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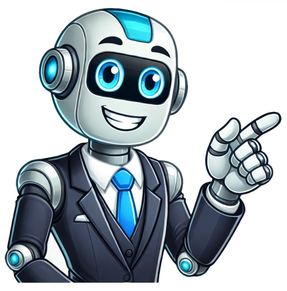

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Get all the study material in Hindi medium and English medium for IIT JEE and NEET preparation This calculator uses the enthalpy of formation of the compounds to calculate the enthalpy change from a reaction scheme. We can define the enthalpy of formation as the enthalpy of a substance at a specified state due to its chemical composition. In other words, it represents the energy required to take that substance to a specified state. In processes involving chemical energy changes, all substances must have the same reference state to be able to use the enthalpy of formation consistently. This reference state corresponds to 25°C (77°F) and 10^5 Pa = 1 bar. Having defined a universal reference state, we can discuss a new term called standard enthalpy of formation. The standard enthalpy of formation is simply the enthalpy of formation with standard conditions as the specified state. By definition, it is the change in enthalpy, ΔH, during the formation of one mole of the substance in its standard state (1 bar and 25°C), from its pure elements, f. The standard enthalpy of formation of all stable elements (i.e., O2, N2, C, and H2) is assumed as zero because we need no energy to take them to that stable state under our atmospheric conditions. For a reaction, the enthalpy change formula is: ΔH°reaction = ∑ΔH°f(products) - ∑ΔH°f(reactants) where: ΔH°reaction — Standard enthalpy change of formation expressed in kJ; ∑ΔH°f(products) — Sum of the standard enthalpies of formation of the products multiplied by their corresponding numbers of moles, expressed in kJ; and ∑ΔH°f(reactants) — Sum of the standard enthalpies of formation of the reactants multiplied by their corresponding numbers of moles, expressed in kJ. Apart from the enthalpy equation, you need to know the standard enthalpies of formation of the compounds. The following table contains some of the most important ones, but you can look at the rest in the enthalpy calculator: As an example, let's suppose we want to know the enthalpy change of the following reaction: 2 $SO_3(g) \rightarrow 2 SO_2(g) + O_2(g)$ Considering the number of moles of the compounds and the enthalpies of the table, we can use the enthalpy change formula: ΔH°reaction = ∑ΔH°f(products) - ∑ΔH°f(reactants) = (2 mol)(−395.72 kJ/mol) - [(2 mol)(−296.83 kJ/mol) + (1 mol)(0)] = -197.87 kJ Check the result with the calculator, and you'll figure out it's the same. Now that you know how to calculate the enthalpy change with the formula, you can use the calculator more confidently! This calculator uses the enthalpy of formation of the compounds to calculate the enthalpy change from a reaction scheme. We can define the enthalpy of formation as the enthalpy of a substance at a specified state due to its chemical composition. In other words, it represents the energy required to take that substance to a specified state. In processes involving chemical energy changes, all substances must have the same reference state to be able to use the enthalpy of formation consistently. This reference state corresponds to 25°C (77°F) and 10^5 Pa = 1 bar. Having defined a universal reference state, we can discuss a new term called standard enthalpy of formation. The standard enthalpy of formation is simply the enthalpy of formation with standard conditions as the specified state. By definition, it is the change in enthalpy, ΔH, during the formation of one mole of the substance in its standard state (1 bar and 25°C), from its pure elements, f. The standard enthalpy of formation of all stable elements (i.e., O2, N2, C, and H2) is assumed as zero because we need no energy to take them to that stable state under our atmospheric conditions. 