Calorimetry: $nH + mc\Delta t = 0$ or $mc\Delta t + mc\Delta = 0$

1. Numerical response question

Left justify your answer in the boxes provided.

Colton and Skyler are performing a calorimetry experiment. They find that 18.5 kJ of energy is transferred when 1.50 g of methanol ($CH_3OH_{(l)}$) is burned. The boys determine that the molar heat of combustion for methanol in this experiment is ±_____ $\frac{kJ}{mol}$

2. Numerical response question

Left justify your answer in the boxes provided.

A tin can calorimeter was used to determine the molar enthalpy of combustion of paraffin wax ($C_{25}H_{52(s)}$) The following data was collected from the list of descriptors in the box below to answer this question.

Mass of calorimeter	15.5 g
Mass of calorimeter & water	104.3 g
Initial temperature of water	22.0 °C
Maximum temperature of water	31.7 °C
Initial mass of wax	35.0 g
Final mass of wax	33.9 g

The molar enthalpy of combustion of wax for this investigation is ±_____ $\frac{MJ}{mol}$. Ignore the heat gained by the tin can.

3. Ethane undergoes complete combustion to form **liquid** water and carbon dioxide. The moles of $O_2(g)$ consumed when 780 kJ of heat is released will be _____ mol of $O_2(g)$.

a	1.50
b	6.00
c	1.75
d	7.00

4. An unknown substance has a molar heat of combustion of -740.2 $\frac{kJ}{mol}$. When 0.250 mol of this substance is burned in a calorimeter containing 7.50 kg of water, the increase of temperature for the water will be _____ °C.

a	12.2
b	4.11
c	7.37
d	5.89

5. A student follows the procedure outlined below:

I	Record the temperature of 30 mL of water in a beaker
II	Add a pellet of NaOH(s) to the water
III	Stir until there is no solid left.
IV	Record the final temperature of the water

Which prediction could be tested with the data collected by ONLY these four steps?

a	The molar heat of reaction for NaOH(s) with $H_2O(l)$ will be -28.4 $\frac{kJ}{mol}$
b	An exothermic reaction will occur when NaOH(s) is added to $H_2O(l)$
c	The solubility of NaOH(s) will decrease as the temperature of the water increases.
d	The temperature change will be less if more NaOH(s) is used

6. When a piece of strontium is dropped into water, the temperature of the water increases. The statement that correctly interprets this information is _____

a	$Sr(s) + H_2O(l) + energy \rightarrow Sr(OH)_2(aq) + H_2(g)$
b	Heat is absorbed by the reaction
c	The reaction is endothermic
d	The reactants have more potential energy than do the products.

7. A group of students are interested in experimentally determining the molar heat of reaction of candlewax ($C_{25}H_{52}(s)$) with oxygen. Their experiment should be based upon the processes of

a	Molar fusion and additivity
b	Combustion and Calorimetry
c	Formation and Calorimetry
d	Neutralization and Calorimetry

8. In an experiment 100 g of methanol (specific heat capacity of 2.53 $\frac{J}{g^{\circ}C}$) at 15.4°C was mixed with 100 g of water at 38.0° C. After thermal equilibrium was reached, the temperature of the mixture was 29.5° C. The amount of energy lost by the water was _____ kJ.

a	3.56
b	2.15
c	5.72
d	33.4

9. Given the equation:

$2CH_3OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 4H_2O(g)$ $\Delta H = -1275.8$ kJ

The amount of methanol ($CH_3OH(l)$) that must be burned to raise the temperature of 700 g of water from 10.0° C to 55.0° C is _____ g

a	13.3
b	4.05
c	6.63
d	9.58

10. If 50.7 kJ of energy is transferred when 6.50 g of glucose ($C_6H_{12}O_6$) is burned in a calorimeter, then the molar enthalpy of combustion for glucose is _____ $\frac{kJ}{mol}$

a	-1.41×10^3
b	$+1.41 \times 10^3$
c	2.67×10^3
d	-2.67×10^3

11. The water in a calorimeter is heated by the complete combustion of methane. The water will show a(n) _____in temperature because the combustion reaction is _____

a	Increase	EXOTHERMIC
b	Increase	ENDOTHERMIC
c	Decrease	EXOTHERMIC
d	Decrease	ENDOTHERMIC

12. David, Michael, and Kolbe mix a 100 g sample of water at 10.5°C with a 250 g sample of water at 50.0 °C . No one in the group has a calculator, so they use good estimating skills to find a reasonable value for the final equilibrium temperature.

They make different statements about the possible answer.

Statement 1	They all agree the temperature is between 10.5° C and 50.0° C.
Statement 2	David says the temperature is closer to 50.0° C than to 10.5° C because there is more hot water.
Statement 3	Kolbe says the temperature should be the average of the two initial temperatures because both samples have the same specific heat capacity
Statement 4	Michael says the amount of thermal energy lost by one sample is equal to the amount of thermal energy gained by the other sample.
Statement 5	They all think the system involves kinetic changes of energy only.

