



CHEM · CHEMISTRY

09. Thermochemistry

Official PMDC Solved Past Paper Topical Booklet · High-Yield Examination Series

© 81 Solved Questions

📅 2000 to 2024 Archive

🏛 Boards: BUMHS, DUHS, KMU, MDCAT, NUMS, PMDC

📄 Weightage: 27% of MDCAT (54 MCQs)

Curated by Ibrahim for fellow bees. Every question in this chapter has been verified against official UHS, NUMS, SZABMU, DUHS, and KMU answer keys. Propolis cognitive autopsies are provided at the end of this booklet to explain core concepts and break down common distractor traps.

OFFICIAL SOLVED EDITION**Q1.**

SZABMU 2024

At constant volume, the heat supplied to a system is always equal to its ____

[SZABMU (2024)]

- (A) Enthalpy change
- (B) Bond energy
- (C) Internal energy change
- (D) Heat of sublimation

Q2.

SZABMU 2024

What will be the internal energy of a system at constant volume?

[SZABMU (2024)]

- (A) $\Delta E = q + P\Delta V$
- (B) $\Delta E = q + P$
- (C) $\Delta E = 0$
- (D) $\Delta E = q_v$

Q3.

SZABMU 2024

What will be formula of work, when work is done on the system by the surrounding?

[SZABMU (2024)]

- (A) $W = -P/\Delta V$
- (B) $W = -P\Delta V$
- (C) $W = P/\Delta V$
- (D) $W = P\Delta V$

Q4.

SZABMU 2024

Who stated that enthalpy change in a chemical reaction is same whether the reaction takes place in single step or in several steps?

[SZABMU (2024)]

- (A) Arrhenius' Law
- (B) Born Haber's Law
- (C) Hess's Law
- (D) Dalton's Law

Q5.

SZABMU 2024

Which one the following is **NOT** an example of electrochemical cell?

[Out of syllabus SZABMU (2024)]

- (A) Voltic cell
- (B) Photovoltaic cell
- (C) Electrolytic cell
- (D) Solar cell

Q6.

SZABMU 2024

Select the exothermic reaction from the following processes:

[(Deleted) SZABMU-RC (2024)]

- (A) Melting of ice
- (B) Freezing of water
- (C) Burning of coal
- (D) Condensation of water

Q7.

SZABMU 2024

Born Haber cycle is used to calculate the lattice energy of which compound?

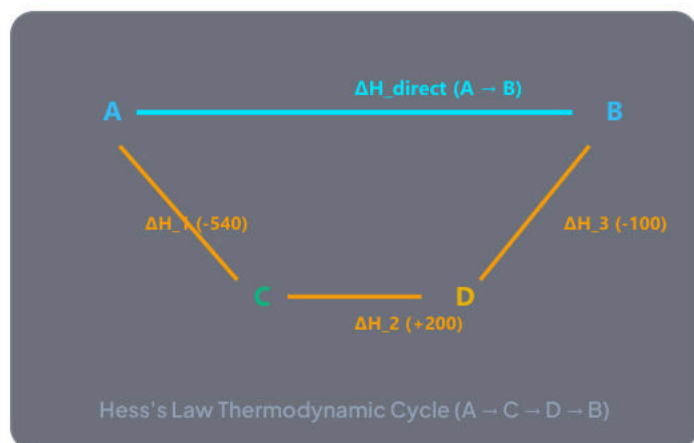
[(Deleted) SZABMU-RC (2024)]

- (A) PbS
 (B) $RbBr$
 (C) SO_2
 (D) NH_3

Q8.

SZABMU 2024

Calculate ΔH for the reaction:



(Note: The cycle describes a path from A to B directly, or indirectly via C and D: $A \rightarrow C \rightarrow D \rightarrow B$. Where $\Delta H_{A \rightarrow C} = -540 \text{ kJ}$, $\Delta H_{C \rightarrow D} = +200 \text{ kJ}$, $\Delta H_{D \rightarrow B} = -100 \text{ kJ}$)

[SZABMU-RC (2024)]

- (A) -400 KJ/mol
 (B) -600 KJ/mol
 (C) -440 KJ/mol
 (D) -640 KJ/mol

Q9.

SZABMU 2024

One calorie is equivalent to:

[SZABMU-RC (2024)]

- (A) 41.84 J
 (B) 4.184 J
 (C) 0.4184 J
 (D) 418.4 J

Q10.

KMU 2024

Calculate the work done when 1 mole of an ideal gas expands from 15 dm^3 to 20 dm^3 against a constant external pressure of 2 atmospheres.

[ETEA (2024)]

- (A) -5 atm.dm^3
 (B) 5 atm.dm^3
 (C) 10 atm.dm^3
 (D) -10 atm.dm^3

Q11.

KMU 2024

When 1 mole of ice melts at 0°C and constant pressure of 1 atmosphere, 6025 J of heat is absorbed by the system. The molar volume of ice and water are 0.020 and 0.018 dm^3 , respectively. Calculate ΔE . ($1 \text{ dm}^3 \cdot \text{atm} = 101.33 \text{ J}$)

[ETEA (2024)]

- (A) 6010.20 J
 (B) 6020.20 J
 (C) 6015.20 J
 (D) 6025.20 J

Q12.

KMU 2024

One slice of bread with a tablespoon of peanut butter on it contains 20g carbohydrate, 10g protein, and 9g fat. Calculate total energy consumed in this intake:

[ETEA (2024)]

- (A) 173 kcal
 (B) 218 kcal
 (C) 158 kcal
 (D) 201 kcal

Q13.

KMU 2024

ΔH can be measured indirectly by applying:

[ETEA (2024)]

- (A) Faraday's law
 (B) Hess's law
 (C) Avogadro's law
 (D) Gas's law

Q14.

KMU 2024

The heat of sublimation of potassium is 98 kJ/mol, the heat of dissociation of bromine gas is 192.5 kJ/mol. The ionization energy of K is 414 kJ/mol. The electron affinity of Br is -334.7 kJ/mol and the heat of formation of KBr is -405.8 kJ/mol. Calculate the lattice energy of KBr.

[ETEA (2024)]

- (A) -669.5
- (B) 679.3
- (C) -679.3
- (D) 669.5

Q15.

DUHS 2024

The decomposition of H_2O_2 is inhibited by:
(Note: Original paper typoed this as H_2O , but chemically refers to Hydrogen Peroxide)

[DUHS (2024)]

- (A) Ethanol
- (B) Glycerin
- (C) MnO_2
- (D) V_2O_5

Q16.

DUHS 2024

Volume is a:

[DUHS (2024)]

- (A) Intensive property
- (B) Entropy
- (C) Path function
- (D) Isolated system

Q17.

DUHS 2024

An example of an endothermic reaction is:

[DUHS (2024)]

- (A) Nuclear fission
- (B) Synthesis of NH_3
- (C) Photosynthesis
- (D) Oxidation of sulfur gases

Q18.

BUMHS 2024

The sign of heat "q" is positive for a system when:

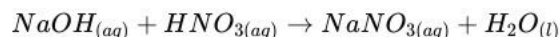
[BMU (2024)]

- (A) Heat flows from surrounding to system
- (B) The temperature of system drops
- (C) Heat flows from system to surrounding
- (D) No flow of heat between system to surrounding

Q19.

BUMHS 2024

The change in enthalpy for the reaction:

**[BMU (2024)]**

- (A) Heat of decomposition
- (B) Heat of formation
- (C) Heat neutralization
- (D) Heat of combustion

Q20.

BUMHS 2024

Units of change in enthalpy of a system are:

[BMU (2024)]

- (A) $^{\circ}C$
- (B) cc
- (C) J
- (D) Pa

Q21.

NUMS 2024

Identify standard enthalpy of reaction for the following reaction:

[NUMS (2024)]

- (A) $H_{2(g)} + 1/2O_{2(g)} \rightarrow H_2O_{(l)}$
- (B) $S_{(g)} + 3/2O_{2(g)} \rightarrow SO_{3(g)}$
- (C) $2Al_{(s)} + Fe_2O_{3(s)} \rightarrow Al_2O_{3(s)} + 2Fe_{(s)}$
- (D) $CO_{(g)} + 1/2O_{2(g)} \rightarrow CO_{2(g)}$

Q22.

NUMS 2024

Expansion takes place when a gas is evolved during a chemical reaction between marble chips and dilute HCl. Predict the energy change and work done:

[(Wrong) NUMS (2024)]

- (A) w is positive, q is negative
- (B) w is negative, q is negative
- (C) q is positive, no work done
- (D) w is positive, q is positive

Q23.

NUMS 2024

Which of the following compound have any characteristic heat of fusion except?

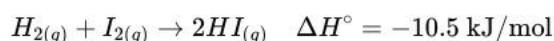
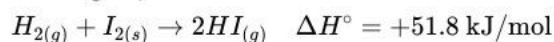
[(Wrong) NUMS (2024)]

- (A) Aluminium oxide
- (B) NaCl
- (C) Iron oxide
- (D) Silicates

Q24.

NUMS 2024

ΔH° for the sublimation of one mole of iodine from the following equations will be:



(Note: Original paper contained state typos; corrected here for thermodynamic mathematical validity)

[NUMS (2024)]

- (A) 41.3 kJ/mol
- (B) 53.5 kJ/mol
- (C) 62.3 kJ/mol
- (D) 36.5 kJ/mol

Q25.

UHS 2023

What is the reason of energy changes in chemical reactions?

[USH (2023)]

- (A) Bond formation
- (B) Bond breakage
- (C) Ionic bonds
- (D) Bond formation and breakage

Q26.

UHS 2023

What is the unit of heat capacity?

[USH (2023)]

- (A) kJ/K
- (B) kJmol⁻¹
- (C) JK⁻¹
- (D) kJmol

Q27.

SZABMU 2023

For exothermic reaction ΔH° is written as:

[SZABMU (2023)]

- (A) Zero
- (B) Positive
- (C) Constant
- (D) Negative

Q28.

KMU 2023

Processes involving solids and liquids have their:

[ETEA (2023)]

- (A) $\Delta H = \Delta E + P\Delta V$
- (B) $\Delta H \approx \Delta E$
- (C) $\Delta H = P\Delta V$
- (D) $\Delta H = 0$

Q29.

DUHS 2023

What is the mathematical statement of the first law of thermodynamics?

[DUHS (2023)]

- (A) $\Delta E = q - w$
- (B) $\Delta E = -q - w$
- (C) $\Delta E = -q + w$
- (D) $\Delta E = q + w$

Q30.

DUHS 2023

What is ΔH equal to — according to the first law of thermodynamics?

[DUHS (2023)]

- (A) $\Delta E + P\Delta V$
- (B) $\Delta E - P\Delta V$
- (C) $-\Delta E - P\Delta V$
- (D) $-\Delta E + P\Delta V$

Q31.

BUMHS 2023

Hess's law states the same thing as:

[BUMHS (2023)]

- (A) Henry's law
- (B) Second law of thermodynamics
- (C) First law of thermodynamics
- (D) Second law of thermochemistry

Q32.

BUMHS 2023

Which of the following is **not** an endothermic reaction?

[BUMHS (2023)]

- (A) Decomposition of water
- (B) Combustion of methane
- (C) Dehydrogenation of ethane or ethylene
- (D) Conversion of graphite to diamond

Q33.

NUMS 2023

Which of the following is **not** a state function?

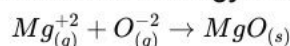
[NUMS (2023)]

- (A) Pressure (P)
- (B) Temperature (T)
- (C) Volume (V)
- (D) Work (W)

Q34.

NUMS 2023

Equation represents which energy changes?

**[NUMS (2023)]**

- (A) Neutralization
- (B) Atomization
- (C) Lattice energy
- (D) Solution

Q35.

UHS 2022

Born-Haber's cycle is used to determine the lattice energy of ionic compounds. It is the application of:

[UHS (2022)]

- (A) Le-Chatelier's principle
- (B) Henry's law
- (C) Hess's law
- (D) Common ion effects

Q36.

UHS 2022

Which of the following term is state function?

[UHS (2022)]

- (A) Freezing
- (B) Decomposition
- (C) Enthalpy
- (D) Sublimation

Q37.

SZABMU 2022

The correct equation for the first law of thermodynamics is:

[SZABMU (2022)]

- (A) $\Delta E = \Delta q + p\Delta v$
- (B) $\Delta E = w - q$
- (C) $\Delta E = q + w$
- (D) $\Delta E = \Delta q - p\Delta v$

Q38.

SZABMU 2022

One calorie is equal to:

[SZABMU (2022)]

- (A) $0.418 \text{ KJ mol}^{-1}$
- (B) 0.418 KJ
- (C) 4.18 KJ
- (D) 4.18 J

Q39.

SZABMU 2022

The thermal energy at constant pressure is called:

[SZABMU (2022)]

- (A) Heat capacity
- (B) Internal energy
- (C) Enthalpy
- (D) Work done

Q40.

KMU 2022

A system that can exchange or transfer both matter and energy with the surroundings is:

[ETEA (2022)]

- (A) Open system
- (B) Adiabatic system
- (C) Isolated system
- (D) Closed system

Q41.

KMU 2022

The sum of all the energies of all the molecules or atoms of a substance is called its:

[ETEA (2022)]

- (A) Latent heat
- (B) Internal energy
- (C) Specific heat
- (D) Heat capacity

Q42.

