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5.1-110

In any process, $\Delta E_{\text{sys}} =$

- (a) ΔE_{surr} (b) $-\Delta E_{\text{surr}}$ (c) 0

5.1-120

Under the convention $\Delta E_{\text{sys}} = q + w$,

(a) **q** is the heat taken up by the system from the surroundings and **w** is the work done by the system on the surroundings

(b) **q** is the heat taken up by the system from the surroundings and **w** is the work done on the system by the surroundings

(c) **q** is the heat released by the system to the surroundings and **w** is the work done by the system on the surroundings

(d) **q** is the heat released by the system to the surroundings and **w** is the work done on the system by the surroundings

5.1-130

$\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$ is mixed with NH_4NO_3 and the container feels cold. Under the convention $\Delta E_{\text{sys}} = q + w$, we can infer that

- (a) $q < 0$ (b) $q = 0$ (c) $q > 0$

5.1-140

Water is injected into a balloon filled with ammonia gas. The balloon shrinks and feels warm. Under the convention $\Delta E_{\text{sys}} = q + w$, we can infer that

- (a) $q < 0$, $w < 0$
- (b) $q < 0$, $w > 0$
- (c) $q > 0$, $w < 0$
- (d) $q > 0$, $w > 0$

5.1-150

Citric acid is mixed with an aqueous baking soda solution in a flask closed by a balloon over the neck. The flask feels cool and the balloon expands. Under the convention

$\Delta E_{\text{sys}} = q + w$, we can infer that

(a) $q < 0$, $w < 0$

(b) $q < 0$, $w > 0$

(c) $q > 0$, $w < 0$

(d) $q > 0$, $w > 0$

5.1-160

A gas is heated in a strong rigid container. Under the convention that q is the heat taken up by the gas,

(a) $\Delta E_{\text{sys}} > q$

(b) $\Delta E_{\text{sys}} = q$

(c) $\Delta E_{\text{sys}} < q$

(d) $\Delta E_{\text{sys}} = -q$

5.1-170

A gas is heated in a cylinder with a moveable piston. Under the convention that q is the heat taken up by the gas,

(a) $\Delta E_{\text{sys}} > q$

(b) $\Delta E_{\text{sys}} = q$

(c) $\Delta E_{\text{sys}} < q$

(d) $\Delta E_{\text{sys}} = -q$

5.1-210

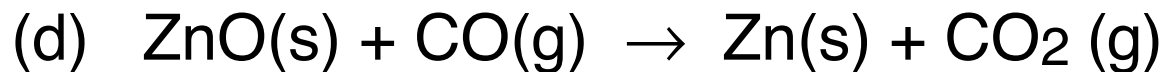
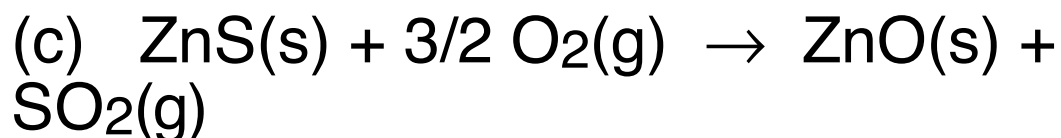
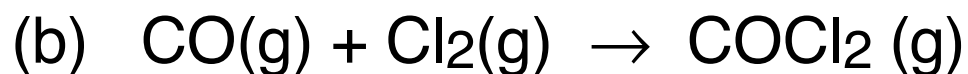
Which of the following statements is true for the reaction



- (a) $\Delta H > \Delta E$
- (b) $\Delta H = \Delta E$
- (c) $\Delta H < \Delta E$

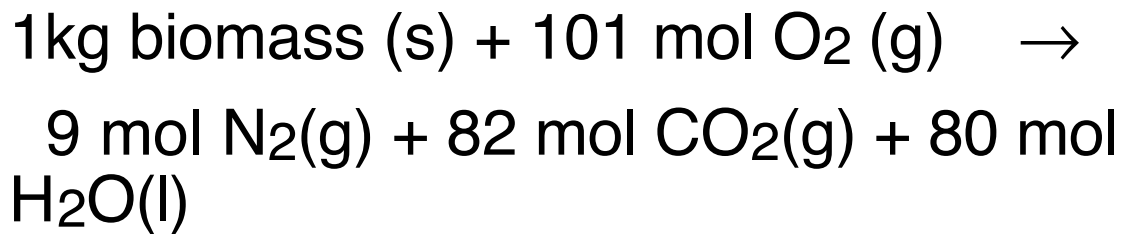
5.1-220

In which of the following reactions will there be the largest difference between ΔH and ΔE ?



