SEPTEMBER 2010
MHS TRIAL NOVEMBER EXAM
SOLUTIONS

Penalties : the usual ones!
* max^m 1 mark off if incorrect numbers of significant figures are given
* max^m 1 mark off if symbols of state are omitted
* 1 mark off each time a unit is omitted from answer that requires a unit

SECTION A $\Sigma = 20$

1. D	2. A	3. C	4. C	5. D	6. D	7. C	8. B	9. B	10. C
11. C	12. D	13. C	14. B	15. D	16. A	17. D	18. B	19. C	20. C

SECTION B Σ = 60 marks * = one mark

1 a K = $[SO_2Cl_2] / [SO_2] [Cl_2]$ * (states not included)
b The reaction was proceeding in the forward direction during the following times
0 – 2 min, 3 – 4 min and 7 – 8 minutes * (All 3 for 1 mark)
c K at 2 minutes K = 0.020/0.050 x 0.081 = 5.0 M^{-1} *
K at 9 minutes K = 0.040/0.060 x 0.081 = 8.2 M^{-1} *
d A temperature change causes the difference in the K values. *
e i) SO_2 added *
ii) temperature has been decreased *
iii) volume has been increased or pressure decreased *
f lower, lower * (both need to be correct for one mark)
g Because it is an exothermic reaction, a lower temperature increases K *
and reducing volume causes an increase in pressure. Reaction favors direction of less number of moles *
(Each change requires an explanation for a full mark)
[1 + 1 + 2 + 1 + (1 + 1 + 1) + 1 + 2 = 11]

2 a $C(g) + 3D(g) \rightleftharpoons 2A(g) + B(g)$ (* correct reactants and products, * for stoichiometry
(– 1 if no $\rightleftharpoons$ sign, - 1 if no or incorrect states)
b equilibrium constant does NOT give any information about the rate of the reaction. *
c Large K values (greater than 10^4) indicates considerable (*/2) more products than reactants (*/2)
d Adding more C will change the concentration fraction but will not change the equilibrium constant.*
The reaction will proceed in the forward direction to re-establish the equilibrium constant.
e From LeChateliers principle, the direction of change in K with partially offset the change made. Therefore an increase in temperature will favor the direction that will cause a reduction in temperature. For an exothermic reaction this would be a back reaction */2 . Therefore the K value will be lowered. */2
f Initially C = 0.50 mol, D = 0.750 mol and V = 2.0L
At eqm B = 0.15 mol [B] = 0.150/2 = 0.075 M, */2
[A] = 2xB = 0.150 M */2
C = 0.50 – 0.15 = 0.35 mol, [C] = 0.35/2 = 0.175M, */2
D = 0.750 – 3 x 0.15 mol = 0.30 mol, [D] = 0.150 M */2
$K = [A]^2[B] / [C][D]^3 = 0.15^2 \times 0.075 / 0.175 \times 0.15^3$ */2 = 2.86 M^{-1} */2
[2 + 1 + 1 + 1 + 1 + 3]

3 a Argon is an inert gas and does not change the partial pressure of any of the other gases present.
Therefore the addition of argon will not cause a shift in the equilibrium position. *
b $Cl_2(g) + 3F_2(g) \rightleftharpoons 2ClF_3(g)$ *
Halving the volume means doubling the pressure. This effectively increase the concentration of each of the gases present. The direction of the reaction will be to the side that will reduce pressure which is the side with the fewest particles. From the equation, 4 mole → 2 mole, therefore the reaction will move to the right or a net forward reaction. *
c $pH = -\log_{10}[H^+]$
as pH = 2.54, therefore [H+] = $10^{-2.54}$ = 0.00288 M
Ka = $\dfrac{[H^+][\text{benzoate ion}]}{[\text{benzoic acid}]}$
$[H^+]$ = [benzoate ion] as they are produced in a 1 : 1 ratio
From the data book Ka of benzoic acid = 6.4 x 10^{-5} M
6.4 x 10^{-5} = $(0.00288)^2$ / [benzoic acid] *
[benzoic acid] = $(0.00288)^2$ / 6.4 x 10^{-5}
= 0.130 M *