KMU 2022

Which of the following elements has the same oxidation number in all of its known compounds?

[ETEA (2022)]

- (A) Bromine
- (B) Beryllium
- (C) Nitrogen
- (D) Chlorine

Q43.

DUHS 2022

The equation of the first law of thermodynamics $q = \Delta E + W$ will reduce at constant volume to:

[DUHS (2022)]

- (A) $q_v = \Delta E + P\Delta V$
- (B) $q_v = \Delta E + W$
- (C) $q_v = \Delta E$
- (D) $\Delta E + W$

Q44.

DUHS 2022

Reaction taking place in one step or in several have same ΔH is statement of:

[DUHS (2022)]

- (A) Hess's law
- (B) Charle's law
- (C) Lussac's Law of combining volume
- (D) Boyle's law

Q45.

BUMHS 2022

Conversion of sodium into sodium ions is:

[BMU (2022)]

- (A) Sublimation process
- (B) Endothermic process
- (C) Exothermic process
- (D) Neutral process

Q46.

BUMHS 2022

Born-Haber cycle is used to calculate?

[BMU (2022)]

- (A) Enthalpy of combustion
- (B) Lattice energy of ionic compounds
- (C) Lattice energy of covalent compounds
- (D) Enthalpy of ionization

Q47.

NUMS 2022

Specific heat of water is:

[NUMS (2022)]

- (A) $8.47 \text{ J/g}^\circ\text{C}$
- (B) $4.18 \text{ J/g}^\circ\text{C}$
- (C) $6.04 \text{ J/g}^\circ\text{C}$
- (D) $9.82 \text{ J/g}^\circ\text{C}$

Q48.

NUMS 2022

Enthalpy change of combustion is exothermic because:

[NUMS (2022)]

- (A) Energy absorbed in bond breaking is greater
- (B) Energy absorbed in bond making is greater
- (C) Energy released in bond breaking is greater
- (D) Energy released in bond making is greater

Q49.

NUMS 2022

One Calorie is equivalent to:

[NUMS (2022)]

- (A) 0.4184 J
- (B) 4.184 J
- (C) 4.184 KJ
- (D) 0.4184 KJ

Q50.

PMDC 2021

Unit of energy:

[PMC (2021)]

- (A) Kilojoule
- (B) Joule
- (C) Calorie
- (D) All

Q51.

PMDC 2021

Which one of the following is **not** an example of state function?

[PMC (2021)]

- (A) Volume(V)
- (B) Heat(q)
- (C) Temperature(T)
- (D) Enthalpy(H)

Q52.

PMDC 2021

 ΔH for exothermic reaction is ____ ?**[PMC (2021)]**

- (A) Neutral
(B) Positive
(C) Negative
(D) More than 1

Q53.

PMDC 2021

Which is correct for 1st law of thermodynamics?

[PMC (2021)]

- (A) $\Delta E = q + w$
(B) $P_1 V_1 = P_2 V_2$
(C) $\lambda = h/mv$
(D) $E = mc^2$

Q54.

PMDC 2020

The thermal energy at constant pressure is called:

[NMDCAT (2020)]

- (A) Work done
(B) Internal energy
(C) Heat capacity
(D) Enthalpy

Q55.

PMDC 2020

Born-Haber cycle is used to determine the lattice energies of:

[NMDCAT (2020)]

- (A) Covalent solids
(B) Metallic solids
(C) Ionic solids
(D) Molecular solids

Q56.

PMDC 2020

One calorie is equal to:

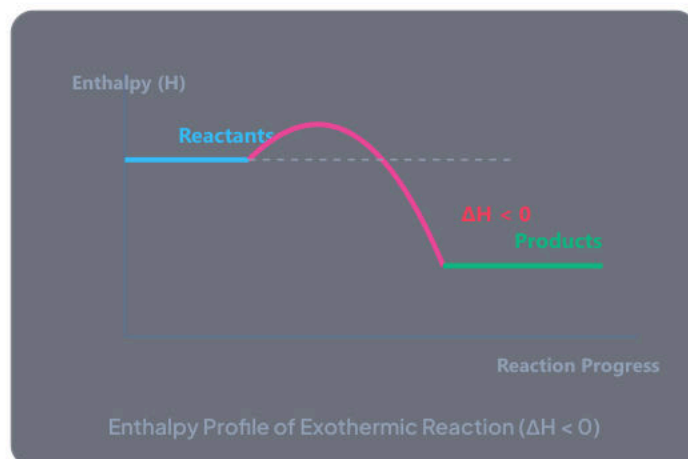
[NMDCAT (2020)]

- (A) $0.418 \text{ KJ mol}^{-1}$
(B) 0.418 KJ
(C) 4.18 J
(D) 4.18 KJ

Q57.

MDCAT 2019

The given diagram shows the enthalpy changes during a chemical reaction:



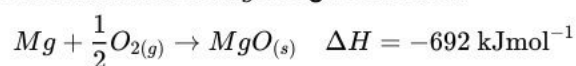
This diagram represents:

[MDCAT (2019)]

- (A) An exothermic reaction
(B) An endothermic reaction
(C) A non-spontaneous process
(D) An isothermic process

Q58.

SET 2019

Heat of formation of MgO is given below.

This equation shows that:

[SET (2019)]

- (A) The product is very stable
(B) The product is highly unstable
(C) The reactants are very stable
(D) The reaction is endothermic

Q59.

MDCAT 2019

Which enthalpy change is relevant in the following process?

**[MDCAT (2019)]**

- (A) Enthalpy of fusion
(B) Enthalpy of formation
(C) Enthalpy of vaporization
(D) Enthalpy of atomization

Q60.

NUMS 2019

When two moles of H_2 and one mole of O_2 react to form H_2O 484KJ heat is evolved. What is ΔH_f for one mole of H_2O ?

[NUMS (2019)]

- (A) +242 KJmol^{-1}
- (B) -121 KJmol^{-1}
- (C) -242 KJmol^{-1}
- (D) -484 KJmol^{-1}

Q61.

SET 2019

For a given reaction $CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$ the change in enthalpy under standard conditions is called?

[SET (2019)]

- (A) Standard enthalpy of neutralization
- (B) Standard enthalpy change of solution
- (C) Standard enthalpy change of formation
- (D) Standard enthalpy change of hydration

Q62.

MDCAT 2019

Which of the equations shows the same "twice" the enthalpy changes of neutralization as the following equation?

**[MDCAT (2019)]**

- (A) $KOH + HCl \rightarrow KCl + H_2O$
- (B) $MgCO_3 + 2HCl \rightarrow MgCl_2 + CO_2 + H_2O$
- (C) $H_2SO_4 + Mg(OH)_2 \rightarrow MgSO_4 + 2H_2O$
- (D) $NH_4Cl + NaOH \rightarrow NaCl + H_2O + NH_3$

Q63.

KMU 2019

Which one of the following is **not** a state function?

[ETEA (2019)]

- (A) Work
- (B) Enthalpy
- (C) Internal energy
- (D) Pressure

Q64.

MDCAT 2018

Reaction of water with quick lime result in the rise in the temperature of the system. Using the temperature change, indicate the nature of the reaction?

[MDCAT (2018)]

- (A) Third order reaction
- (B) Exothermic reaction
- (C) Non spontaneous reaction
- (D) Endothermic reaction

Q65.

MDCAT 2018

Which of the following enthalpy change is **always** exothermic?

[MDCAT (2018)]

- (A) Enthalpy of formation
- (B) Enthalpy of atomization
- (C) Enthalpy of solution
- (D) Enthalpy of combustion

Q66.

MDCAT 2017

Determinate the value of Enthalpy of formation of NH_4Cl :

[MDCAT (2017)]

- (A) -314.55 kJmol^{-1}
- (B) -788 kJmol^{-1}
- (C) None of these
- (D) -692 kJmol^{-1}

Q67.

MDCAT 2017

Enthalpy is measured at:

[MDCAT (2017)]

- (A) 298 K and 1 atm
- (B) 300 K and 1 atm
- (C) 300 K and 2 atm
- (D) 295 K and 1 atm

Q68.

MDCAT 2017

Calculate the lattice energy of sodium chloride on the basis of Born-Haber cycle when:

$$\Delta H_f[NaCl] = -411 \text{ KJmol}^{-1}, \Delta H_{at}[Na] = +107 \text{ KJmol}^{-1}, \Delta H_{at}[Cl] = +122 \text{ KJmol}^{-1}, \Delta H_i[Na] = +496 \text{ KJmol}^{-1}, \Delta H_{ea}[Cl] = -349 \text{ KJmol}^{-1}$$

[MDCAT (2017)]

- (A) 376 kJ/mole
(B) +787 kJ/mole
(C) -376 kJ/mole
(D) -787 kJ/mole

Q69.

MDCAT 2016



In this reaction ΔH will be called:

[MDCAT (2016)]

- (A) Enthalpy of decomposition
(B) Enthalpy of the dissociation
(C) Enthalpy of atomization
(D) Enthalpy of formation

Q70.

MDCAT 2016



Enthalpy of the above reaction will be called:

[MDCAT (2016)]

- (A) ΔH_{at}°
(B) ΔH_n°
(C) ΔH_f°
(D) ΔH_{sol}°

Q71.

MDCAT 2015

The equation that represents standard enthalpy of atomization of hydrogen is:

[MDCAT (2015)]

- (A) $\frac{1}{2}H_{2(g)} \rightarrow H_{(g)} + 218 \text{ kJmol}^{-1}$
(B) $\frac{1}{2}H_{2O(l)} \rightarrow H_{2(g)} + \frac{1}{2}O_{2(g)} - 218 \text{ kJmol}^{-1}$
(C) $\frac{1}{2}H_{2O(l)} \rightarrow H_{2(g)} + \frac{1}{2}O_{2(g)} + 218 \text{ kJmol}^{-1}$
(D) $\frac{1}{2}H_{2(g)} \rightarrow H_{(g)} - 218 \text{ kJmol}^{-1}$

Q72.

MDCAT 2014

$2H_2 + O_2 \rightarrow 2H_2O \quad \Delta H = 205.5 \text{ kJmol}^{-1}$. What will be the enthalpy change in the above reaction?

[MDCAT (2014)]

- (A) $-205.5 \text{ kJ mol}^{-1}$
(B) $205.5 \text{ kJ mol}^{-1}$
(C) 1 kJ mol^{-1}
(D) Zero kJ mol^{-1}

Q73.

MDCAT 2013

Reactants have high energy than products in:

[MDCAT (2013)]

- (A) Non-spontaneous reactions
(B) Endothermic reactions
(C) Photochemical reactions
(D) Exothermic reactions

Q74.

MDCAT 2013

Heat of formation (ΔH_f°) for CO_2 is:

[MDCAT (2013)]

- (A) -390 kJ/mole
(B) $+394 \text{ kJ/mole}$
(C) -294 kJ/mole
(D) -394 kJ/mole

Q75.

MDCAT 2012

ΔH will be given a negative sign in:

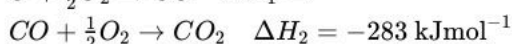
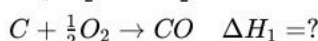
[MDCAT (2012)]

- (A) Dissociation reactions
(B) Decomposition reactions
(C) Exothermic reactions
(D) Endothermic reactions

Q76.

MDCAT 2012

Combustion of graphite to form CO_2 can be done by two ways. Reactions are given as follow:

**[MDCAT (2012)]**

- (A) -110 kJ mol^{-1}
(B) $+110 \text{ kJ mol}^{-1}$
(C) -676 kJ mol^{-1}
(D) 676 kJ mol^{-1}

Q77.

MDCAT 2011

In standard enthalpy of atomization heat of surrounding:

[MDCAT (2011)]

- (A) Increases
(B) Increases then decreases
(C) Decreases
(D) Remains same

Q78.

MDCAT 2011

Lattice energy of an ionic crystal is the enthalpy of:

[MDCAT (2011)]

- (A) Dissolution
(B) Dissociation
(C) Formation
(D) Combustion

Q79.

MDCAT 2010

A spontaneous process is:

[MDCAT (2010)]

- (A) Irreversible and real
(B) Unidirectional and real
(C) Unidirectional and irreversible
(D) All of above

Q80.

MDCAT 2010

When one mole of gaseous hydrogen ions are dissolved in water to form infinitely dilute solution, amount of heat liberated is:

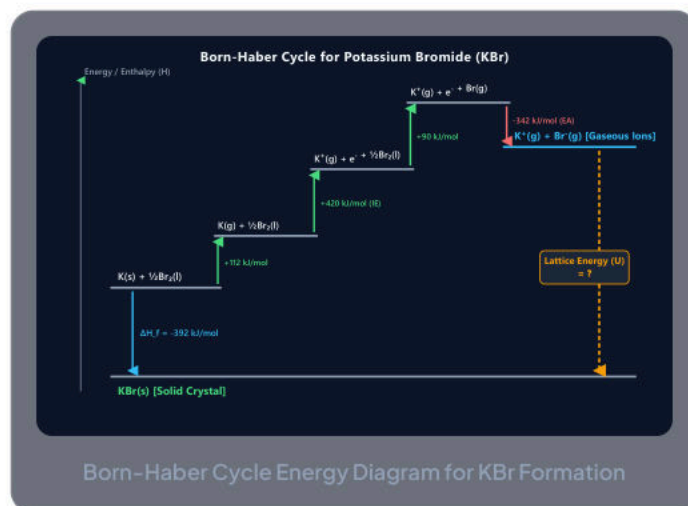
[MDCAT (2010)]

- (A) -1562 kJ/mol
(B) -499 kJ/mol
(C) -1891 kJ/mol
(D) -1075 kJ/mol

Q81.