5.1-230

The complete combustion of 1 kg of bacterial biomass occurs with the approximate stoichiometry



and $\Delta H = -25,000\text{ kJ}$ at 25°C and 1.00 atm .
 ΔE for this reaction at 25°C and 1.00 atm is

- (a) $(-25,000 + 2.5 \times 70)\text{ kJ}$
- (b) $(-25,000 - 2.5 \times 70)\text{ kJ}$
- (c) $(-25,000 + 2.5 \times 10)\text{ kJ}$
- (d) $(-25,000 - 2.5 \times 10)\text{ kJ}$

5.1-241

For the change $\text{CO}_2(g) \rightarrow \text{CO}_2(s)$

- (a) $\Delta H < 0$ (b) $\Delta H = 0$ (c) $\Delta H > 0$

5.1-242

For the change $\text{H}_2\text{O} (l) \rightarrow \text{H}_2\text{O} (g)$

- (a) $\Delta H < 0$ (b) $\Delta H = 0$ (c) $\Delta H > 0$

5.1-310

For water near its triple point, $\Delta H_{\text{fus}}=6.0$ kJ/mol and $\Delta H_{\text{vap}}=45.0$ kJ/mol. Thus ΔH for the sublimation of water near its triple point is

- (a) -39.0 kJ/mol
- (b) +39.0 kJ/mol
- (c) -51.0 kJ/mol
- (d) +51.0 kJ/mol

5.1-330

For which of the following does $\Delta H_f^\circ = 0$?

(a) O_3 (g)

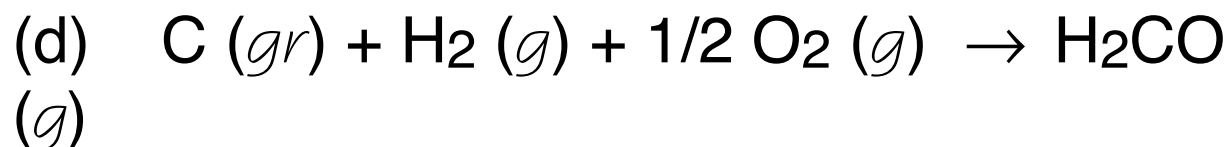
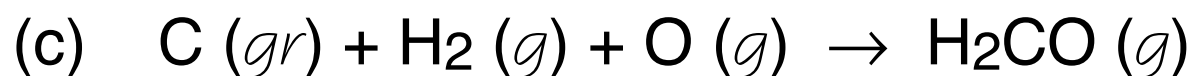
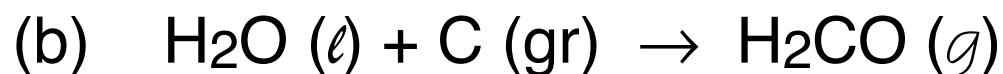
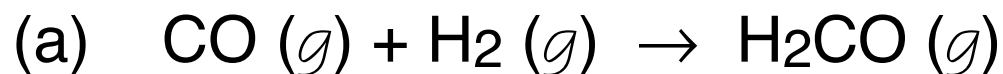
(b) I_2 (g)

(c) H_2O (l)

(d) H_2 (g)

5.1-340

ΔH_f° for $\text{H}_2\text{CO} (g)$ is the enthalpy change at 25°C and 1 atm for the reaction

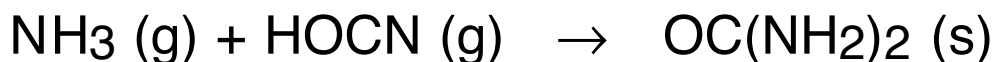


5.1-415

It was once thought that biological molecules could only be formed by living organisms. The divide between “organic” and “inorganic” chemistry was shattered in 1828 when Wöhler found that urea, previously known only as the nitrogenous waste product of animals, could be formed from inorganic reagents. Given the enthalpies of formation

ammonia (g)	−46 kJ/mol
isocyanic acid (g)	−102 kJ/mol
urea (s)	−333 kJ/mol

the enthalpy change in the urea-forming reaction



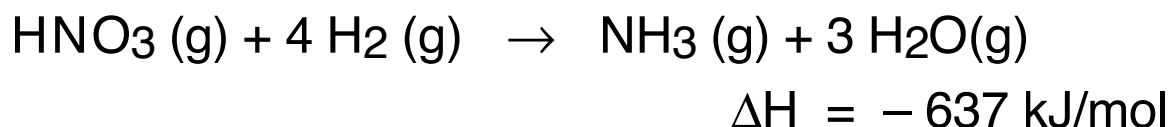
is

- (a) $(-46 - 102 - 333)$ kJ/mol
- (b) $(+46 + 102 - 333)$ kJ/mol
- (c) $(-46 - 102 + 333)$ kJ/mol
- (d) $(+46 + 102 + 333)$ kJ/mol

