**Energetics – Hmk 2 (Ans)**

**1.** (a) *Standard enthalpy of formation* The enthalpy change when one mole of a compound  
**(1)** is formed from its consistuent element **(1)** in their normal or standard state **(1)** under standard conditions

*Standard enthalpy of combustion* The enthalpy change when one mole of a compound  
**(1)** is completely burnt in oxygen **(1)** under standard condition or at 298K and 100kPa **(1)**

6

(b) H = Hf products – Hf reactants or cycle **(1)**

= 3HfCO2 + 4Hf H2O – Hf C3 H7OH **(1)**

= –2022 kJ mol–1 **(1)** 3

(c) (i) Enthalpy = 200 × 4.2 × 15 **(1)**

= 12.6 kJ **(1)**

(ii) Moles C3H7OH = 0.90/60 **(1)**

12.6 kJ **(1)**

(iii) Enthalpy of combustion = –12.6/0.015 **(1)**

= –840 kJ mol–1 **(1)**

(iv) *Reason 1* Incomplete combustion

Heat lost to surroundings

*Reason 2* Heat capacity of the apparatus

Any two **(2)** 8

[17]

**2.** (a) (The enthalpy/heat change) when one mole **(1)** is completely burned/combusted in oxygen/air **(1)**

under standard conditions or 100K Pa/lbar/latm/760mm Hg **(1)** and 298K or STP

Penalise first mark if heat adsorped. Penalise first mask if “energy change” stated

3

(b) HR= H products – H reactants or cycle or   
HR = HCO2+2HH2O – HCH4 **(1)**

= (–394) +2 (–286) – (–75) **(1)**

= –891 (kJ mol–1)

*Allow +891 [max 1]*

3

(c) (i) Enthalpy (Do not allow energy) required to break a covalent bond **(1)**

*Allow second mark separately*

averaged over (many) compounds **(1)**

(ii) Ha =  Bonds broken –  Bonds made or cycle **(1)**



BE (C–H)=  **(1)** = 4155 (kJ mol–1) **(1)**

*Allow 415–416*

(iii) 4020 = 2BE (C–C) + 8 BE (C–H) **(1)**

CE if 3BE(C–C) used

BE (C–C) +  = 348 (kJmol–1) **(1)** *Allow 346–350* 7

Mark conseq

Note: Using 390, the given answer, BE (C–C) = 450 [2]

The common wrong answer in C(ii) is 378 this gives BE(C–C) as 498 conseq [2]

[13]

**3.** (a) Enthalpy (Energy) to break a (covalent) bond **(1) OR dissociation energy**Varies between compounds so average value used **(1) QL mark**

OR average of dissociation energies in a single molecule / e.g. CH4  
Do not allow mention of energy to form bonds  
but with this case can allow second mark otherwise 2nd mark  
consequential on first

2

(b) (i) 1/2 N2 + 3/2 H2  NH3 **(1)**

Ignore s s

(ii) H = ()bonds broken – ()bonds formed **(1)** = 1/2 × 944 + 3/2 × 436 – 3 × 388 **(1)** = –38 kJ mol–1 **(1)**

Ignore no units, penalise wrong units  
Score 2/3 for -76  
1/3 for +38  
Allow 1/3 for +76

4

(c) 4 (C–H) + (C=C) + (H–H) – (6 (C–H) + (C–C)) = –136 **(1)**(C=C) + (H–H) – ((C–C) + 2 (C–H)) = –136  
2 (C–H) = 836 **(1)**(C–H) = 418 (kJ mol–1) **(1)**

Note: allow (1) for –836  
another (1) for –418

3

[9]

A = 31

B = 27

C = 23

D = 19

E = 15