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| **1.** | (a) | Moles = 0.1/16 = 6.25 x 10-3 (M1)  Heat released = M1 x 890 = 5.56 kJ (M2) or 5560 J  Q = Hc x ΔT so ΔT = q/Hc = M2/120 = 46.4 K or oC (M3) |
|  | (b) | Moles of methane = 10,000/890 = 11.2 (M4) = moles of CO2  Mass of CO2 = M4 x 44 = 494 g (M5)  [5] |
| **2.** | (a) | q = mcΔT = 150 x 4.18 x 64 = 40100 J or 40.1 kJ (M1)  n = 2.12/32 = 0.0663 (M2)  M1/M2 = 606 kJmol-1 so ΔH = -606 kJmol-1 (M3) |
|  | (b) | Heat loss (M4)  To the air or surroundings (M5)  [5] |
| **3.** | (a) | MgO + 2HCl 🡪 MgCl2 + H2O (M1) |
| (b) | q = mcΔT = 50 x 4.18 x 32 = 6690 J or 6.69 kJ (M2)  HCl is limiting so n (HCl) = 0.05x3 = 0.15 (M3)  n (MgO) = M3/2 = 0.075 (M4)  M2/M4 = 89.2 kJmol-1 so ΔH = -89.2 kJmol-1 (M5)  [5] |
| **4.** | (a) | C2H6 + 3.5O2 🡪 2CO2 + 3H2O (M1) |
|  | (b) | ΔH = ΣΔHf(p) - ΣΔHf(r) or suitable cycle (M2) = 3(-286) + 2(-394) – (-85) (M3)  = -1561 kJmol-1 (M4) |
|  | (c) | q = 100/30 x M4 = 5200 kJ (M5)  [5] |
| **5.** | (a) | Bonds broken = 6(C-H) + C-C + C=C + 4.5(O=O) = 5664 kJmol-1 (M1)  Bonds formed = 6(C=O) + 6(O-H) = 7236 kJmol-1 (M2)  ΔH = M1 = M2 = -1572 kJmol-1 (M3) |
|  | (b) | Bond enthalpies are average values and may not be correct for specific equation (M4)  Calculation produces water in gaseous state but standard state of water is liquid (M5)  [5] |
| **6.** | (a) | Energy change for a reaction is independent of the route (M1) |
|  | (b) | C6H14 🡪 C6H6 + 4H2 (M2) |
|  | (c) | ΔH = ΣΔHC(r) - ΣΔHc(p) or suitable cycle (M3)  = -4163 – (-3267) – 4(-286) (M4)  = +248 kJmol-1 (M5)  [5] |

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| **7.** | (a) | As below but with Ag instead of Na and F instead of Cl  All species correct (M1) state symbols all correct (M2) shape and arrows correct (M3) |
|  | (b) | atomisation enthalpy of F = Bond dissociation enthalpy of F-F /2 (M4)  +298 + x/2 + 732 – 348 – 955 = -203 (M5)  x/2 = 70 so x = 140 kJmol-1 (M6)  [max 5] |
| **8.** | (a) | AgCl(s) 🡪 Ag+(aq) + Cl-(aq) (M1) |
|  | (b) | As below but with Ag instead of Na  All species and arrows (M2)  State symbols (M3) |
|  | (c) | +77 = -(-905) – 464 + x (M4)  x = -364 kJmol-1 (M5) |
|  | (d) | Enthalpy of solution significantly endothermic so unlikely to be soluble (M6)  [max 5] |