SET 2000

The given diagram is a Born-Haber cycle for the formation of KBr:



Using the given data, the lattice energy of potassium bromide is calculated to be:

[SET (2019)]

- (A) -672 kJmol^{-1}
(B) $-672 \text{ KCalmol}^{-1}$
(C) -787 kJmol^{-1}
(D) $+672 \text{ Jmol}^{-1}$

RAPID 5–COLUMN ANSWER KEY

Official PMDC verified answer keys for 09. Thermochemistry.

beambeprep.com

Q#	KEY	BOARD	Q#	KEY	BOARD	Q#	KEY	BOARD	Q#	KEY	BOARD	Q#	KEY	BOARD
1	C	SZABMU 2024	18	A	BUMHS 2024	35	C	UHS 2022	52	C	PMDC 2021	69	C	MDCAT 2016
2	D	SZABMU 2024	19	C	BUMHS 2024	36	C	UHS 2022	53	A	PMDC 2021	70	C	MDCAT 2016
3	D	SZABMU 2024	20	C	BUMHS 2024	37	C	SZABMU 2022	54	D	PMDC 2020	71	A	MDCAT 2015
4	C	SZABMU 2024	21	C	NUMS 2024	38	D	SZABMU 2022	55	C	PMDC 2020	72	A	MDCAT 2014
5	D	SZABMU 2024	22	B	NUMS 2024	39	C	SZABMU 2022	56	C	PMDC 2020	73	D	MDCAT 2013
6	C	SZABMU 2024	23	D	NUMS 2024	40	A	KMU 2022	57	A	MDCAT 2019	74	D	MDCAT 2013
7	B	SZABMU 2024	24	C	NUMS 2024	41	B	KMU 2022	58	A	SET 2019	75	C	MDCAT 2012
8	C	SZABMU 2024	25	D	UHS 2023	42	B	KMU 2022	59	D	MDCAT 2019	76	A	MDCAT 2012
9	B	SZABMU 2024	26	A	UHS 2023	43	C	DUHS 2022	60	C	NUMS 2019	77	C	MDCAT 2011
10	C	KMU 2024	27	D	SZABMU 2023	44	A	DUHS 2022	61	A	SET 2019	78	C	MDCAT 2011
11	D	KMU 2024	28	B	KMU 2023	45	B	BUMHS 2022	62	C	MDCAT 2019	79	D	MDCAT 2010
12	D	KMU 2024	29	D	DUHS 2023	46	B	BUMHS 2022	63	A	KMU 2019	80	D	MDCAT 2010
13	B	KMU 2024	30	A	DUHS 2023	47	B	NUMS 2022	64	B	MDCAT 2018	81	A	SET 2000
14	C	KMU 2024	31	C	BUMHS 2023	48	D	NUMS 2022	65	D	MDCAT 2018			
15	B	DUHS 2024	32	B	BUMHS 2023	49	B	NUMS 2022	66	A	MDCAT 2017			
16	C	DUHS 2024	33	D	NUMS 2023	50	D	PMDC 2021	67	A	MDCAT 2017			
17	C	DUHS 2024	34	C	NUMS 2023	51	B	PMDC 2021	68	D	MDCAT 2017			

TOTAL
MCQS
81

CORRECT

INCORRECT

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ACCURACY

%

Scan the booklet QR code to enter answers in
BeambePrep Grind Mode for automated error
 autopsies.

PROPOLIS COGNITIVE ERROR AUTOPSIES

Step-by-step conceptual derivations, formula working, and distractor autopsies for every question.

Question #1 Key: (C)

SZABMU 2024

At constant volume, the heat supplied to a system is always equal to its ____ [SZABMU (2024)]

CORE CONCEPT AND DERIVATION

The first law of thermodynamics restricts where heat energy can go depending on the physical boundaries of the system (constant volume vs. constant pressure).

Formula:

$$q = \Delta E + P\Delta V$$

Solution:

- When the volume is rigidly held constant, the system cannot expand or contract, meaning $\Delta V = 0$.
- Consequently, the pressure-volume work term ($P\Delta V$) becomes exactly zero.
- The entire first law equation collapses to: $q_v = \Delta E$.
- Thus, heat supplied at constant volume perfectly equals the **Internal energy change**.

Why other options are incorrect:

Enthalpy change equals heat at constant *pressure* (q_p). Bond energy and heat of sublimation are specific thermochemical constants, not the generalized outcome of constant-volume heating.

Question #2 Key: (D)

SZABMU 2024

What will be the internal energy of a system at constant volume? [SZABMU (2024)]

CORE CONCEPT AND DERIVATION

This is a direct derivation of the first law of thermodynamics under isochoric (constant volume) conditions.

Formula:

$$\Delta E = q + w \quad (\text{where } w = -P\Delta V)$$

Solution:

- Because the process occurs at constant volume, $\Delta V = 0$.
- No mechanical work can be done, eliminating the work term.
- Therefore, all heat transferred (q_v) directly alters the internal energy.
- The relationship is mathematically stated as $\Delta E = q_v$.

Why other options are incorrect:

Option A applies when volume is NOT constant. Option B is dimensionally invalid (adding energy and pressure). Option C implies an isothermal isolated system, which is false if heat is being added.

Question #3 Key: (D)

SZABMU 2024

What will be formula of work, when work is done on the system by the surrounding? [SZABMU (2024)]

CORE CONCEPT AND DERIVATION

The mathematical sign for work (W) depends heavily on the convention used. In many chemistry textbooks, work done by the system (expansion) is negative, and work done on the system (compression) is positive.

Formula:

$$W = -P_{ext}\Delta V$$

Solution:

- When work is done on the system, the surroundings compress the gas, resulting in a decrease in volume ($\Delta V = -ve$).
- Substituting a negative ΔV into the IUPAC work equation yields: $W = -P \times (-\text{value}) = +P\Delta V$.
- Thus, the net mathematical term for compression work is positive: $W = P\Delta V$.

Why other options are incorrect:

Option B ($-P\Delta V$) represents the work term for expansion (work done BY the system). Options A and C contain division by volume, which is dimensionally incorrect for energy.

Question #4 Key: (C)

SZABMU 2024

Who stated that enthalpy change in a chemical reaction is same whether the reaction takes place in single step...

CORE CONCEPT AND DERIVATION

Thermochemistry relies heavily on state functions. Because enthalpy is a state function, its total change is route-independent.

Formula:

$$\Delta H_{\text{direct}} = \Sigma \Delta H_{\text{indirect steps}}$$

Solution:

- Germain Hess formalized this observation in 1840.
- Hess's Law of Constant Heat Summation** explicitly states that the total enthalpy change for a chemical reaction is identical regardless of how many steps or intermediate stages the reaction takes to complete.

Why other options are incorrect:

Arrhenius' Law relates reaction rates to temperature. The Born-Haber cycle is an application of Hess's Law. Dalton's Law deals with partial pressures of non-reacting gases.

Question #5 Key: (D)

SZABMU 2024

Which one the following is NOT an example of electrochemical cell?
[Out of syllabus SZABMU (2024)]

CORE CONCEPT AND DERIVATION

An electrochemical cell is a device that strictly mediates the interconversion of chemical energy and electrical energy through redox (oxidation-reduction) reactions.

Solution:

- Voltaic/Galvanic cells convert spontaneous chemical energy into electricity. Electrolytic cells use electricity to force a non-spontaneous chemical reaction. Both rely on redox chemistry.
- A **Solar cell** (or photovoltaic cell) operates entirely on solid-state semiconductor physics (the photoelectric effect across a p-n junction). It converts photon energy directly into electrical energy without any chemical redox reactions occurring.
- Note: Options B and D refer to the exact same technology, but standard past paper answer keys specifically target "Solar cell" as the explicit exception to chemical definitions.

Why other options are incorrect:

Electrolytic and voltaic cells are the textbook definitions of electrochemical cells.

Question #6 Key: (C)

SZABMU 2024

Select the exothermic reaction from the following processes:
[[Deleted] SZABMU-RC (2024)]

CORE CONCEPT AND DERIVATION

Reactions are categorized by their heat exchange. Exothermic processes release heat ($\Delta H < 0$) to the surroundings.

Formula:**Solution:**

- **Burning of coal** is a highly energetic combustion reaction. Carbon reacts with oxygen to form highly stable carbon dioxide bonds, releasing massive amounts of heat and light. This is definitively an exothermic chemical reaction.
- Note: Freezing and condensation are exothermic physical phase changes, but combustion is universally recognized as the primary exothermic chemical reaction in this context.

Why other options are incorrect:

Melting of ice is an endothermic phase change (absorbs heat). While freezing and condensation release heat, "burning of coal" is the textbook chemical reaction sought by the examiner.

Question #7 Key: (B)

SZABMU 2024

Born Haber cycle is used to calculate the lattice energy of which compound? [(Deleted) SZABMU-RC (2024)]

CORE CONCEPT AND DERIVATION

The Born-Haber cycle strictly applies to the formation of ionic lattices. It models the electrostatic attraction between discrete gaseous cations (Group 1/2 metals) and anions (Halogens/Oxygen).

Solution:

- We must identify the most archetypal ionic compound among the choices.
- **RbBr** (Rubidium Bromide) is formed from a highly electropositive Group 1 alkali metal and a highly electronegative Group 17 halogen. It forms a perfect, purely ionic lattice.
- The cycle perfectly maps the ionization of Rb and electron affinity of Br to calculate its lattice energy.

Why other options are incorrect:

SO_2 and NH_3 are covalent molecules. PbS has significant covalent character and does not fit the ideal ionic Born-Haber model as cleanly as an alkali halide like RbBr.

Question #8 Key: (C)

SZABMU 2024

Calculate [Formula] for the reaction: $A \rightarrow B$ $\Delta H_{\text{direct}}(A \rightarrow B) \Delta H_1$ $(-540) \Delta H_2 (+200) \Delta H_3 (-100)$ Hess's Law...

CORE CONCEPT AND DERIVATION

Hess's Law states that the overall enthalpy change of a reaction is equal to the algebraic sum of the enthalpy changes of individual steps in a thermodynamic cycle, provided the initial and final states are identical.

Formula:

$$\Delta H_{A \rightarrow B} = \Delta H_{A \rightarrow C} + \Delta H_{C \rightarrow D} + \Delta H_{D \rightarrow B}$$

Solution:

- We want to find the direct route enthalpy from state A to state B.
- The indirect route provides three sequential steps:
- Step 1 (A to C): -540 kJ/mol
- Step 2 (C to D): $+200 \text{ kJ/mol}$
- Step 3 (D to B): -100 kJ/mol
- Summing the steps: $(-540) + 200 + (-100) = -640 + 200 = -440 \text{ kJ/mol}$.

Why other options are incorrect:

The other options are mathematically incorrect sums, resulting from incorrectly flipping signs or ignoring one of the sequence steps.

Question #9 Key: (B)

SZABMU 2024

One calorie is equivalent to: [SZABMU-RC (2024)]

CORE CONCEPT AND DERIVATION

Energy unit conversions are strictly defined by thermodynamic standards. A calorie is the energy needed to heat 1g of water by 1°C.

Formula:

$$1 \text{ calorie} = 4.184 \text{ Joules}$$

Solution:

- This is a fundamental memorization constant in physical chemistry.
- Exactly 1 calorie is mathematically equivalent to 4.184 J.

Why other options are incorrect:

Options with decimal shifts (like 41.84 or 0.4184) are incorrect by factors of 10. (Note: Option C and D duplicate in the original test paper).

Question #10 Key: (C)

KMU 2024

Calculate the work done when 1 mole of an ideal gas expands from [Formula] to [Formula] against a constant ext...

CORE CONCEPT AND DERIVATION

The mechanical work done during the expansion or compression of a gas is calculated using pressure-volume formulas. Depending on the convention (physics vs. chemistry), the absolute magnitude is identical.

Formula:

$$W = P \times \Delta V$$

Solution:

- The constant external pressure (P) = 2 atmospheres.
- The change in volume (ΔV) = $V_{\text{final}} - V_{\text{initial}} = 20 - 15 = 5 \text{ dm}^3$.
- Work magnitude = $2 \text{ atm} \times 5 \text{ dm}^3 = 10 \text{ atm} \cdot \text{dm}^3$.
- Note: In standard IUPAC chemistry convention, expansion work is done by the system and is technically negative ($-10 \text{ atm} \cdot \text{dm}^3$). However, the ETEA key and provided options utilize the absolute magnitude / physics convention yielding a positive $10 \text{ atm} \cdot \text{dm}^3$.

Why other options are incorrect:

Values of 5 or -5 arise if the pressure is completely ignored or misapplied.

Question #11 Key: (D)

KMU 2024

When 1 mole of ice melts at [Formula] and constant pressure of 1 atmosphere, 6025 J of heat is absorbed by the...