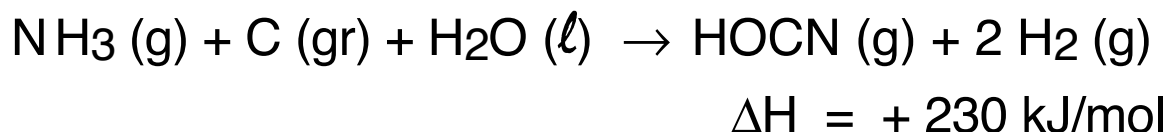
5.1-420

Wöhler's synthesis of urea broke the organic/inorganic divide because ammonia and cyanic acid had been synthesized earlier from unequivocally inorganic precursors.

In 1781 Priestley prepared ammonia from nitric acid and hydrogen with the net reaction



and in 1782 Scheele prepared cyanic acid from ammonia and graphite with the net reaction

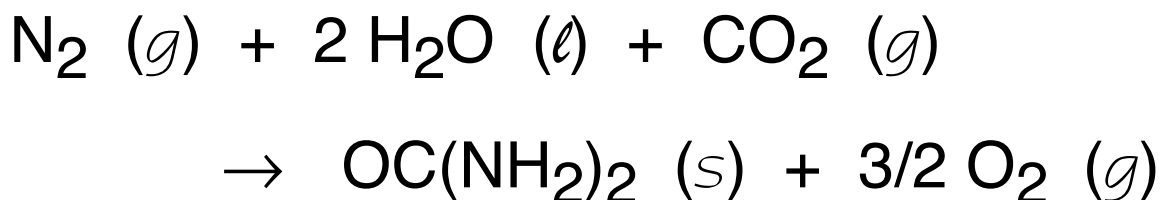


Considering the above reactions at constant pressure, which of the following is not true

- (a) The hydrogenation of 1 mol of HNO₃ in Priestley's reaction releases 637 kJ of heat
- (b) The formation of 1 mol of H₂O in Priestley's reaction releases 212 kJ of heat
- (c) The formation of 1 mol of HOCN by a combination of Priestley's reaction and Scheele's reaction takes up 407 kJ of heat
- (d) The conversion of 1 mol of NH₃ to HOCN by Scheele's reaction takes up 230 kJ of heat

5.1-510

Given that the heat of combustion of urea is 632 kJ/mol, formation of urea from the constituents of our atmosphere



has a ΔH of

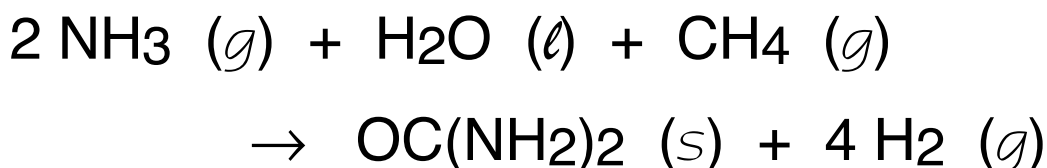
- (a) $- 632 \text{ kJ/mol}$
- (b) $+ 632 \text{ kJ/mol}$
- (c) not derivable from the data given

5.1-520

In 1952, Urey & Miller were able to produce urea by sparking a hydrogen-rich mixture of gases. Given the heats of combustion

ammonia (<i>g</i>)	383 kJ/mol
methane (<i>g</i>)	890 kJ/mol
urea (<i>s</i>)	632 kJ/mol
hydrogen (<i>g</i>)	286 kJ/mol

ΔH for the reaction



is

- (a) $(-383 - 2 \times 890 + 4 \times 632 + 286)$ kJ/mol
- (b) $(-2 \times 383 - 890 + 632 + 4 \times 286)$ kJ/mol
- (c) $(+2 \times 383 + 890 - 632 - 4 \times 286)$ kJ/mol
- (d) not derivable from the data given

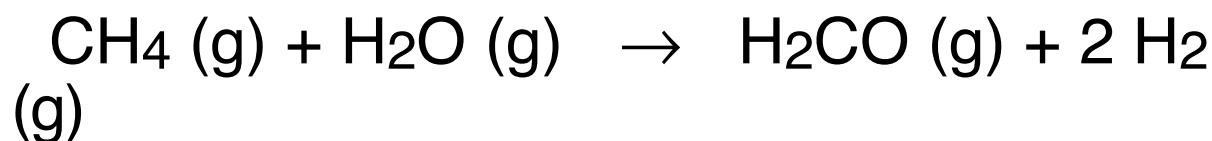
5.1-530

In addition to urea, electrical discharge experiments produce a variety of organic molecules including amino acids (pieces of proteins) and nucleotide bases (pieces of genetic code). The vital energy trapping steps are thought to be the formation of hydrogen cyanide and formaldehyde.