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He has led several national research projects, pioneering innovative approaches to novel materials for high technology. Passionate about making science accessible, Dominik has created various calculators, mostly in physics and math categories. In his free time, he enjoys family walks, city explorations, mountain hiking, and traveling everywhere by bike. See full profileCheck our editorial policySteven WoodingSteven Wooding is a physicist by training with a degree from the University of Surrey specializing in nuclear physics. He loves data analysis and computer programming. He has worked on exciting projects such as environmentally aware radar, using genetic algorithms to tune radar, and building the UK vaccine queue calculator. Steve is now the Editorial Quality Assurance Coordinator here at Omni Calculator, making sure every calculator meets the standards our users expect. In his spare time, he enjoys cycling, photography, wildlife watching, and long walks. See full profileCheck our editorial policy545 people find this calculator helpfulThis enthalpy calculator will help you calculate the change in enthalpy of a reaction. Read on to learn how to calculate enthalpy and its definition. We will also explain the difference between endothermic and exothermic reactions, as well as provide you with an example of calculations.Enthalpy measures the total energy of a thermodynamic system — either in the form of internal energy or volume multiplied by pressure. It is a state function depending only on the equilibrium state of a system. The more interesting quantity is the change of enthalpy — the total energy that was exchanged within a system. It is a simplified description of the energy transfer (energy is in the form of heat or work done during expansion).There are two main types of thermodynamic reactions: endothermic and exothermic. An endothermic reaction causes absorption of heat from the surroundings. An exothermic one releases heat to the surroundings. Both these reaction types cause energy level differences and, therefore, differences in enthalpy. All you need to remember for the purpose of this calculator is: If the reaction is endothermic, the change in enthalpy is positive, as heat is gained (absorbed from the surroundings). If the reaction is exothermic, the change in enthalpy is negative, as heat is lost (released to the surroundings). Enthalpy, by definition, is the sum of the internal energy of the system and the product of the system's volume and pressure:H=U+pV\footnotesize H = U +pV\H=U+pVwhere UUU stands for internal energy, ppp for pressure and VVV for volume. Notice that the second part closely remembers the equations we met at the combined gas law calculator: the relationship between pressure and volume allows us to find a similar connection between quantity of matter and temperature. If you want to calculate the change in enthalpy, though, you need to consider two states — initial and final. We will assume that the pressure is constant while the reaction takes place. Then, the change in enthalpy is actually:ΔH=(U2−U1)+p·(V2−V1)\footnotesize