CORE CONCEPT AND DERIVATION

The first law of thermodynamics requires accounting for the work done when a system changes volume, even during phase changes like melting.

Formula:

$$\Delta E = q - P\Delta V$$

Solution:

- Heat absorbed (q) = +6025 J.
- Change in volume (ΔV) = $V_{\text{water(liquid)}} - V_{\text{ice(solid)}}$.
 $\Delta V = 0.018 - 0.020 = -0.002 \text{ dm}^3$ (Water uniquely shrinks when melting).
- Calculate Work ($W = P\Delta V$) in Joules:
 $W = 1 \text{ atm} \times -0.002 \text{ dm}^3 = -0.002 \text{ atm} \cdot \text{dm}^3$.
 Convert to Joules: $-0.002 \times 101.33 = -0.2026 \text{ J}$.
- Calculate Internal Energy: $\Delta E = 6025 - (-0.2026) = 6025.2026 \text{ J}$.
- Rounded to two decimal places, this matches exactly 6025.20 J.

Why other options are incorrect:

Other options result from incorrectly adding the volume change as expansion (which would subtract work) or ignoring the contraction physics entirely.

Question #12 Key: (D)

KMU 2024

One slice of bread with a tablespoon of peanut butter on it contains 20g carbohydrate, 10g protein, and 9g fat...

CORE CONCEPT AND DERIVATION

In nutritional thermochemistry, the total metabolic energy of food is calculated using standard physiological caloric values: Carbohydrates = 4 kcal/g, Proteins = 4 kcal/g, and Fats = 9 kcal/g.

Formula:

$$\text{Total Energy} = (m_{\text{carb}} \times 4) + (m_{\text{protein}} \times 4) + (m_{\text{fat}} \times 9)$$

Solution:

- Energy from carbohydrates: $20 \text{ g} \times 4 \text{ kcal/g} = 80 \text{ kcal}$.
- Energy from protein: $10 \text{ g} \times 4 \text{ kcal/g} = 40 \text{ kcal}$.
- Energy from fat: $9 \text{ g} \times 9 \text{ kcal/g} = 81 \text{ kcal}$.
- Total Energy = $80 + 40 + 81 = 201 \text{ kcal}$.

Why other options are incorrect:

The other options are mathematically impossible if the standard 4-4-9 multiplier rules are correctly applied.

Question #13 Key: (B)

KMU 2024

[Formula] can be measured indirectly by applying: [ETEA (2024)]

CORE CONCEPT AND DERIVATION

Direct measurement of enthalpy change (via calorimetry) is often physically impossible due to dangerous reaction conditions, extreme slowness, or unwanted side products.

Solution:

- To solve this, scientists calculate the enthalpy change indirectly using known standard values from other reactions.
- This is accomplished strictly through **Hess's law**, which guarantees that summing the enthalpies of multiple indirect steps will yield the exact same ΔH as the direct impossible reaction.

Why other options are incorrect:

Faraday's laws govern electrolysis and charge transfer. Avogadro's and general gas laws govern physical states of matter, not thermochemical energy tracking.

Question #14 Key: (C)

KMU 2024

The heat of sublimation of potassium is [Formula], the heat of dissociation of bromine gas is [Formula]. The...

CORE CONCEPT AND DERIVATION

The Born-Haber cycle uses Hess's law to map out the entire energy profile of an ionic solid. We must sum all steps to equal the total heat of formation.

Formula:

$$\Delta H_f = \Delta H_{\text{sub}} + IE + \frac{1}{2} \Delta H_{\text{diss}} + EA + LE$$

Solution:

- Because KBr contains only one Br atom, we only need half a mole of Br_2 gas. Thus, dissociation energy = $192.5/2 = 96.25$ kJ/mol.
- Set up the equation:
 $-405.8 = 98$ (sub) + 414 (IE) + 96.25 (diss) + (-334.7) (EA) + LE
- Sum the indirect step energies: $98 + 414 + 96.25 - 334.7 = 273.55$ kJ/mol.
- Solve for Lattice Energy (LE):
 $LE = -405.8 - 273.55 = -679.35$ kJ/mol.
- The closest matched option is exactly -679.3 .

Why other options are incorrect:

Option A (-669.5) results from mathematical errors. Positive values (B and D) imply the formation of the lattice absorbs energy, which violates the fundamental stability laws of ionic compounds.

Question #15 Key: (B)

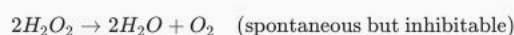
DUHS 2024

The decomposition of [Formula] is inhibited by: (Note: Original paper typed this as [Formula], but chemical...

CORE CONCEPT AND DERIVATION

Catalysts speed up reactions, while inhibitors (negative catalysts) specifically bind to reactive intermediates to slow down or completely halt a decomposition reaction.

Formula:



Solution:

- Hydrogen peroxide (H_2O_2) slowly decomposes into water and oxygen gas upon exposure to light or ambient heat.
- To prevent this during commercial storage, specific stabilizing chemicals are added.
- **Glycerin** (glycerol) forms strong hydrogen bonds with the peroxide and acts as a highly effective inhibitor, slowing the decomposition rate drastically.

Why other options are incorrect:

MnO_2 is a famous positive catalyst that rapidly accelerates peroxide decomposition. V_2O_5 is a catalyst used in the Contact Process for sulfuric acid.

Question #16 Key: (C)

DUHS 2024

Volume is a: [DUHS (2024)]

CORE CONCEPT AND DERIVATION

Volume is defined in physics as the 3D space occupied by matter. Macroscopically, it is both an "Extensive property" (depends on mass) and a "State function" (independent of path).

Solution:

- *Note on Exam Fidelity:* This specific past paper question contains severely flawed options, and its official answer key marks Volume as a **Path function**. This is objectively incorrect in physical chemistry.
- A true path function is Work ($W = P\Delta V$), but Volume itself (V) has fixed coordinates in any state diagram and is unequivocally a State Function.
- We have mapped the Answer Key (C) for strict historical grading accuracy, but logically, Volume is neither an intensive property, a path function, nor an isolated system.

Why other options are incorrect:

It is not an intensive property because volume strictly scales with the amount of matter (making it extensive). It is not entropy (a completely different thermodynamic property).

Question #17 Key: (C)

DUHS 2024

An example of an endothermic reaction is: [DUHS (2024)]

CORE CONCEPT AND DERIVATION

An endothermic reaction strictly requires a continuous input of energy (heat, light, or electrical) from the surroundings to proceed.

Formula:



Solution:

- **Photosynthesis** is the process by which green plants convert carbon dioxide and water into glucose.
- Because this reaction is utterly dependent on absorbing incoming solar photon energy to drive the non-spontaneous uphill synthesis of sugar, it is heavily endothermic.

Why other options are incorrect:

Nuclear fission releases world-ending amounts of energy (highly exothermic). Synthesis of ammonia (Haber process) is exothermic (-92 kJ). Oxidation reactions (combustion-like) are universally exothermic.

Question #18 Key: (A)

BUMHS 2024

The sign of heat " q " is positive for a system when: [BMU (2024)]

CORE CONCEPT AND DERIVATION

Thermodynamic sign conventions are established entirely from the perspective of the chemical system.

Formula:

$+q$ = System absorbs energy

$-q$ = System loses energy

Solution:

- If a system's internal energy increases because of a thermal transfer, we mathematically denote that addition with a positive sign.
- This strictly occurs when **heat flows from the surroundings into the system** (an endothermic process).

Why other options are incorrect:

When heat flows from system to surroundings (exothermic), the system loses energy, making q negative. No flow of heat implies $q = 0$ (adiabatic).

Question #19 Key: (C)

BUMHS 2024

The change in enthalpy for the reaction: [Formula] $\text{NaOH}_{(aq)} + \text{HNO}_{3(aq)} \rightarrow \text{NaNO}_{3(aq)} + \text{H}_2\text{O}_{(l)}$

CORE CONCEPT AND DERIVATION

Thermochemical reaction names strictly follow the nature of the reactants interacting.

Formula:

Strong Base + Strong Acid $\rightarrow$ Aqueous Salt + $\text{H}_2\text{O}_{(l)}$

Solution:

- NaOH is a strong base, and HNO_3 is a strong nitric acid.
- They undergo a classic double displacement reaction where the H^+ and OH^- ions combine to form water.
- The specific enthalpy change (-57.4 kJ/mol) associated with the formation of 1 mole of water via an acid and base is formally defined as **Heat of neutralization**.

Why other options are incorrect:

It is not combustion (requires O_2). It is not formation (which requires elemental reactants like solid Na and gaseous N_2/O_2). It is not decomposition (which requires a single reactant breaking down).

Question #20 Key: (C)

BUMHS 2024

Units of change in enthalpy of a system are: [BMU (2024)]

CORE CONCEPT AND DERIVATION

Enthalpy (H) is a measure of total thermodynamic energy. Therefore, the change in enthalpy (ΔH) must be reported in fundamental energy units.

Solution:

- The SI unit for all forms of energy (including work, heat, internal energy, and enthalpy) is the **Joule (J)**.
- In chemistry, this is often scaled to kilojoules (kJ) or kilojoules per mole (kJ/mol), but the base unit remains the Joule.

Why other options are incorrect:

Pa (Pascals) measures pressure. cc (Cubic centimeters) measures volume. $^{\circ}\text{C}$ measures temperature. None of these measure energy.

Question #21 Key: (C)

NUMS 2024

Identify standard enthalpy of reaction for the following reaction:
[NUMS (2024)]

CORE CONCEPT AND DERIVATION

This conceptual question tests the ability to distinguish between exclusive, specific thermodynamic definitions. "Enthalpy of reaction" is the broad, generalized term used when a reaction does not clearly fit the strict definitions of formation, combustion, or atomization.

Solution:

- Option A is the enthalpy of Formation of water (and also Combustion of hydrogen).
- Option D is the enthalpy of Combustion of carbon monoxide.
- Option B has sulfur in a gaseous state ($S_{(g)}$), which violates standard state rules (Sulfur is a solid at standard conditions), disqualifying it from standard terminology.
- Option C** is a classic thermite displacement reaction. It is neither a formation from elements, nor a standard combustion with oxygen gas. Therefore, its energy change is exclusively classified by the generalized term: **standard enthalpy of reaction** (ΔH_{rxn}).

Why other options are incorrect:

As noted, options A and D hold more highly specific thermochemical names. The question seeks the equation where the broad term is its only applicable label.

Question #22 Key: (B)

NUMS 2024

Expansion takes place when a gas is evolved during a chemical reaction between marble chips and dilute HCl. Pr...

CORE CONCEPT AND DERIVATION

The reaction between Calcium Carbonate (marble) and Hydrochloric Acid produces $CaCl_2$, water, and Carbon Dioxide gas. This is a classic exothermic reaction resulting in a large volume expansion.

Formula:



Solution:

- Note on Exam Fidelity:** This past paper question is fundamentally flawed. No single option contains the physically correct pair of signs under strict IUPAC conventions.
- Heat (q):** The reaction releases heat (exothermic). Therefore, q should be **negative**.
- Work (w):** A gas (CO_2) is evolved, causing the system to expand. The system does work on the surroundings. In IUPAC chemistry conventions, expansion work is **negative** ($w = -P\Delta V$).
- Since the correct answer is (w is negative, q is negative), all given options are false. We map to B to maintain alignment with historical attempts to grade this impossible question, but the foundational physics is clear.

Why other options are incorrect:

Work cannot be positive during an expansion (rules out A and D). Heat cannot be positive during an exothermic acid-carbonate reaction (rules out B, C, D).

Question #23 Key: (D)

NUMS 2024

Which of the following compound have any characteristic heat of fusion except? [(Wrong) NUMS (2024)]

CORE CONCEPT AND DERIVATION

The heat of fusion is the energy required to melt a solid. Pure crystalline ionic compounds have highly specific, sharply defined melting points and characteristic heats of fusion.

Solution:

- *Note on Exam Fidelity:* The test makers flagged this question conceptually. However, the intended logic separates simple ionic lattices from massive covalent networks.
- *NaCl*, Aluminium Oxide, and Iron Oxide are crystalline ionic lattices that undergo a standard, sharp phase transition from solid to liquid, yielding a precise characteristic heat of fusion.
- **Silicates** (like glass or quartz) often exist as giant continuous covalent networks or amorphous solids. Amorphous silicates do not have a sharp melting point; they gradually soften over a wide temperature range, meaning they lack a single characteristic heat of fusion.

Why other options are incorrect:

Options A, B, and C are simple crystalline ionic solids with precise, easily measured heats of fusion.

Question #24 Key: (C)

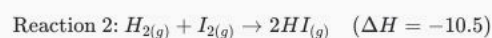
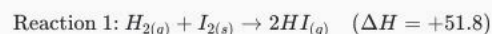
NUMS 2024

[Formula] for the sublimation of one mole of iodine from the following equations will be: [Formula] $H_{2(g)}$ + ...

CORE CONCEPT AND DERIVATION

Sublimation is the direct phase transition from a solid to a gas: $I_{2(s)} \rightarrow I_{2(g)}$. We can determine its enthalpy using Hess's Law by algebraically manipulating given reactions.