Given the standard enthalpies of formation,

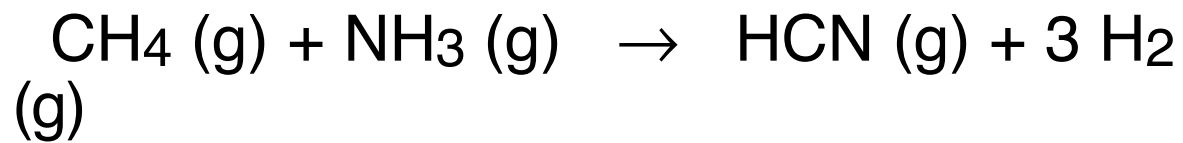
CH ₄ (g)	-74.8	kJ/mol
NH ₃ (g)	-46.1	kJ/mol
H ₂ O (g)	-241.8	kJ/mol
HCN (g)	131.5	kJ/mol
H ₂ CO (g)	-108.6	kJ/mol

ΔH° for forming formaldehyde from hydrogen rich gases



- is
- (a) (+ 74.8 + 241.8 - 108.6) kJ/mol
 - (b) (- 74.8 - 241.8 + 108.6) kJ/mol
 - (c) (- 74.8 - 241.8 - 108.6) kJ/mol
 - (d) not derivable from the data given

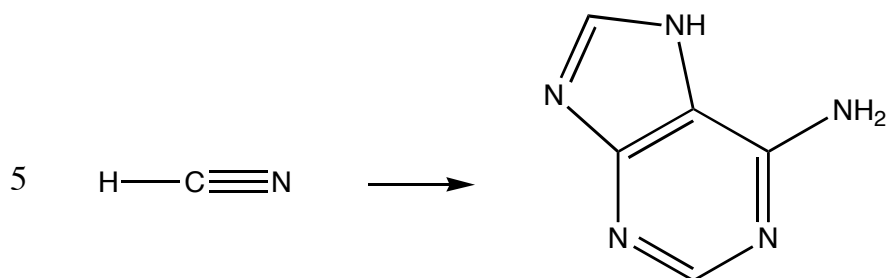
ΔH° for forming hydrogen cyanide from hydrogen rich gases



- is
- (a) $(+ 74.8 + 46.1 - 131.5)$ kJ/mol
 - (b) $(+ 74.8 + 46.1 + 131.5)$ kJ/mol
 - (c) $(- 74.8 - 46.1 - 131.5)$ kJ/mol
 - (d) not derivable from the data given

5.1-540

Adenine, a nucleotide base, is believed to have formed in the “prebiotic soup” by condensation of 5 hydrogen cyanide molecules



with $\Delta H^\circ = -560.6 \text{ kJ/mol}$ adenine.

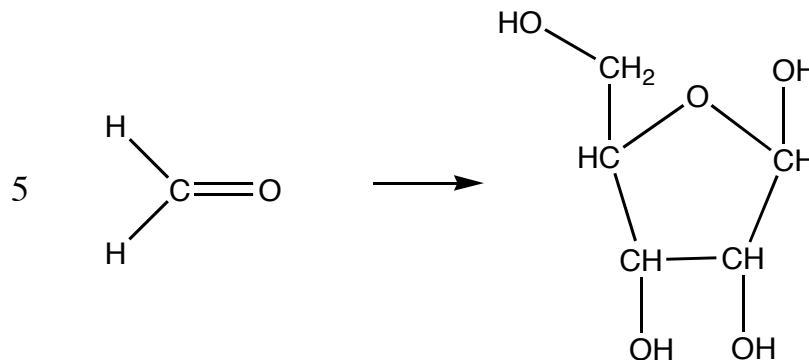
Since $\Delta H_f^\circ (\text{HCN}) = 131.5 \text{ kJ/mol}$,

$\Delta H_f^\circ(\text{adenine}) =$

- (a) $(131.5 - 560.6 / 5) \text{ kJ/mol}$
- (b) $(5 \times 131.5 - 560.6) \text{ kJ/mol}$
- (c) $(-5 \times 131.5 + 560.6) \text{ kJ/mol}$
- (d) is not derivable from the data given