The number of **TRUE** statements given above is/are _____.

a	1
b	2
c	4
d	5

13. If 0.250 mol of element X is burned in oxygen to produce 0.250 mol of the corresponding oxide, then the temperature of 200.0 g of the surrounding water rises 15.0 °C. The molar heat of formation for the oxide is _____ $\frac{kJ}{mol}$

a	-1.26
b	-3.15
c	-12.6
d	-50.3

14. In a calorimetric experiment, the complete combustion of 4.708 g of cyclopentane ($C_5H_{10}(l)$) caused the temperature of 3.800 kg of water to increase by 10.40°C. This data would indicate that the molar enthalpy of combustion of cyclopentane is _____ $\frac{kJ}{mol}$

a	2430
b	2381
c	2467
d	2891

15. A single reactant (X(s)) undergoes a chemical reaction in a bomb calorimeter. The following observations are gathered.

Room Temperature	21.00 °C
Mass of reactant	5.66 g
Molar mass of reactant	45.91 $\frac{g}{mol}$
Initial temperature of water in calorimeter	29.7 °C
Final temperature of water in calorimeter	11.3 °C
Mass of water in calorimeter	150 mL

According to this information, the molar enthalpy of reaction for X(s) is _____ $\frac{kJ}{mol}$

a	+93.8
b	+49.4
c	-44.4
d	-1.43

16. A 7.08 kJ sample of heat is required to raise the temperature of a calorimeter and its contents by 1.00 °C. When 0.900 g of ethane ($C_2H_6(g)$) is ignited in a calorimeter, the temperature of the calorimeter and its contents rises by 9.70 °C.

Based on this information, the molar enthalpy of combustion of ethane is _____ $\frac{kJ}{mol}$

a	7.63×10^1
b	2.15×10^3
c	2.53×10^3
d	2.30×10^3

17. Consider the following balanced reaction.

$$\mathbf{H_2SO_4(aq) + 2NaOH(aq) \rightarrow 2H_2O(l) + Na_2SO_4(aq)}$$

In an attempt to determine ΔH of this acid-base neutralization reaction, a student mixes 50.0 mL of 0.200 $\frac{mol}{L}$ NaOH(aq) with 50.0 mL of 0.100 $\frac{mol}{L}$ H_2SO_4(aq). Both solutions are at an initial temperature of 20.0°C.

The reaction takes place in a well insulated container with negligible heat absorbing capacity. The temperature of the mixture increases to 21.3°C. Assuming the solutions are like water (with a density of 1.00 $\frac{g}{mL}$ and a specific heat capacity of 4.19 $\frac{kJ}{kg°C}$), the calculated enthalpy of reaction for H_2SO_4(aq) is _____ $\frac{kJ}{mol}$

a	-10.9
b	-109
c	-54.5
d	-27.4

18. To raise the temperature of a calorimeter and its contents 1.00 °C requires 5028 J. When 0.500 mol of fuel is burned in the calorimeter, the temperature of the calorimeter increased 4.00 °C. Using this information, the molar enthalpy of combustion of the fuel is _____ $\frac{kJ}{mol}$ is

a	+10.1
b	-10.1
c	-40.2
d	+40.2

19. A Bunsen burner that uses methane provides 500 kJ of energy for each mole of fuel burned. The number of moles of methane needed to heat 2000 mL of water from 25.0°C to 50.0°C is ___ mol.

a	0.419
b	5.00
c	21.0
d	24.0

20. A sample of AgI(s) is formed from its elements. In a bomb calorimeter of 500 mL of water goes from a temperature of 13.2°C to 16.1°C. This reaction releases _____ J of thermal energy.

a	2.59×10^{-3} J
b	6.08 J
c	33.7 J
d	6.08×10^{3} J

21. A single reactant is allowed to undergo a chemical reaction in the bomb of a calorimeter. The following observations are recorded from this experiment.

Room Temperature	21.00 °C
Mass of reactant	1.23 g
Molar mass of reactant	56.5 $\frac{g}{mol}$
Initial temperature of water in calorimeter	18.45 °C
Final temperature of water in calorimeter	24.85 °C
Mass of water in calorimeter	86.00 g

According to this information, the molar enthalpy of reaction is _____ $\frac{g}{mol}$

a	-42.2
b	-50.2
c	-63.2
d	-106

22. A sample of NO_2(g) is formed from its elements inside a bomb calorimeter. The correct observation for the water surrounding the reaction chamber is _____

a	temperature of the water will rise because the reaction is endothermic
b	temperature of the water will fall because the reaction is endothermic
c	temperature of the water will rise because the reaction is exothermic
d	temperature of the water will fall because the reaction is exothermic

23. Ethyne (acetylene) is completely burned to yield gaseous products. If its molar heat of combustion is -1255.5 $\frac{kJ}{mol}$, then combustion 1.00 mol of ethyne will heat 7.50 kg of water by ____ °C

a	49.4
b	39.9
c	52.6
d	34.1

Solutions:

1. 395
2. 1.16
3. C
4. D
5. B
6. D
7. B
8. A
9. C
10. A
11. A
12. C
13. D
14. C
15. A
16. D
17. B
18. C
19. A
20. D
21. D
22. B
23. B