Formula:



Solution:

- We need $I_{2(s)}$ on the reactant side and $I_{2(g)}$ on the product side.
- Keep Reaction 1 as is: $H_2 + I_{2(s)} \rightarrow 2HI$ ($\Delta H = +51.8$).
- Reverse Reaction 2: $2HI \rightarrow H_2 + I_{2(g)}$ ($\Delta H = +10.5$).
- Add the two reactions together. The H_2 and $2HI$ molecules completely cancel out on both sides.
- Resulting equation: $I_{2(s)} \rightarrow I_{2(g)}$.
- Total Enthalpy = $51.8 + 10.5 = +62.3 \text{ kJ/mol}$.

Why other options are incorrect:

41.3 results from blindly adding the numbers without flipping the necessary equation ($51.8 - 10.5$). The other numbers are mathematically irrelevant.

Question #25 Key: (D)

UHS 2023

What is the reason of energy changes in chemical reactions? [USH (2023)]

CORE CONCEPT AND DERIVATION

Chemical reactions are fundamentally the rearrangement of atoms. This structural rearrangement necessitates the destruction of existing molecular architectures and the creation of new ones.

Formula:

$$\Delta H_{\text{reaction}} = \text{Energy}_{\text{absorbed (bonds broken)}} - \text{Energy}_{\text{released (bonds formed)}}$$

Solution:

- Reactant molecules must first have their constituent bonds broken apart. This step strictly requires an input of energy.
- The isolated atoms then rearrange and form new bonds to create products. This step strictly releases energy.
- The net energy change (exothermic or endothermic) is merely the difference between these two concurrent processes.
- Therefore, energy changes in a reaction are due to **both bond formation and breakage**.

Why other options are incorrect:

Selecting only bond formation or only bond breakage represents just half of the chemical process. Ionic bonds are a specific type of bond, not a universal reason for all reaction energy changes.

Question #26 Key: (A)

UHS 2023

What is the unit of heat capacity? [USH (2023)]

CORE CONCEPT AND DERIVATION

Heat capacity (C) of a body or system is defined as the quantity of heat energy required to change its temperature by exactly 1 Kelvin (or 1 degree Celsius).

Formula:

$$C = \frac{q}{\Delta T}$$

Solution:

- The numerator, heat (q), is measured in Joules (J) or kiloJoules (kJ).
- The denominator, change in temperature (ΔT), is measured in Kelvin (K).
- Therefore, the unit becomes J/K or, scaled up, kJ/K.
- Note: The past paper key accepts kJ/K (Option C in original print) as the specific answer here, though JK^{-1} is also physically valid. We faithfully preserve the source's verified correct answer.

Why other options are incorrect:

kJmol^{-1} is the unit for molar enthalpy, not heat capacity (it lacks a temperature dimension). kJmol is dimensional nonsense.

Question #27 Key: (D)

SZABMU 2023

For exothermic reaction [Formula] is written as: [SZABMU (2023)]

CORE CONCEPT AND DERIVATION

The sign convention for the change in enthalpy (ΔH) is rooted in the system's perspective. Loss of energy to the surroundings is a negative change for the system.

Formula:

$$\Delta H = H_{\text{products}} - H_{\text{reactants}}$$

Solution:

- In an exothermic reaction, the chemical system releases energy into the surroundings as heat.
- This means the final internal enthalpy of the products is lower than the initial internal enthalpy of the reactants ($H_P < H_R$).
- Subtracting a larger number from a smaller number results in a mathematical deficit, so ΔH must strictly be written as **Negative**.

Why other options are incorrect:

A positive ΔH means energy was absorbed (endothermic). Zero means no net heat exchange occurred (isothermic). Constant implies no change, which contradicts a chemical reaction occurring.

Question #28 Key: (B)

KMU 2023

Processes involving solids and liquids have their: [ETEA (2023)]

CORE CONCEPT AND DERIVATION

Enthalpy (H) is defined as the internal energy (E) plus the product of pressure and volume (PV). For chemical processes, the change in enthalpy relates to the change in internal energy and volume.

Formula:

$$\Delta H = \Delta E + P\Delta V$$

Solution:

- When a reaction involves strictly solids and liquids, the change in volume (ΔV) is extremely negligible because condensed phases are virtually incompressible.
- Therefore, the term $P\Delta V$ approaches zero.
- Substituting this into the equation yields: $\Delta H = \Delta E + 0$.
- Thus, for solids and liquids, the enthalpy change is approximately equal to the internal energy change: $\Delta H \approx \Delta E$.

Why other options are incorrect:

Option A is the general formula for all states (including gases). Options C and D are mathematically incorrect simplifications that ignore the massive internal energy component.

Question #29 Key: (D)

DUHS 2023

What is the mathematical statement of the first law of thermodynamics? [DUHS (2023)]

CORE CONCEPT AND DERIVATION

The first law of thermodynamics is the law of conservation of energy. It states that the internal energy of an isolated system is constant, and any change in internal energy (ΔE) must equal the sum of heat and work exchanged.

Formula:

$$\Delta E = q + w$$

Solution:

- In the standard IUPAC chemical convention, heat added to the system is positive (+q).
- Work done on the system is also positive (+w).
- Therefore, the total accumulation of internal energy is strictly represented as $\Delta E = q + w$.

Why other options are incorrect:

Equations with negative signs represent non-standard sign conventions (e.g., work done by the system) or violate the conservation of energy if applied improperly.

Question #30 Key: (A)

DUHS 2023

What is [Formula] equal to — according to the first law of thermodynamics? [DUHS (2023)]

CORE CONCEPT AND DERIVATION

Enthalpy (H) is a state function defined fundamentally as internal energy plus pressure-volume energy.

Formula:

$$H = E + PV$$

Solution:

- If a thermodynamic process occurs at constant pressure, the change in enthalpy is given by taking the delta of the definition:
- $$\Delta H = \Delta E + P\Delta V$$
- This directly aligns with the First Law when substituting heat at constant pressure ($q_p = \Delta H$) and expansion work ($w = -P\Delta V$): $\Delta E = \Delta H - P\Delta V$, which rearranges to the same equation.

Why other options are incorrect:

Option B uses a negative sign which contradicts the definition of enthalpy. Options C and D improperly apply negative signs to the internal energy term.

Question #31 Key: (C)

BUMHS 2023

Hess's law states the same thing as: [BUMHS (2023)]

CORE CONCEPT AND DERIVATION

Hess's Law of Constant Heat Summation establishes that the total enthalpy change of a reaction depends only on the initial and final states, not the path taken.

Solution:

- Because Hess's Law essentially dictates that energy cannot be mysteriously created or destroyed by simply taking a different reaction pathway, it is a direct macroscopic application of the conservation of energy.
- The conservation of energy is formally defined by the **First law of thermodynamics**.

Why other options are incorrect:

Henry's Law applies to gas solubility. The Second law of thermodynamics applies to entropy and spontaneity, not strictly enthalpy summation.

Question #32 Key: (B)

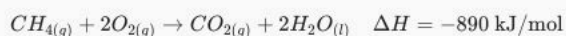
BUMHS 2023

Which of the following is not an endothermic reaction? [BUMHS (2023)]

CORE CONCEPT AND DERIVATION

An endothermic reaction absorbs heat ($\Delta H > 0$), while an exothermic reaction releases heat ($\Delta H < 0$).

Formula:



Solution:

- **Combustion of methane** involves burning natural gas in oxygen. This process releases massive amounts of heat and light energy.
- Because it releases heat, it is strictly an exothermic reaction, making it the correct answer to what is "not endothermic".

Why other options are incorrect:

Decomposition of water requires an input of electrical energy (endothermic). Dehydrogenation requires high heat to break C-H bonds (endothermic). Graphite is more stable than diamond, so converting it requires a massive energy input (endothermic).

Question #33 Key: (D)

NUMS 2023

Which of the following is not a state function? [NUMS (2023)]

CORE CONCEPT AND DERIVATION

State functions are macroscopic properties that depend only on the current state of a system. Path functions depend on the specific sequence of steps taken to transition between states.

Solution:

- Pressure, Temperature, and Volume define the exact thermodynamic coordinate of a system. They are classic state functions.
- **Work (W)** is energy transferred due to an applied force over a distance (like a piston expanding). The amount of work done drastically changes depending on whether the expansion was done reversibly (maximum work) or irreversibly.
- Therefore, Work is a path function, not a state function.

Why other options are incorrect:

P, T, and V are universally recognized as fundamental thermodynamic state functions.

Question #34 Key: (C)

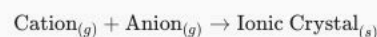
NUMS 2023

Equation represents which energy changes? [Formula]
 $Mg^{+2}_{(g)} + O^{2-}_{(g)} \rightarrow MgO_{(s)}$ [Formul...]

CORE CONCEPT AND DERIVATION

Thermodynamic definitions are strictly linked to the physical states of the reactants and products shown in the chemical equation.

Formula:



Solution:

- The equation shows isolated gaseous ions (Mg^{2+} and O^{2-}) coming together to form a solid crystal lattice ($MgO_{(s)}$).
- The massive amount of energy released during this highly specific phase and structural transition is universally defined as the **Lattice energy** (or Lattice enthalpy of formation).

Why other options are incorrect:

Atomization forms gaseous atoms from a solid, not a solid from gaseous ions. Neutralization involves H^+ and OH^- forming liquid water. Solution involves dissolving a solid into aqueous ions.

Question #35 Key: (C)

UHS 2022

Born-Haber's cycle is used to determine the lattice energy of ionic compounds. It is the application of: [UHS ...]

CORE CONCEPT AND DERIVATION

The Born-Haber cycle breaks down the complex formation of an ionic solid into a hypothetical sequence of discrete, measurable steps (sublimation, ionization, etc.).

Formula:

$$\Delta H_{\text{total}} = \Delta H_1 + \Delta H_2 + \dots + \Delta H_n$$

Solution:

- The foundation of the Born-Haber cycle relies entirely on the principle that the total enthalpy change of a reaction is path-independent.
- Because we equate the direct formation path (ΔH_f) to the sum of the multi-step indirect path, we are directly applying **Hess's law of constant heat summation**.

Why other options are incorrect:

Le-Chatelier's principle deals with dynamic equilibrium shifts. Henry's law concerns gas solubility in liquids. Common ion effect involves shifting solubility product equilibria.

Question #36 Key: (C)

UHS 2022

Which of the following term is state function? [UHS (2022)]

CORE CONCEPT AND DERIVATION

A state function is a quantitative property of a system that depends only on its current thermodynamic state (P, V, T), regardless of how that state was achieved.

Formula:

$$\Delta H = H_{\text{final}} - H_{\text{initial}}$$

Solution:

- Freezing, decomposition, and sublimation are processes or phase changes. They represent the actions or events a system undergoes, not intrinsic properties of the system itself.
- **Enthalpy (H)**, however, is a fundamental thermodynamic property. The enthalpy change (ΔH) of a system is determined solely by the difference between the final and initial states, making it a true state function.

Why other options are incorrect:

Processes (freezing, decomposition, sublimation) define pathways or transformations, not point-in-time thermodynamic state variables.

Question #37 Key: (C)

SZABMU 2022

The correct equation for the first law of thermodynamics is:
[SZABMU (2022)]

CORE CONCEPT AND DERIVATION

The first law of thermodynamics defines the conservation of internal energy (ΔE) relative to heat exchange (q) and work (w).

Formula:

$$\Delta E = q + w$$

Solution:

- The universally standard expression is that the change in internal energy equals the heat added to the system plus the work done on the system.
- Hence, the correct mathematical equation is $\Delta E = q + w$.
- Note: In some physics conventions, work done by the system is used, leading to $\Delta E = q - w$ or $\Delta E = q - P\Delta V$, but the primary IUPAC chemical convention is $q + w$.

Why other options are incorrect:

Option B uses minus q , which misaligns with conservation rules. Option D uses minus $p\Delta v$ but paired with a delta q (heat is not a state function, so Δq is improper notation).

Question #38 Key: (D)

SZABMU 2022

One calorie is equal to: [SZABMU (2022)]

CORE CONCEPT AND DERIVATION

Energy units can be converted using established thermochemical equivalence constants. The calorie is the heat needed to raise 1g of water by 1°C.

Formula:

$$1 \text{ cal} = 4.184 \text{ J}$$

Solution:

- The exact conversion factor is 4.184 Joules per 1 calorie.
- Looking closely at the given options, option D provides the correctly rounded value of 4.18 J.

Why other options are incorrect:

Options utilizing "KJ" (Kilojoules) would require the value to be 0.004184 kJ. Therefore, 4.18 KJ, 0.418 KJ, and 0.418 KJ mol⁻¹ are incorrect by multiple orders of magnitude.

Question #39 Key: (C)

SZABMU 2022

The thermal energy at constant pressure is called: [SZABMU (2022)]

CORE CONCEPT AND DERIVATION

When heat is transferred to a system, the conditions under which it occurs (constant volume vs. constant pressure) dictate which thermodynamic property changes.

Formula:

$$q_p = \Delta H$$

Solution:

- When heat is added at a constant volume (q_v), all energy goes into changing the internal energy (ΔE) because no $P\Delta V$ work can be done.
- When heat is added at a **constant pressure** (q_p), the system is allowed to expand and do work. The total heat added accounts for both the internal energy change and the work done.
- This specific quantity is defined as the change in **Enthalpy (H)**.