5.1-550

Ribose, the sugar in RNA, is believed to have formed in the “prebiotic soup” by condensation of 5 formaldehyde molecules



with $\Delta H^\circ = -505 \text{ kJ/mol}$ ribose. Since $\Delta H_f^\circ(\text{H}_2\text{CO}, g) = -108.6 \text{ kJ/mol}$, $\Delta H_f^\circ(\text{ribose}) =$

- (a) $(5 \times 108.6 + 519.5) \text{ kJ/mol}$
- (b) $(5 \times 108.6 - 519.5) \text{ kJ/mol}$
- (c) $(-5 \times 108.6 - 519.5) \text{ kJ/mol}$
- (d) is not derivable from the data given

5.1-610

To calculate the C-Cl bond enthalpy from $\Delta H_f^\circ(\text{CCl}_4, \ell)$, which of the following data is not needed ?

- (a) $\Delta H_f^\circ(\text{C}, g)$
- (b) $\Delta H_f^\circ(\text{Cl}, g)$
- (c) $\Delta H^\circ_{\text{fus}}(\text{CCl}_4)$
- (d) $\Delta H^\circ_{\text{vap}}(\text{CCl}_4)$

5.1-630

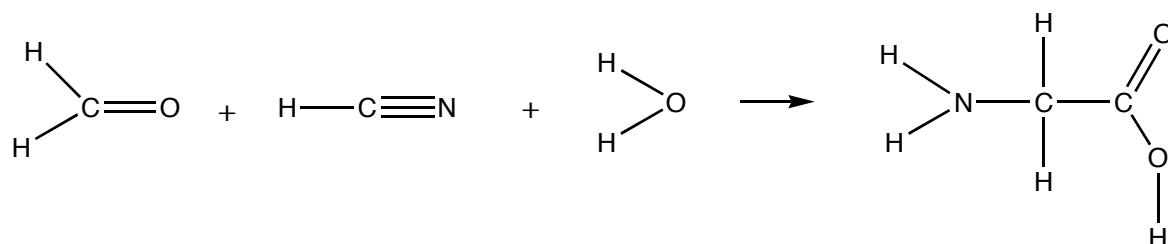
A millionth of a dehydrated *E. coli* bacterium contains about 5830 C, 9380 H, 2670 O and 1550 N atoms with the bonds listed in (a). An alternative arrangement is given in (b). Which has the lower enthalpy ?

<u>bond type</u>	(a) <u># of bonds</u>	(b) <u># of bonds</u>
H-C	7300	4040
H-N	1600	0
H-O	480	5340
C-C	3930	9640
C=C	300	0
C-N	2760	0
C=N	240	0
C-O	240	0
C=O	1190	0
N≡N	0	780
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total bond H	69,360 eV	74,820 eV

Morowitz (pp. 64-66)

5.1-640

Glycine, an amino acid, is believed to have formed in the prebiotic soup by the Strecker synthesis, with the net result



To estimate the enthalpy change for this reaction from bond enthalpies, which of the following bond enthalpies is not needed?

- | | |
|---------|---------|
| (a) H-N | (c) C-C |
| (b) C=O | (d) C≡N |

5.1-710

The molar heat capacity at 25°C should be close to 25 J / mol K for all of the following except

- (a) Pt (b) Kr (c) W (d) Pb

5.1-720

Which of the following gases has the greatest molar heat capacity?

- (a) Ne (b) Ar (c) H₂ (d) CH₄

5.1-730

Which of the following has the smallest specific heat capacity?

(a) Xe (g)

(b) Al (s)

(c) Ar (g)

(d) Sn (s)

5.1-810

Which material will show the greatest increase in temperature after falling from a given height?

- (a) the one with the greatest molar C_p
- (b) the one with the smallest molar C_p
- (c) the one with the greatest specific C_p
- (d) the one with the smallest specific C_p

5.1-820

If you drink 200 mL of an ice-cold (0°C) beverage, then how many kcal are used to warm the liquid to body temperature (37°C)? You can assume that the heat capacity and density of the beverage is essentially the same as that of water.

(a) 200

(b) 0.200

(c) 7400

(d) 7.400

5.1-830

The oceans are heat buffers for the planet. If the water were replaced by an equal mass of a liquid of triple the molecular weight and half the molar heat capacity, the same heat transfers would cause the temperature variations of the oceans to be about

- (a) $3/2$ as great
- (b) $2/3$ as great
- (c) $1/6$ as great
- (d) 6 times as great