ΔH = (U_2-U_1)+p·(V_2-V_1)ΔH=(U2−U1)+p·(V2−V1)ΔH=ΔU+p·ΔV\footnotesize ΔH = ΔU+ p\cdot ΔV\ΔH=ΔU+p·ΔVwhere: U2U_2U2 and V2V_2V2 — Internal energy and volume of the products of the reaction, respectively; U1U_1U1 and V1V_1V1 — Internal energy and volume of the reactants, respectively; ppp — Constant pressure; ΔU\ΔUΔU — Change in internal energy; ΔV\ΔVΔV — Change in volume; and ΔH\ΔHΔH — Change in enthalpy. For more specific problems, we can define the standard enthalpy of formation of a compound, denoted as ΔHf°ΔH_\mathrm{f}\degreeΔHf°. It represents the change in enthalpy during the formation of one mole of a substance under standard conditions of temperature and pressure (p=105 Pa=1 barp = 10^5\ \mathrm{Pa} = 1\ \mathrm{bar}p=105 Pa=1 bar and T=25°C=298.15 KT = 25 \degree \mathrm{C} = 298.15\ \mathrm{K}T=25°C=298.15 K), from its pure elements in their respective reference states. The reference state of an element is its most stable configuration under the above-mentioned conditions. Some examples of reference states are nitrogen in the form of gas molecules N2\mathrm N_{2}N2 and carbon in the form of graphite. The standard enthalpy of formation formula for a reaction is as follows:ΔH°reaction=∑ΔHf°(products) −ΔHf°(reactants)\footnotesize \begin{split} ΔH\degree_\mathrm{reaction}& = \sum ΔH_\mathrm{f}\degree(\mathrm{products})\\ &\qquad\ \- ΔH_\mathrm{f}\degree(\mathrm{reactants}) \end{split}ΔH°reaction =∑ΔHf°(products) −ΔHf°(reactants)where: ΔH°reactionΔH\degree_\mathrm{reaction}ΔH°reaction — Standard enthalpy change of formation expressed in kJ; ΔHf°(products)ΔH_\mathrm{f}\degree(\mathrm{products})ΔHf°(products) — Sum of the standard enthalpies of formation of the products expressed in kJ/mol; and ΔHf°(reactants)ΔH_\mathrm{f}\degree(\mathrm{reactants})ΔHf°(reactants) — Sum of the standard enthalpies of formation of the reactants, expressed in kJ/mol. If you're paying attention, you might have observed that ΔHf°(products)ΔH_\mathrm{f}\degree(\mathrm{products})ΔHf°(products) and ΔHf°(reactants)ΔH_\mathrm{f}\degree(\mathrm{reactants})ΔHf°(reactants) have different units than ΔH°reactionΔH\degree_\mathrm{reaction}ΔH°reaction. This is because you need to multiply them by the number of moles, i.e., the coefficient before the compound in the reaction. We'll show you later an example that should explain it all. But before that, you may ask, "How to calculate standard enthalpy of formation for each compound?" The most straightforward answer is to use the standard enthalpy of formation table! Here's an example one:The symbols in the brackets indicate the state: s\mathrm{s}s — solid, l\mathrm{l}l — liquid, g\mathrm{g}g — gas, and aq\mathrm{aq}aq — dissolved in water. If you need the standard enthalpy of formation for other substances, select the corresponding compound in the enthalpy calculator's drop-down list. We included all the most common compounds! Let's practice our newly obtained knowledge using the above standard enthalpy of formation table. For example, we have the following reaction:2SO3(g)→2SO2(g)+O2(g)2\mathrm{SO}_{3\mathrm{(g)}}\rightarrow 2\mathrm{SO}_{2\mathrm{(g)}} + \mathrm{O}_{2\mathrm{(g)}}2SO3(g)→2SO2(g)+O2(g)What is the enthalpy change in this case? We sum ΔHf°ΔH_\mathrm{f}\degreeΔHf° for SO2(g)\mathrm{SO}_{2\mathrm{(g)}}SO2(g) and O2(g)O_{2\mathrm{(g)}}O2(g) and subtract the ΔHf°ΔH_\mathrm{f}\degreeΔHf° for SO3(g)\mathrm{SO}_{3\mathrm{(g)}}SO3(g). Remember to multiply the values by corresponding coefficients!