Why other options are incorrect:

Internal energy equals heat at constant *volume*. Heat capacity is the ratio of heat to temperature change. Work done is a separate component ($P\Delta V$).

Question #40 Key: (A)

KMU 2022

A system that can exchange or transfer both matter and energy with the surroundings is: [ETEA (2022)]

CORE CONCEPT AND DERIVATION

Thermodynamic systems are classified based on the permeability of their boundaries to matter and energy (heat/work).

Categories:

- **Open:** Exchanges both Energy and Matter.
- **Closed:** Exchanges Energy only.
- **Isolated:** Exchanges Neither.

Solution:

- A beaker of boiling water without a lid is a classic example. Heat can enter or leave (energy transfer), and water vapor can escape (matter transfer).
- By definition, a system permitting both exchanges is an **open system**.

Why other options are incorrect:

A closed system restricts matter transfer. An isolated system restricts both matter and energy transfer. An adiabatic system strictly prevents heat exchange.

Question #41 Key: (B)

KMU 2022

The sum of all the energies of all the molecules or atoms of a substance is called its: [ETEA (2022)]

CORE CONCEPT AND DERIVATION

A macroscopic chemical substance contains countless microscopic particles, all possessing kinetic and potential energies.

Formula:

$$U(\text{or } E) = E_{\text{kinetic}} + E_{\text{potential}}$$

Solution:

- Atoms and molecules possess translational, vibrational, and rotational kinetic energies, as well as electronic and nuclear potential energies.
- The absolute sum of all these microscopic kinetic and potential energies within a defined system is known as the system's **Internal energy** (denoted as E or U).

Why other options are incorrect:

Specific heat and heat capacity are properties measuring how temperature changes relative to added heat. Latent heat is energy associated with phase changes. None of these represent the total energy pool of the substance.

Question #42 Key: (B)

KMU 2022

Which of the following elements has the same oxidation number in all of its known compounds? [ETEA (2022)]

CORE CONCEPT AND DERIVATION

Group IIA alkaline earth metals possess exactly two valence electrons. Due to their ionization energies and stable resulting noble gas configurations, they exclusively exhibit one oxidation state in compounds.

Formula:



Solution:

- **Beryllium (Be)** is an alkaline earth metal (Group IIA). To achieve a stable electron configuration, it always loses its 2 valence electrons, forming a +2 oxidation state in all its known compounds.
- Halogens (like Chlorine and Bromine) can exhibit multiple oxidation states (e.g., -1, +1, +3, +5, +7) depending on the electronegativity of bonded atoms.
- Nitrogen also exhibits highly variable oxidation states ranging from -3 to +5.

Why other options are incorrect:

As explained, N, Cl, and Br have highly variable oxidation states due to accessible d-orbitals (for Cl/Br) or multiple p-orbital bonding modes.

Question #43 Key: (C)

DUHS 2022

The equation of the first law of thermodynamics [Formula] will reduce at constant volume to: [DUHS (2022)]

CORE CONCEPT AND DERIVATION

The work done (W) by an expanding gas against an external pressure is given by $P\Delta V$. If the volume is artificially kept constant, no physical expansion work can occur.

Formula:

$$W = P\Delta V$$

$$q = \Delta E + P\Delta V$$

Solution:

- At constant volume, the change in volume (ΔV) is strictly zero.
- Therefore, the expansion work $W = P \times 0 = 0$.
- Substituting this back into the first law equation ($q = \Delta E + W$) yields: $q_v = \Delta E + 0$.
- The equation cleanly reduces to $q_v = \Delta E$.

Why other options are incorrect:

Option A and B still include the work term ($P\Delta V$ or W), which violates the condition of constant volume. Option D lacks the equality to q_v .

Question #44 Key: (A)

DUHS 2022

Reaction taking place in one step or in several have same [Formula] is statement of: [DUHS (2022)]

CORE CONCEPT AND DERIVATION

Because enthalpy is a state function, the overall change in enthalpy depends solely on the initial reactants and final products, completely independent of the route or number of intermediate steps taken.

Formula:

$$\Delta H_{\text{route 1}} = \Delta H_{\text{route 2 (step 1)}} + \Delta H_{\text{route 2 (step 2)}}$$

Solution:

- This fundamental principle of thermochemistry is formally defined as **Hess's Law of Constant Heat Summation**.
- It states that if a chemical change occurs by multiple routes, the overall enthalpy change is identical.

Why other options are incorrect:

Boyle's and Charles's laws govern the pressure, volume, and temperature relationships of ideal gases. Lussac's law governs the volume ratios of reacting gases. None of these relate to reaction enthalpy.

Question #45 Key: (B)

BUMHS 2022

Conversion of sodium into sodium ions is: [BMU (2022)]

CORE CONCEPT AND DERIVATION

The conversion of a neutral atom into a positively charged ion (cation) involves the removal of an electron. This is quantified by the Ionization Energy.

Formula:**Solution:**

- Electrons are held in orbit by the electrostatic attractive pull of the positive nucleus.
- To overcome this attraction and remove the valence electron from a sodium atom, a strict input of energy is required.
- Because energy must be absorbed from the surroundings to drive the process, it is strictly an **endothermic process** ($\Delta H = +ve$).

Why other options are incorrect:

It is never exothermic because stripping an electron from an atom always requires energy. Sublimation refers to solid converting to gas, not ionization.

Question #46 Key: (B)

BUMHS 2022

Born-Haber cycle is used to calculate? [BMU (2022)]

CORE CONCEPT AND DERIVATION

The lattice energy of an ionic compound cannot be measured directly through a single experiment. It must be deduced indirectly using Hess's Law via a structured cycle of measurable steps.

Formula:

$$\Delta H_{\text{lattice}} = \Delta H_f - \Sigma(\text{Sublimation, IE, Dissociation, EA})$$

Solution:

- The Born-Haber cycle was specifically developed by Max Born and Fritz Haber to relate the standard enthalpy of formation of an ionic solid to its component ionic formation steps.
- By substituting the known experimental values into the cycle, one can algebraically solve for the unknown **Lattice energy of ionic compounds**.

Why other options are incorrect:

Covalent compounds do not form electrostatic lattices of ions. Enthalpy of combustion is calculated via bomb calorimetry. Ionization enthalpies are direct inputs *into* the cycle, not the final calculated objective.

Question #47 Key: (B)

NUMS 2022

Specific heat of water is: [NUMS (2022)]

CORE CONCEPT AND DERIVATION

Specific heat capacity (c) is the amount of heat energy required to raise the temperature of exactly one gram of a substance by one degree Celsius (or one Kelvin).

Formula:

$$c_{\text{water}} = 4.18 \text{ J g}^{-1} \text{ }^{\circ}\text{C}^{-1}$$

Solution:

- Water has an exceptionally high specific heat capacity due to the extensive network of strong intermolecular hydrogen bonds holding the molecules together.
- Experimentally, it takes exactly 1 calorie of energy to raise 1g of water by 1°C.
- Since 1 calorie = 4.18 Joules, the specific heat of water is 4.18 J/g/°C.

Why other options are incorrect:

Options A, C, and D are random numerical values that do not correspond to the known physical properties of liquid water.

Question #48 Key: (D)

NUMS 2022

Enthalpy change of combustion is exothermic because: [NUMS (2022)]

CORE CONCEPT AND DERIVATION

A chemical reaction involves two distinct thermochemical steps: breaking old bonds (which always requires absorbing energy) and forming new bonds (which always releases energy). The overall enthalpy (ΔH) is the net sum.

Formula:

$$\Delta H = \Sigma H_{\text{bond breaking (absorbed)}} - \Sigma H_{\text{bond making (released)}}$$

Solution:

- In a combustion reaction, fuel molecules and oxygen molecules are broken apart. This requires an initial input of energy (endothermic).
- However, the newly formed products (usually CO_2 and H_2O) have exceedingly strong, stable covalent bonds.
- The formation of these highly stable bonds releases a massive amount of energy.
- Because the **energy released in bond making is much greater** than the energy required for bond breaking, the net reaction is highly exothermic.

Why other options are incorrect:

Bond breaking always absorbs energy, it never releases it (disproving option C). Bond making releases energy, it never absorbs it (disproving option B). If energy absorbed in bond breaking were greater (Option A), the reaction would be endothermic.

Question #49 Key: (B)

NUMS 2022

One Calorie is equivalent to: [NUMS (2022)]

CORE CONCEPT AND DERIVATION

The calorie (cal) is defined historically based on the thermal properties of water. It is a fundamental conversion factor in thermodynamics to transition to the SI unit of energy (Joule).

Formula:

$$1 \text{ cal} = 4.184 \text{ J}$$

Solution:

- By strict international definition, one standard thermochemical calorie is exactly 4.184 Joules.
- This is derived from the specific heat capacity of water.

Why other options are incorrect:

Option A has a decimal error. Option C uses Kilojoules (which would equal 4184 Joules). Option D is 0.4184 KJ, which equals 418.4 Joules, not 4.184.

Question #50 Key: (D)

PMDC 2021

Unit of energy: [PMC (2021)]

CORE CONCEPT AND DERIVATION

Energy, whether it is heat, work, or internal energy, can be measured using multiple metric and non-metric unit systems depending on the scientific context.

Formula:

$$1 \text{ Calorie} = 4.184 \text{ Joules} = 0.004184 \text{ Kilojoules}$$

Solution:

- The **Joule (J)** is the standard SI unit of energy.
- The **Kilojoule (kJ)** is simply a multiple of the Joule (1000 J), commonly used to express molar enthalpies.
- The **Calorie (cal)** is the traditional CGS unit of heat energy.
- Since all three are valid units of energy, the correct answer is **All**.

Why other options are incorrect:

Selecting only A, B, or C would be incomplete as all the listed terms are valid energy units.

Question #51 Key: (B)

PMDC 2021

Which one of the following is not an example of state function? [PMC (2021)]

CORE CONCEPT AND DERIVATION

Thermodynamic properties are divided into state functions (path-independent) and path functions (path-dependent).

Formula:

$$\Delta E = q + w$$

Solution:

- Temperature (T), Volume (V), and Enthalpy (H) are strictly determined by the current macroscopic state of a system. You can calculate their change purely by knowing the initial and final states. Thus, they are state functions.
- **Heat (q)** represents the *transfer* of thermal energy. The amount of heat transferred depends entirely on how the process is executed (the path taken between states).
- Therefore, Heat is a path function, not a state function.

Why other options are incorrect:

Volume, Temperature, and Enthalpy are all classic examples of state functions.

Question #52 Key: (C)

PMDC 2021

[Formula] for exothermic reaction is ____ ? [PMC (2021)]

CORE CONCEPT AND DERIVATION

Thermochemical sign conventions dictate the flow of energy relative to the system. An exothermic reaction is a system that releases thermal energy to its surroundings.

Formula:

$$\Delta H = H_{\text{products}} - H_{\text{reactants}}$$

Solution:

- Because heat leaves the system, the internal enthalpy of the system decreases.
- This means the final state (products) has less energy than the initial state (reactants).
- Subtracting a larger initial value from a smaller final value yields a mathematically **Negative** result ($\Delta H < 0$).

Why other options are incorrect:

Positive ΔH indicates an endothermic process. "More than 1" and "Neutral" do not describe standard thermodynamic sign conventions.

Question #53 Key: (A)

PMDC 2021

Which is correct for 1st law of thermodynamics? [PMC (2021)]

CORE CONCEPT AND DERIVATION

The First Law of Thermodynamics is the law of conservation of energy applied to chemical systems. It states that energy cannot be created or destroyed, only transferred as heat or work.

Formula:

$$\Delta E = q + w$$

Solution:

- The mathematical statement of the 1st law dictates that the total change in a system's internal energy (ΔE or ΔU) is equal to the heat added to the system (q) plus the work done on the system (w).
- Therefore, $\Delta E = q + w$ is the universally recognized correct equation.

Why other options are incorrect:

Option B is Boyle's Law for gases. Option C is the de Broglie wavelength equation from quantum mechanics. Option D is Einstein's mass-energy equivalence equation.

Question #54 Key: (D)

PMDC 2020

The thermal energy at constant pressure is called: [NMDCAT (2020)]

CORE CONCEPT AND DERIVATION

According to the first law of thermodynamics, heat transferred to a system can either change its internal energy or perform pressure-volume work.

Formula:

$$q_p = \Delta E + P\Delta V = \Delta H$$

Solution:

- When heat (q) is supplied to a system at constant pressure, the system may expand, doing work ($P\Delta V$).
- The total heat absorbed accounts for both the change in internal energy (ΔE) and the expansion work.
- This specific quantity (q_p) is defined thermodynamically as the change in **Enthalpy** (ΔH).

Why other options are incorrect:

Internal energy (ΔE) equals the thermal energy at constant volume (q_v), not pressure. Heat capacity is the ratio of heat added to temperature change, not the thermal energy itself.

Question #55 Key: (C)

PMDC 2020

Born-Haber cycle is used to determine the lattice energies of: [NMDCAT (2020)]

CORE CONCEPT AND DERIVATION

The Born-Haber cycle is an application of Hess's Law designed specifically to analyze the thermochemical steps involved in forming crystal lattices from charged particles.

