2.3.1 ENTHALPY CHANGES TEST MS

1. (a) (a reaction) that releases energy/ (a reaction) that releases heat/ a reaction with a negative ΔH (1) 1

(b) (i) diagram to show
upward **hump** (1)
$CO_2 + (2)H_2O$/ carbon dioxide and water below
reactants (1) 2

(ii) E_a marked (1)
if an arrowhead is included, it must be upwards 1

[4]

2. (a) (i) bonds broken

(N — N) + (O == O) + (N — H) = 163 + 497 + 4(390) = 2220 (kJ mol^{-1}) (1)

bonds made

(N ≡ N) + $4(\tilde{O}H)$ = 945 + 4(463) = 2797 $(KJ\ mo\tilde{l}^{1})$ (1)

broken ΔH is +ve and made ΔH is −ve (1)

enthalpy of reaction $\tilde{=}$ 577 $(KJ\ mo\tilde{l}^{1})$ (1) 4

(ii) $\frac{577}{32} = 18.0(KJ)(1)$ 1

(b) N-N bond is weak/ higher Ea for ammonia/ rate too slow for ammonia/ too much energy to break bonds in ammonia / hydrazine is liquid/ do not need pressurised containers/ more moles/ lots of gas produced by hydrazine/ more energy per mole produced by hydrazine (1) 1

[6]

3. (i) to break a bond energy has to be put in/ ✓
breaking bonds is endothermic 1

(ii) energy needed to break 1 mole **of bonds** ✓
in the **substance** in the gaseous state ✓ 2

(iii) bonds broken:
3(C–H) + (C–O) + (O–H) + 1½ (O=O) = 2781 kJ ✓
bonds made:
2(C=O) + 4(O–H) = 3470 kJ ✓
$\Delta H_c = -689$ ✓ (kJ mol^{-1}) 3

(iv) actual bond enthalpies may be different from average values ✓

conditions are not standard / methanol/ water is a liquid under standard conditions ✓ 2

[8]

4. (a) (enthalpy change) when 1 mole of substance/ element/ compound (1)

NOT energy needed

is completely burnt (1) 2

(b) $C_3H_7OH(l) + 4½\ O_2(g) \rightarrow 3CO_2(g) + 4H_2O(I)$

correctly balanced equation (1)

state symbols (species must be correct) (1) 2

(c) (i) $q = mc\Delta T$ (1)

$\Delta H = 50 \times 4.18 \times 12.8 = 2675\ (J) = 2.68\ (kJ)$ (1) 2
ignore sign

(ii) Mr propan-1-ol = 60 (1)

number moles = 0.00167 (1) 2

(iii) $\Delta H = -(1608\ (KJ\ mol^{-1})$ (1) 1

(iv) heat losses (1)

thermal capacity of beaker ignored (1)

conditions were non-standard (1)

combustion could be incomplete (1)

propan-1-ol evaporates (1)

water evaporates (1) 2

[11]

5. (i) $4C(s) + 5H_2(g) \rightarrow C_4H_{10}(g)$

reagents and products (1)

state symbols (1) 2

(ii) $4C + 5H_2 \xrightarrow{X} C_4H_{10}$

$4(-394)\ 5(-286)\ -2877$

$4CO_2\ 5H_2O$

cycle (1)

correct values (1)

answer (1)

$X - 2877 = 4(-394) + 5(-286)$

$X = -129\ (kJ\ mol^{-1})$ 3

[5]

6. (a) (heat/ energy change) when 1 mole of substance is formed (1)
from its elements (1) 2

(b) $C(s) + 2H_2(g) \rightarrow CH_4(g)$
balanced equation (1)
state symbols (1) 2

(c) cycle drawn/ sum of enthalpy changes products – sum of enthalpy changes reactants (1)
$-75 - 242 + \times = -110$ (1) 3
$\Delta H = 207$ (kJ mol^{-1}) (1)

(d) any industrial use, examples include
manufacture of ammonia/ for Haber process 1
manufacture of margarine/ hydrogenation of alkenes

[8]

7. (i) (enthalpy/ energy change) when 1 mole of substance/compound formed ✓
from its elements ✓
under standard conditions ✓ (if conditions quoted must be correct – 25 C/298 K, 1 atm/100 kPa/101 kPa) 3

(ii) $Mg(s) + N_2(g) + 3O_2(g)$ ✓ $Mg(NO_3)_2(s)$
balanced species ✓
state symbols ✓ 2

(iii) cycle ✓
$x - 791 = -602 - 2(33)$ ✓
$x = 123$ ✓ 3

[8]