ΔH°reaction=2 mol·(−296.83 kJ/mol)+1 mol·0 kJ/mol−2 mol·(−395.72 kJ/mol)\footnotesize \begin{split} ΔH\degree_\mathrm{reaction} \!&=\! 2\ \mathrm{mol}\!\cdot\!(-296.83\ \mathrm{kJ/mol})\\ &\!+\! 1\ \mathrm{mol} \cdot 0\ \mathrm{kJ/mol}\\ &\!-\! 2\ \mathrm{mol}\cdot(-395.72\ \mathrm{kJ/mol}) \end{split}ΔH°reaction=2 mol·(−296.83 kJ/mol)+1 mol·0 kJ/mol−2 mol·(−395.72 kJ/mol)Notice that the coefficient units mol\mathrm{mol}mol eliminates the mol\mathrm{mol}mol in the denominator, so the final answer is in kJ\mathrm{kJ}kJ:ΔH°reaction=197.78 kJΔH\degree_\mathrm{reaction} = 197.78\ \mathrm{kJ}ΔH°reaction=197.78 kJThat's it! Still, isn't our enthalpy calculator a quicker way than all of this tedious computation? Our pressure conversion tool will help you change units of pressure without any difficulties!The enthalpy calculator has two modes. You can calculate the enthalpy change from the reaction scheme or by using the enthalpy formula. If you select the former: Look at the reaction scheme that appeared at the top of the calculator. Do you need an additional reactant/product (C or F)? If so, enter the values of the coefficients and select the additional substances from the list (or select Custom option). Fill in the fields in the Reactants section. You need to provide the coefficient before the compound and select your substance from the drop-down list (they're ordered alphabetically). If you can't find the right one, select the Custom option and enter the standard enthalpy of formation in kJ/mol (if you don't have this on hand, check some online reference tables, like this one at Chemistry LibreTexts). Do the same thing for the Products. Verify the reaction scheme below and read the result. That's the standard enthalpy change of formation for your reaction! Optionally, check the standard enthalpy of formation table (for your chosen compounds) we listed at the very bottom. If you want to calculate the enthalpy change from the enthalpy formula: Begin with determining your substance's change in volume. Let's assume your liquid expanded by 555 liters. Find the change in the internal energy of the substance. Let's say your substance's energy increased by 2000 J2000\ \mathrm{J}2000 J. Measure the pressure of the surroundings. We will assume 1 atmosphere. Input all of these values to the equation ΔH=ΔU+p·ΔVΔH = ΔU + p\cdot ΔVΔH=ΔU+p·ΔV to obtain the change in enthalpy: ΔH=2000 J+1 atm·5 l=2000 J+101,325 Pa·0.005 m3=2506.63 J\footnotesize \begin{split} ΔH &= 2000\ \mathrm{J}+1\ \mathrm{atm}\cdot 5\ \mathrm{l}\\ &=2000\ \mathrm{J}+101,\!325\ \mathrm{Pa}\cdot0.005\ \mathrm{m^3}\\ &=2506.63\ \mathrm{J} \end{split}ΔH=2000 J+1 atm·5 l=2000 J+101,325 Pa·0.005 m3=2506.63 J Our enthalpy calculator can also find the enthalpy based on the initial and final internal energy and volume. FAQsIn chemistry, enthalpy (at constant pressure) determines the heat transfer of a system. Roughly speaking, the change in enthalpy in a chemical reaction equals the amount of energy lost or gained during the reaction. A system often tends towards a state when its enthalpy decreases throughout the reaction.Yes. A chemical reaction that has a negative enthalpy is said to be exothermic. This means that the system loses energy, so the products have less energy than the reactants. Therefore, the term 'exothermic' means that the system loses or gives up energy.You can calculate the enthalpy change in a basic way using the enthalpy of products and reactants: ΔH° = ∑ΔHproducts − ΔHreactants For example, let's look at the reaction Na+ + Cl- → NaCl. To find enthalpy change: Use the enthalpy of product NaCl (-411.15 kJ). Find the enthalpy of Na+ (-240.12 kJ) and Cl- (-167.16 kJ). Calculate enthalpy change: ΔH° = 1 × -411.15 kJ − (1 × -240.12 kJ − 1 × 167.16 kJ) = -3.87 kJ Remember corresponding coefficients! All pure elements in their standard state (e.g., oxygen gas, carbon in graphite form, etc.) have a standard enthalpy of formation zero. Enthalpy of formation means enthalpy change during the formation of one mole of a substance. But an element formed from itself means no enthalpy change, so its enthalpy of formation will be zero.-571.7 kJ. Let's assume the formation of water, H2O, from hydrogen gas, H2, and oxygen gas, O2. To find enthalpy: Write the formation reaction: 2H2 + O2 → 2H2O. Note that the enthalpy of H2 and O2 in their elemental state is zero. Calculate the enthalpy as: ∑ΔHproducts − ΔHreactants = 2 × -285.83 kJ − (2 × 0 kJ + 0 kJ) = -571.7 kJ. Calculate enthalpy change fromanA + bnB + cnC → dnD + enE +
fnFSelectNoneCustomAg(s)Ag+(aq)Ag2O(s)Ag2S(s)AgBr(aq)AgBr(s)AgCl(aq)AgCl(s)AgI(aq)AgI(s)AgNO3(s)Al(s)Al2O3(s)Al3+(aq)AlCl3(s)As(s)As2S3(s)AsO4 3−(aq)B(s)B2O3(s)Ba(s)Ba2+(aq)BaCl2(s)BaCO3(aq)BaCO3(s)BaO(s)BaSO4(s)BF3(g)Br−(aq)Br(g)Br2(g)Br2(l)C(g)C(s) - DiamondC(s) - GraphiteCH3CHO(g)CH3CHO(l) - AcetaldehydeCH3COCH3(l) - AcetoneCH3COOH(aq)CH3COOH(l) - Acetic acidCH3NH2(g) - MethylamineCH3OH(g)CH3OH(l) - MethanolCH4(g) - MethaneCHCl3(l)(COOH)2(s) - Oxalic acidC2H2(g) - AcetyleneC2H4(g) - EthyleneC2H5OH(g)C2H5OH(l) - EthanolC2H6(g) - EthaneC3H6(g) - CyclopropaneC3H6(g) - PropyleneC3H8(g) - PropaneC4H10(g) - ButaneC5H12(g) - PentaneC6H12(l) - CyclohexaneC6H12O6(s) - FructoseC6H12O6(s) - GlucoseC6H14(l) - HexaneC6H5COOH(s) - Benzoic acidC6H5NH2(l) - AnilineC6H5OH(s) - PhenolC6H6(l) - BenzeneC7H8(l) - TolueneC8H10(l) - OctaneC12H22O11(s) - SucroseCO(g)CO(NH2)2(s) -
UreaCO2(g)CO2 2−(aq)CCl4(g)CCl4(l)Ca(g)Ca(OH)2(aq)Ca(OH)2(s)CaBr2(s)CaC2(s)CaCl2(aq)CaCl2(s)CaCO3(aq)CaCO3(s)CaF2(aq)CaF2(s)CaO(s)CaSO4(aq)CaSO4(s)Ce(s)Ce3+(aq)Ce4+(aq)Cl(g)Cl−(aq)Cl2(g)CoO(s)Cr2O3(s)CS2(l)Cu(s)Cu+(aq)Cu2+(aq)Cu2O(s)CuO(s)CuS(s)CuSO4(s)D2(g)D2O(l)D2O(g)F−(aq)F2(g)Fe(s)Fe2+(aq)Fe3+(aq)FeO(s)Fe2O3(s) - HematiteFe3O4(s) - MagnetiteFeS(s) -
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acidHF(aq)HF(g)Hg(g)Hg(l)Hg2Cl2(s)HgO(s)HgS(s)HI(g)HN3(g)HNO3(aq)HNO3(l)HNO3(s)I−(aq)I2(g)I2(s)K(g)K(s)K+(aq)K2S(aq)K2S(s)KBr(s)KCl(s)KClO3(s)KClO4(s)KF(s)KI(s)KOH(aq)KOH(s)Mg(g)Mg(OH)2(s)Mg(s)Mg2+(aq)MgBr2(s)MgCl2(s)MgCO3(s)MgO(s)MgSO4(s)MnO(s)MnO2(s)N2(g)N2H4(g)N2H4(l)N2O(g)N2O4(g)N2O4(l)Na(g)Na(s)Na+(aq)Na2CO3(s)NaBr(s)NaCl(s)NaF(s)NaHCO3(s)NaI(s)NaOH(aq)NaOH(s)NH2CH2COOH(s)
- GlycineNH2OH(s)NH3(aq)NH3(g) - AmmoniaNH4+(aq)NH4Cl(s)NH4ClO4(s)NH4NO3(s)NiO(s)NO(g)NO2(g)NO3−(aq)O2(g)O3(g)OH−(aq)P(s)P4(g)P4O10(s)Pb(s)Pb2+(aq)Pb3O4(s)PbBr2(aq)PbBr2(s)PbCl2(s)PbO(s)PbO2(s)PbSO4(s)PCl3(g)PCl3(l)PCl5(g)PCl5(s)PH3(g)S(s) - MonoclinicS(s) - RhombicS2−(aq)SbCl3(g)SbCl5(g)SbH3(g)SF6(g)Si(s)SiO2(s)SiO2(s) - αSn(s) - GraySn(s) -
WhiteSnCl2(s)SnCl4(l)SnO(s)SnO2(s)SO2(g)SO3(g)SO4 2−(aq)Zn(s)Zn2+(aq)ZnO(s)ZnS(s)SelectNoneCustomAg(s)Ag+(aq)Ag2O(s)Ag2S(s)AgBr(aq)AgBr(s)AgCl(aq)AgCl(s)AgI(aq)AgI(s)AgNO3(s)Al(s)Al2O3(s)Al3+(aq)AlCl3(s)As(s)As2S3(s)AsO4 3−(aq)B(s)B2O3(s)Ba(s)Ba2+(aq)BaCl2(s)BaCO3(aq)BaCO3(s)BaO(s)BaSO4(s)BF3(g)Br−(aq)Br(g)Br2(g)Br2(l)C(g)C(s) - DiamondC(s) - GraphiteCH3CHO(g)CH3CHO(l) -
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