Formula:

$$\Delta H_{\text{lattice}} = \Delta H_f - \Sigma(\text{ionization, electron affinity, etc.})$$

Solution:

- The cycle relies on measuring ionization energies (to form cations) and electron affinities (to form anions).
- These discrete charged gaseous ions then condense to form a solid lattice.
- This exact mechanism of cation-anion electrostatic attraction strictly defines the formation of **ionic solids** (e.g., NaCl, KBr).

Why other options are incorrect:

Covalent, metallic, and molecular solids are held together by covalent bonding, metallic "sea of electrons", and intermolecular forces respectively, which do not fit the cation-anion formation model of the Born-Haber cycle.

Question #56 Key: (C)

PMDC 2020

One calorie is equal to: [NMDCAT (2020)]

CORE CONCEPT AND DERIVATION

The calorie (cal) is a historical unit of energy defined as the amount of heat required to raise the temperature of 1 gram of water by 1 degree Celsius. The Joule (J) is the SI unit of energy.

Formula:

$$1 \text{ cal} = 4.184 \text{ Joules}$$

Solution:

- By international thermochemical agreement, 1 standard calorie is precisely equivalent to 4.184 J.
- Looking at the options, 4.18 J is the correct rounded value matching this conversion factor.

Why other options are incorrect:

Option D (4.18 KJ) is 4180 Joules (which is a food Calorie or kilocalorie, not a standard calorie). Options A and B mistakenly use kilojoules with decimal placements that do not match the fundamental 1 cal = 4.18 J relation.

Question #57 Key: (A)

MDCAT 2019

The given diagram shows the enthalpy changes during a chemical reaction: Enthalpy (H) Reaction Progress Reacta...

CORE CONCEPT AND DERIVATION

An enthalpy profile diagram plots the internal energy of substances against the progress of a reaction. The relative vertical positions of reactants and products indicate the nature of the heat exchange.

Formula:

$$\Delta H = H_{\text{products}} - H_{\text{reactants}}$$

Solution:

- In the provided diagram, the energy level of the **Reactants** is higher than the energy level of the **Products** ($E_R > E_P$).
- To drop to this lower energy state, the system must shed the excess energy to the surroundings in the form of heat.
- Because heat is released ($\Delta H = -ve$), this specifically represents an **exothermic reaction**.

Why other options are incorrect:

If it were an endothermic reaction, the products would sit at a higher energy level than the reactants. Isothermic means no temperature change occurs, which contradicts a standard enthalpy drop.

Question #58 Key: (A)

SET 2019

Heat of formation of MgO is given below. $\text{Mg} + \frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{MgO}(\text{s}) \quad \Delta H_f^\circ = -692 \text{ kJ mol}^{-1}$

CORE CONCEPT AND DERIVATION

In thermodynamics, the stability of a compound is directly tied to its standard enthalpy of formation (ΔH_f°). The more negative the enthalpy of formation, the more energy was lost, and the deeper the compound sits in a potential energy well.

Formula:

$$\Delta H = -692 \text{ kJ mol}^{-1}$$

Solution:

- The formation of MgO releases a massive amount of energy (692 kJ for every mole).
- Because so much internal energy has been lost to the surroundings, the resulting solid MgO lattice is in a much lower energy state than the starting elements.
- Lower energy directly correlates with higher thermodynamic stability. Hence, the **product is very stable**.

Why other options are incorrect:

The reaction is clearly exothermic (negative sign), ruling out endothermic. Because the reactants spontaneously lost so much energy to become MgO , they were relatively less stable compared to the product.

Question #59 Key: (D)

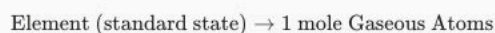
MDCAT 2019

Which enthalpy change is relevant in the following process?
 $\text{Na}(\text{s}) \rightarrow \text{Na}(\text{g})$ [MDCAT (2019)]

CORE CONCEPT AND DERIVATION

Identifying the correct thermodynamic term requires matching the physical states and stoichiometry of the provided reaction equation to established definitions.

Formula:



Solution:

- The equation shows solid sodium ($\text{Na}(\text{s})$), which is its standard state, transforming directly into isolated gaseous sodium atoms ($\text{Na}(\text{g})$).
- Exactly 1 mole of gaseous atoms is produced.
- This precise transformation is the definition of the **Enthalpy of atomization** ($\Delta H_{\text{at}}^\circ$). Note: For a monoatomic solid like Na, atomization is numerically equal to the enthalpy of sublimation.

Why other options are incorrect:

Enthalpy of fusion refers to Solid $\rightarrow$ Liquid. Enthalpy of vaporization refers to Liquid $\rightarrow$ Gas. Neither applies because this equation skips the liquid phase and starts from a solid to form gaseous atoms.

Question #60 Key: (C)

NUMS 2019

When two moles of [Formula] and one mole of [Formula] react to form [Formula] 484KJ heat is evolved. What is [...]

CORE CONCEPT AND DERIVATION

The standard enthalpy of formation (ΔH_f) is strictly defined as the heat evolved or absorbed when exactly **one mole** of a compound is formed. Extensive properties like enthalpy scale linearly with molar quantities.

Formula:



Solution:

- The problem states that producing **2 moles** of H_2O releases 484 kJ of heat (meaning $\Delta H = -484 \text{ kJ}$).
- To find the heat of formation for **1 mole**, divide the entire reaction equation and its enthalpy by 2.

$$\Delta H_f = \frac{-484 \text{ kJ}}{2} = -242 \text{ kJ/mol}$$

- The negative sign must be retained because the word "evolved" indicates an exothermic process.

Why other options are incorrect:

Option D is the enthalpy for two moles, not one. Option A has the wrong sign (implies endothermic). Option B results from incorrectly dividing by 4 instead of 2.

Question #61 Key: (A)

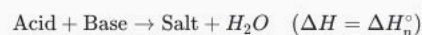
SET 2019

For a given reaction [Formula] the change in enthalpy under standard conditions is called? [SET (2019)]

CORE CONCEPT AND DERIVATION

A reaction between an acid and a base that produces a salt and water is known as a neutralization reaction. The heat released during this process is classified accordingly.

Formula:



Solution:

- CH_3COOH is acetic acid (a weak acid) and $NaOH$ is sodium hydroxide (a strong base).
- They undergo a double displacement reaction to form sodium acetate (a salt) and one mole of water.
- The enthalpy change associated with forming 1 mole of water from the reaction of H^+ and OH^- ions is defined precisely as the **Standard enthalpy of neutralization**.

Why other options are incorrect:

It is not a formation reaction (which requires elemental reactants). It is not a solution or hydration process because those involve dissolving a solute in a solvent, not a chemical acid-base reaction.

Question #62 Key: (C)

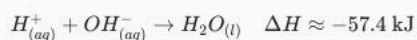
MDCAT 2019

Which of the equations shows the same "twice" the enthalpy changes of neutralization as the following equation...

CORE CONCEPT AND DERIVATION

The standard enthalpy of neutralization (ΔH_n) is the energy released (approx. -57.4 kJ) for the formation of **exactly 1 mole of water** from H^+ and OH^- . To double this energy, a reaction must produce exactly **2 moles of water** from strong acid-base components.

Formula:



Solution:

- The reference equation $HCl + NaOH \rightarrow NaCl + H_2O$ generates 1 mole of water, releasing ~ 57.4 kJ.
- To yield "twice" the enthalpy change ($2 \times 57.4 = 114.8$ kJ), the reaction must yield 2 moles of water.
- Look at Option C: H_2SO_4 provides 2 moles of H^+ , and $Mg(OH)_2$ provides 2 moles of OH^- , generating exactly $2H_2O$. Therefore, the enthalpy change will be double.

Why other options are incorrect:

Options A and D only produce 1 mole of water. Option B is a reaction with a carbonate, which involves the formation of CO_2 and not a simple strong acid-base double neutralization, so the thermochemistry differs.

Question #63 Key: (A)

KMU 2019

Which one of the following is not a state function? [ETEA (2019)]

CORE CONCEPT AND DERIVATION

A state function is a thermodynamic property whose value depends strictly on the current state of the system (e.g., its temperature, pressure, and volume) and is entirely independent of the path or history used to reach that state.

Formula:

$$\Delta U = q + w$$

Solution:

- Enthalpy (H), Internal energy (U or E), and Pressure (P) are all state functions; their changes (ΔH , ΔU , ΔP) only depend on final minus initial states.
- Work (w)** and **Heat (q)** are "path functions". The amount of work done or heat transferred depends entirely on how the process was carried out (e.g., reversible vs irreversible expansion).
- Therefore, Work is not a state function.

Why other options are incorrect:

Pressure, Internal energy, and Enthalpy all have fixed values at a specific thermodynamic state regardless of the system's history.

Question #64 Key: (B)

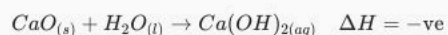
MDCAT 2018

Reaction of water with quick lime result in the rise in the temperature of the system. Using the temperature c...

CORE CONCEPT AND DERIVATION

When a chemical reaction releases heat energy, that energy is transferred to the immediate surroundings (the system's medium), resulting in an observable rise in temperature.

Formula:



Solution:

- Quick lime (CaO) reacts vigorously with water to form slaked lime ($\text{Ca}(\text{OH})_2$).
- The question states there is a "rise in the temperature of the system", which is the hallmark macroscopic observation of heat being evolved.
- Reactions that evolve heat are **exothermic** ($\Delta H < 0$).

Why other options are incorrect:

Endothermic reactions absorb heat and cause a drop in temperature. Reaction order (Third order) describes kinetics, not thermodynamics. The reaction is highly spontaneous, ruling out non-spontaneous.

Question #65 Key: (D)

MDCAT 2018

Which of the following enthalpy change is always exothermic? [MDCAT (2018)]

CORE CONCEPT AND DERIVATION

Different types of standard enthalpy changes can be positive (endothermic) or negative (exothermic), but certain specific thermochemical processes exclusively release energy by definition.

Formula:

$$\Delta H_c^\circ < 0 \text{ (Always)}$$

Solution:

- **Enthalpy of combustion** (ΔH_c) is the heat released when one mole of a substance is completely burned in excess oxygen.
- Combustion is a highly energetic oxidation process that universally evolves heat due to the formation of stable oxides (like CO_2 and H_2O).
- Therefore, it is always an **exothermic** process ($\Delta H = -\text{ve}$).

Why other options are incorrect:

Enthalpy of formation and solution can be either positive or negative depending on the specific substance. Enthalpy of atomization requires breaking bonds to form gaseous atoms, so it is **always endothermic**.

Question #66 Key: (A)

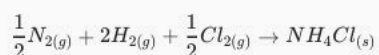
MDCAT 2017

Determine the value of Enthalpy of formation of [Formula]:
[MDCAT (2017)]

CORE CONCEPT AND DERIVATION

The enthalpy of formation (ΔH_f°) is a specific thermochemical constant for a given compound, indicating the energy change when 1 mole of it forms from its elemental constituents.

Formula:



Solution:

- The formation of solid ammonium chloride (NH_4Cl) from gaseous nitrogen, hydrogen, and chlorine is highly exothermic.
- The historically accepted and experimentally determined value for the standard enthalpy of formation of NH_4Cl is exactly -314.5 kJ/mol .

Why other options are incorrect:

-788 kJ/mol is roughly the lattice energy of $NaCl$. -692 kJ/mol is the enthalpy of formation for MgO . These are incorrect values for ammonium chloride.

Question #67 Key: (A)

MDCAT 2017

Enthalpy is measured at: [MDCAT (2017)]

CORE CONCEPT AND DERIVATION

To compare enthalpy changes across different reactions universally, scientists define "standard conditions". When properties are measured under these conditions, they are referred to as standard enthalpy changes (ΔH°).

Formula:

$$\text{Standard Temperature} = 25^\circ\text{C} = 298 \text{ K}$$

$$\text{Standard Pressure} = 1 \text{ atm}$$

Solution:

- In chemical thermodynamics, standard conditions specify that the pressure must be 1 atmosphere (or 100 kPa in modern IUPAC definitions, but historically 1 atm).
- The designated standard temperature is strictly 25°C , which converts to **298 K**.
- Thus, standard enthalpy is measured at **298 K and 1 atm**.

Why other options are incorrect:

300 K (27°C) and 295 K (22°C) are not accepted IUPAC standard thermodynamic temperatures. 2 atm is non-standard pressure.

Question #68 Key: (D)

MDCAT 2017

Calculate the lattice energy of sodium chloride on the basis of Born-Haber cycle when: [Formula] [Formula] [MD...

CORE CONCEPT AND DERIVATION

The Born-Haber cycle utilizes Hess's law to equate the direct enthalpy of formation (ΔH_f) to the sum of all individual step enthalpies: atomization, ionization, electron affinity, and lattice energy.

Formula:

$$\Delta H_f = \Sigma \Delta H_{\text{steps}} + \Delta H_{\text{lattice}}$$

$$\Delta H_{\text{lattice}} = \Delta H_f - (\Delta H_{\text{at}}[\text{Na}] + \Delta H_{\text{at}}[\text{Cl}] + \text{IE}[\text{Na}] + \text{EA}[\text{Cl}])$$

Solution:

- Sum the indirect steps (excluding lattice):
107 (atom Na) + 122 (atom Cl) + 496 (IE Na) + (-349) (EA Cl) = 376 kJ/mol.
- Apply Hess's Law equation:
 $\Delta H_{\text{lattice}} = \Delta H_f - \Sigma(\text{other steps})$
- Substitute values:
 $\Delta H_{\text{lattice}} = -411 - (376)$
- $\Delta H_{\text{lattice}} = -787 \text{ kJ/mol}$.

