breaking and forming bonds both release energy
- C) Breaking bonds absorbs energy; forming bonds releases energy
- D) Neither process changes energy
- E) Bond energy is unrelated to reaction enthalpy

Part I - Multiple Choice (continued)

13. For $\text{CH}_3\text{OH}(\text{l}) + 3/2 \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2 \text{H}_2\text{O}(\text{l})$, use ΔH°_f values -238.7, 0, -393.5, and -285.8 kJ/mol, respectively. What is $\Delta H^\circ_{\text{rxn}}$?

- A) -726.4 kJ
- B) +726.4 kJ
- C) -1204.4 kJ
- D) -440.6 kJ
- E) +238.7 kJ

14. Given $\text{S} + \text{O}_2 \rightarrow \text{SO}_2$, $\Delta H = -296.8 \text{ kJ}$, and $2 \text{SO}_2 + \text{O}_2 \rightarrow 2 \text{SO}_3$, $\Delta H = -197.8 \text{ kJ}$, find ΔH for $2 \text{S} + 3 \text{O}_2 \rightarrow 2 \text{SO}_3$.

- A) -494.6 kJ
- B) +791.4 kJ
- C) -98.9 kJ
- D) -791.4 kJ
- E) -395.7 kJ

15. A calorimeter has $C = 185 \text{ J/}^\circ\text{C}$ and warms from 22.40°C to 28.90°C . How much heat does it absorb?

- A) 28.5 J
- B) 1.20 kJ
- C) 0.0351 kJ
- D) 207 kJ
- E) 6.50 kJ

16. A 45.0 g metal at 21.5°C is placed in 85.0 g water at 62.0°C . The final temperature is 58.7°C . If $C_{\text{s,water}} = 4.184 \text{ J/(g}\cdot^\circ\text{C)}$, what is $C_{\text{s,metal}}$?

- A) $4.18 \text{ J/(g}\cdot^\circ\text{C)}$
- B) $0.315 \text{ J/(g}\cdot^\circ\text{C)}$
- C) $0.701 \text{ J/(g}\cdot^\circ\text{C)}$
- D) $1.40 \text{ J/(g}\cdot^\circ\text{C)}$
- E) $-0.701 \text{ J/(g}\cdot^\circ\text{C)}$

Part I - Multiple Choice (continued)

17. A gas absorbs 1.85 kJ of heat while expanding from 2.50 L to 7.75 L against 1.00 atm. Use $w = -P\Delta V$ and $101.3 \text{ J} = 1 \text{ L}\cdot\text{atm}$. What is ΔE ?

- A) +1.32 kJ
- B) +2.38 kJ
- C) -1.32 kJ
- D) -2.38 kJ
- E) +1.85 kJ

18. How much heat is released when 15.8 g $\text{H}_2\text{O}(\text{g})$ condenses? $\Delta H_{\text{vap}} = 40.7 \text{ kJ/mol}$; molar mass $\text{H}_2\text{O} = 18.02 \text{ g/mol}$.

- A) +35.7 kJ
- B) -643 kJ
- C) -2.26 kJ
- D) +2.26 kJ
- E) -35.7 kJ

19. $\text{CoCl}_2 + 2 \text{AgNO}_3 \rightarrow 2 \text{AgCl} + \text{Co}(\text{NO}_3)_2$. If 12.89 g CoCl_2 and 25.00 g AgNO_3 react, which reagent limits the reaction? Molar masses: $\text{CoCl}_2 = 129.84$, $\text{AgNO}_3 = 169.87 \text{ g/mol}$.

- A) CoCl_2
- B) AgNO_3
- C) AgCl
- D) $\text{Co}(\text{NO}_3)_2$
- E) Neither; they are stoichiometric

20. Convert 36.0 km to centimeters and report the answer with correct significant figures.

- A) $3.60 \times 10^3 \text{ cm}$
- B) $3.60 \times 10^4 \text{ cm}$
- C) $3.60 \times 10^5 \text{ cm}$
- D) $3.60 \times 10^6 \text{ cm}$
- E) $3.6 \times 10^6 \text{ cm}$

Part II - Written Response (40 points)

Show all work. Unsupported answers may not receive full credit.

Written Question 1

A student mixes 50.00 mL of 0.2000 M $\text{BaCl}_2(\text{aq})$ with 75.00 mL of 0.1500 M $\text{Na}_2\text{SO}_4(\text{aq})$. The dry precipitate has a mass of 2.10 g. Write the balanced molecular, complete ionic, and net ionic equations. Identify the limiting reagent. Calculate the theoretical mass and percent yield of BaSO_4 . Molar mass $\text{BaSO}_4 = 233.39 \text{ g/mol}$.

Three balanced equations

Limiting-reagent setup

Theoretical yield and percent yield with units

Written Question 2

50.00 mL of 1.000 M HCl(aq) and 50.00 mL of 1.000 M NaOH(aq), both initially at 22.40 °C, are mixed in a coffee-cup calorimeter. The final temperature is 28.90 °C. Assume density = 1.00 g/mL and $C_s = 4.184 \text{ J/(g} \cdot ^\circ\text{C)}$. Write the balanced molecular and net ionic equations. Calculate q_{solution} , q_{reaction} , and ΔH per mole of H_2O formed. Classify the reaction as endothermic or exothermic.

Molecular and net ionic equations

Mass, temperature change, and q_{solution}

q_{reaction} , molar enthalpy, sign, and classification

Written Question 3

Calculate $\Delta H^\circ_{\text{rxn}}$ for $\text{C}_2\text{H}_5\text{OH}(\text{l}) + 3 \text{O}_2(\text{g}) \rightarrow 2 \text{CO}_2(\text{g}) + 3 \text{H}_2\text{O}(\text{l})$. Use ΔH°_f : $\text{C}_2\text{H}_5\text{OH}(\text{l}) = -277.6 \text{ kJ/mol}$, $\text{CO}_2(\text{g}) = -393.5 \text{ kJ/mol}$, $\text{H}_2\text{O}(\text{l}) = -285.8 \text{ kJ/mol}$, $\text{O}_2(\text{g}) = 0 \text{ kJ/mol}$. Show the products-minus-reactants setup, every coefficient, units, sign, and classification.

Products sum

Reactants sum

Subtraction, final value, and classification

Written Question 4

Propane burns according to $\text{C}_3\text{H}_8 + 5 \text{O}_2 \rightarrow 3 \text{CO}_2 + 4 \text{H}_2\text{O}$, $\Delta H = -2220 \text{ kJ}$ per mole of reaction. If 10.0 g propane reacts with 30.0 g O_2 , determine the limiting reagent, mass of excess propane remaining, mass of CO_2 formed, and heat released. Molar masses: $\text{C}_3\text{H}_8 = 44.11$, $\text{O}_2 = 32.00$, $\text{CO}_2 = 44.01 \text{ g/mol}$.

Moles and limiting-reagent comparison

Excess propane remaining

CO_2 yield

Heat released with sign, units, and significant figures