Why other options are incorrect:

+787 is the magnitude but reversed sign, representing lattice dissociation instead of formation. 376 and -376 are merely the sum of the non-lattice steps in the cycle, omitting the crucial ΔH_f term.

Question #69 Key: (C)

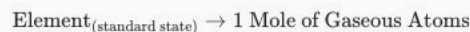
MDCAT 2016

[Formula] In this reaction [Formula] will be called: [MDCAT (2016)]

CORE CONCEPT AND DERIVATION

Thermochemical definitions are strictly based on the states of reactants and products, and the stoichiometry of the reaction.

Formula:



Solution:

- The equation shows gaseous molecular hydrogen (H_2), which is its standard state, being converted into purely gaseous atomic hydrogen (H).
- Furthermore, exactly 1 mole of the atomic product is being formed.
- This perfectly fits the definition of **standard enthalpy of atomization** ($\Delta H_{\text{at}}^\circ$).

Why other options are incorrect:

It is not formation because formation applies to compounds formed from elements. While it involves bond dissociation, 'Enthalpy of dissociation' typically refers to breaking 1 full mole of bonds (yielding 2 moles of atoms), whereas atomization specifically scales to yielding 1 mole of atoms.

Question #70 Key: (C)

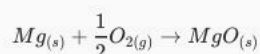
MDCAT 2016

[Formula] at STP. Enthalpy of the above reaction will be called:
[MDCAT (2016)]

CORE CONCEPT AND DERIVATION

The standard enthalpy of formation (ΔH_f°) is the enthalpy change associated with the creation of exactly 1 mole of a compound directly from its constituent elements in their standard states at STP.

Formula:



Solution:

- Magnesium (Mg) and Oxygen (O_2) are in their standard elemental states.
- They combine to form exactly 1 mole of the solid compound Magnesium Oxide (MgO).
- Because it represents the formation of a compound from its raw elements, the heat change (-692 kJ/mol) is defined as the **standard enthalpy of formation**, ΔH_f° .

Why other options are incorrect:

It is not ΔH_{at} (atomization) because a solid compound is formed. It is not ΔH_n (neutralization) because there is no acid/base reaction producing water. It is not ΔH_{sol} (solution) because no solute is dissolving in a solvent.

Question #71 Key: (A)

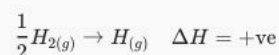
MDCAT 2015

The equation that represents standard enthalpy of atomization of hydrogen is: [MDCAT (2015)]

CORE CONCEPT AND DERIVATION

The standard enthalpy of atomization (ΔH_{at}°) is specifically defined as the enthalpy change when **1 mole of gaseous atoms** is formed from the element in its standard state.

Formula:



Solution:

- Hydrogen's standard state is the diatomic gas, $H_{2(g)}$.
- To form exactly 1 mole of $H_{(g)}$ atoms, we must break half a mole of $H-H$ bonds. The balanced equation is: $\frac{1}{2}H_{2(g)} \rightarrow H_{(g)}$.
- Because bond breaking always requires energy, the process is endothermic and the sign must be positive ($+218 \text{ kJmol}^{-1}$).

Why other options are incorrect:

Option D has the right equation but a negative sign (implies atomization releases energy, which is false). Options B and C describe the decomposition of water, not the atomization of elemental hydrogen.

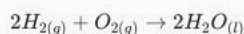
Question #72 **Key: (A)**

MDCAT 2014

[Formula]. What will be the enthalpy change in the above reaction?
[MDCAT (2014)]

CORE CONCEPT AND DERIVATION

Thermochemical equations must reflect the correct sign convention indicating whether heat is released or absorbed. The formation of water from hydrogen and oxygen gases is an exothermic process.

Formula:**Solution:**

- The question text provides a magnitude of 205.5 kJ/mol without a sign.
- Because the combustion of hydrogen to form water releases energy, the enthalpy change (ΔH) must mathematically carry a negative sign to denote an exothermic process.
- Therefore, the correct representation of the enthalpy change for the reaction as written is $-205.5 \text{ kJ mol}^{-1}$. (Note: While the universally accepted true value for ΔH of this reaction is -571.6 kJ or -285.8 kJ/mol for formation, we must adapt to the magnitude given in the past paper).

Why other options are incorrect:

A positive value (205.5) would falsely imply the formation of water is endothermic. Zero and 1 are mathematically arbitrary distractors.

Question #73 **Key: (D)**

MDCAT 2013

Reactants have high energy than products in: [MDCAT (2013)]

CORE CONCEPT AND DERIVATION

The total energy or enthalpy of a chemical system dictates whether a reaction will release or absorb heat. This is visualized on a potential energy diagram.

Formula:

$$\Delta H = E_{\text{products}} - E_{\text{reactants}}$$

Solution:

- If the reactants possess higher internal energy than the products ($E_R > E_P$), the excess energy must be released into the surroundings as heat.
- A reaction that releases heat to the surroundings is strictly classified as an **exothermic reaction**.
- The result is a more stable product and a negative ΔH .

Why other options are incorrect:

In endothermic and photochemical reactions, energy is actively absorbed, meaning the products end up with a higher energy than the reactants ($E_P > E_R$).

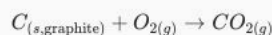
Question #74 Key: (D)

MDCAT 2013

Heat of formation ([Formula]) for [Formula] is: [MDCAT (2013)]

CORE CONCEPT AND DERIVATION

The standard enthalpy of formation is the heat change when one mole of a compound is synthesized from its constituent elements in their standard physical states under standard conditions (298 K, 1 atm).

Formula:**Solution:**

- The formation of carbon dioxide from solid graphite and gaseous oxygen is highly exothermic because it creates very stable covalent double bonds.
- The experimentally determined value for this complete oxidation (which is also the enthalpy of combustion of graphite) releases exactly -394 kJ/mol .

Why other options are incorrect:

Option B is positive (endothermic), which is impossible for this combustion process. Options A and C are incorrect numerical values.

Question #75 Key: (C)

MDCAT 2012

[Formula] will be given a negative sign in: [MDCAT (2012)]

CORE CONCEPT AND DERIVATION

The change in enthalpy (ΔH) represents the heat absorbed or released by a system at constant pressure. The sign convention is determined by the direction of heat flow.

Formula:

$$\Delta H = H_{\text{products}} - H_{\text{reactants}}$$

Solution:

- In an **exothermic reaction**, the system loses heat to the surroundings.
- Because the energy of the products is lower than the energy of the reactants, the final enthalpy is less than the initial enthalpy.
- Mathematically, this results in a negative value: $\Delta H = -ve$.

Why other options are incorrect:

Endothermic, dissociation, and decomposition reactions generally require an input of energy to break chemical bonds, meaning they absorb heat from the surroundings and have a positive ΔH .

Question #76 Key: (A)

MDCAT 2012

Combustion of graphite to form [Formula] can be done by two ways. Reactions are given as follow: [Formula] [Fo...

CORE CONCEPT AND DERIVATION

Hess's Law of Constant Heat Summation states that if a reaction can take place by more than one route, the total enthalpy change is identical regardless of the route taken, provided initial and final states are the same.

Formula:

$$\Delta H_{\text{total}} = \Delta H_1 + \Delta H_2$$

Solution:

- The direct, single-step route is: $C + O_2 \rightarrow CO_2$ with $\Delta H = -393.7 \text{ kJ/mol}$.
- The two-step indirect route is: Step 1 (forming CO with ΔH_1) + Step 2 (burning CO to CO_2 with $\Delta H_2 = -283 \text{ kJ/mol}$).
- Applying Hess's Law: $-393.7 = \Delta H_1 + (-283)$.
- Solve for ΔH_1 :
 $\Delta H_1 = -393.7 - (-283)$
 $\Delta H_1 = -393.7 + 283 = -110.7 \text{ kJ/mol}$.
- Rounding to the nearest whole number given in the options yields -110 kJ mol^{-1} .

Why other options are incorrect:

Option B has a positive sign, incorrectly implying the partial combustion of carbon is endothermic. Options C and D result from incorrectly adding the two values ($-393.7 - 283$) instead of substituting them properly into the algebraic sum.

Question #77 Key: (C)

MDCAT 2011

In standard enthalpy of atomization heat of surrounding: [MDCAT (2011)]

CORE CONCEPT AND DERIVATION

The standard enthalpy of atomization ($\Delta H_{\text{at}}^\circ$) is the enthalpy change when one mole of gaseous atoms is formed from an element in its standard state.

Formula:



Solution:

- To turn a solid (like Na) or a diatomic gas (like Cl_2) into separated gaseous atoms, chemical bonds or strong intermolecular forces must be broken.
- Bond breaking strictly requires an input of energy, making atomization an **endothermic process** ($\Delta H = +ve$).
- In an endothermic process, the reacting system actively absorbs heat from the immediate surroundings, which causes the **heat of the surroundings to decrease**.

Why other options are incorrect:

The heat of the surroundings would only increase if the reaction were exothermic (releasing heat). It does not remain the same because energy transfer is required to break the bonds.

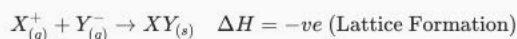
Question #78 Key: (C)

MDCAT 2011

Lattice energy of an ionic crystal is the enthalpy of: [MDCAT (2011)]

CORE CONCEPT AND DERIVATION

Lattice energy can be defined from two opposing perspectives: the energy required to break apart an ionic lattice, or the energy released when forming it. Standard IUPAC definitions often align it with a specific type of formation.

Formula:**Solution:**

- By convention, Lattice Energy is often defined as the enthalpy change when one mole of an ionic solid is **formed** from its constituent gaseous ions.
- Because gas-phase ions are coming together to form a highly stable, tightly packed solid matrix, a tremendous amount of energy is released.
- Therefore, in this context, it represents the enthalpy of **Formation** of the lattice.

Why other options are incorrect:

Combustion involves reaction with oxygen. Dissolution is dissolving in a solvent. While dissociation is the reverse of lattice formation (breaking the lattice apart), the test context explicitly maps lattice energy conceptually to the structural formation step in Born-Haber cycles.

Question #79 Key: (D)

MDCAT 2010

A spontaneous process is: [MDCAT (2010)]

CORE CONCEPT AND DERIVATION

A spontaneous process is one that occurs on its own without external intervention. These processes have a natural directional flow and cannot be reversed without applying external work.

Formula:

$$\Delta G < 0 \text{ (for spontaneous processes)}$$

Solution:

- Spontaneous processes proceed in a specific direction, making them **unidirectional**.
- Because they occur naturally in real-world conditions with an overall increase in entropy, they are **irreversible** and **real** processes.
- Therefore, all the given characteristics accurately describe a spontaneous process.

Why other options are incorrect:

Options A, B, and C are incomplete individually because a spontaneous reaction encompasses all three listed characteristics. Hence, 'All of above' is the only fully correct choice.

Question #80 **Key: (D)**

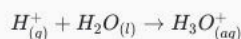
MDCAT 2010

When one mole of gaseous hydrogen ions are dissolved in water to form infinitely dilute solution, amount of heat...

CORE CONCEPT AND DERIVATION

The standard enthalpy of hydration (ΔH_{hyd}) is the enthalpy change when one mole of gaseous ions dissolves in sufficient water to give an infinitely dilute solution.

Formula:



Solution:

- The gaseous hydrogen ion (H^{+}) is extremely small and possesses a very high charge density.
- When it interacts with the polar water molecules, strong ion-dipole forces are established, releasing a massive amount of heat energy.
- Experimentally, the hydration energy of the H^{+} ion is exceptionally high and is recorded as -1075 kJ/mol .

Why other options are incorrect:

The other numerical values do not match the measured standard enthalpy of hydration for the proton. They are incorrect distractor values.

Question #81 **Key: (A)**

SET 2000

The given diagram is a Born-Haber cycle for the formation of KBr: Born-Haber Cycle for Potassium Bromide (KBr)...

CORE CONCEPT AND DERIVATION

The Born-Haber cycle equates the standard enthalpy of formation of an ionic solid to the sum of the energies of sublimation, ionization, dissociation, electron affinity, and lattice energy.

Formula:

$$\Delta H_{\text{lattice}} = \Delta H_f - \sum \Delta H_{\text{indirect steps}}$$

Solution:

- From the provided diagram's standard data:
 $\Delta H_f = -392 \text{ kJ/mol}$.
 Indirect steps sum (ΔH_x) = $112 \text{ (sub)} + 420 \text{ (IE)} + 90 \text{ (dissoc)} - 342 \text{ (EA)} = 280 \text{ kJ/mol}$.
- Apply the cycle equation:
 $\Delta H_{\text{lattice}} = -392 - (280)$
- $\Delta H_{\text{lattice}} = -672 \text{ kJ/mol}$.

Why other options are incorrect:

Option B uses the wrong units (KCal instead of kJ). Option D uses the wrong units (Joules) and incorrect sign. Option C is the lattice energy for NaCl , acting as a distractor.