4 a Reduce energy requirements by providing an alternative pathway or
To control the rate of reaction and ensure particular products are formed or
As lower temp increases yield in an exothermic reaction, a catalyst is used to increase the rate. *
b A lower temperature will result in an increase in the equilibrium constant for an exothermic reaction.
Therefore there will be an increase in the yield.*
Compression of the gases results in the increased concentration of all gases. The direction of the reaction will favour the side that has fewer particles, which is also the forward reaction.
Therefore there will be an increase in the yield.*
c Waste gas B can be recycled in stage 2. *
Also the gases could be compressed and collected or
Reacted to make it inert (any suitable answer can be accepted). *
d Generate its own electricity. or
Heat exchange for incoming gases in step 1. (any suitable answer can be accepted). *
[1 + 2 + 1 + 1 = 5]

5. a Heat of combustion ΔH_c is defined as the energy **released** when 1 mole of the fuel is burnt under standard conditions (combustion reactions always release heat) *
whereas ΔH refers to the **change** in enthalpy (which is directional) as the enthalpy of the products is less than that of the reactants so ΔH is negative. *
b $C_7H_{16}(l) + 11O_2(g) \rightarrow 7CO_2(g) + 8H_2O(l)$ *
c $M(C_7H_{16})$ = 100.0 g mol^{-1}
$\Delta H_c = 8.50 \times 5.71$ kJ *
$\therefore \Delta H_c = (8.50 \times 5.71 \times 100.0) \div 1.00 =$ **4.85 × 10^3 kJ mol^{-1}** * (must be positive)
(1 mark only if answer is 48.5 kJ/g) [2 + 1 + 2 = 5]

6. a finely divided solid ⇒ larger surface area ⇒ greater rate of reaction ⇒ less chance of heat loss ⇒ more accurate ΔT and ΔH. *
Also, larger surface area ⇒ reaction is more likely to be complete ⇒ more accurate ΔT and ΔH.
(Not all this detail is needed.)
b i. $n(C_8H_{18}) = 1.00 \div 114.0$ mol *(8.77 × 10^{-3} mol)*
$\therefore$ for 1.00 g, $E(C_8H_{18}) = (1.09 \times 10^4 \times 1.00) \div (2 \times 114.0)$ * = **47.8 kJ** *
ii.: ΔT = 41.9 - 18.7 = 23.2 ^oC *
$\therefore$ total E = C.F. x ΔT
= 1.27 × 23.2 kJ *(29.5 kJ)* per 1.30 g *
$\therefore$ for 1.00 g, E(methofuel) = (1.27 × 23.2) ÷ 1.30 = **22.7 kJ** *
iii. petrol is more efficient, (*/2) 47.8 kJ/g for petrol compared to 22.7 kJ/g for methofuel. (*/2)
iv. cellulose sources include wood, grass, cane, bamboo, etc. - and plants are a renewable resource (*/2) while petrol is not. (*/2)
(anything sensible) [1 + (2 + 3 + 1 + 1) = **9**]

7. a standard zinc half cell: - contains1.0 M $Zn^{2+}(aq)$ solution and a pure zinc metal electrode at 298 K. *
(Note that there aren't any gases involved in a standard zinc half cell so 101.3 kPa pressure isn't relevant - read the question carefully!) – ½ if pressure included).
b $2BrO_3^-(aq) + 12H^+(aq) + 10e^- \rightarrow Br_2(l) + 6H_2O(l)$ *
- this half cell reaction is straightforward since the overall equation gives you $5Zn(s) \rightarrow 5Zn^{2+}(aq) + 10e^-$ rather easily.
c cathode is positive *
d i. salt bridge: any unreactive electrolyte, **solution such as $NaNO_3(aq)$, $KNO_3(aq)$, etc. ***
(Note that HCl(aq) would react with Zn and $NH_4NO_3(aq)$ would produce NH_3 molecules which would remove Zn^{2+} ions as $Zn(NH_3)_4^{2+}$, so they would be unsuitable.)
ii. bromate electrode: any unreactive electrode such as C(s), Pt(s), solid stainless steel, solid low temperature conductive ceramic, etc.* [1 + 1 + 1 + (1 + 1) = 5]

8. a $Cu^{2+}(aq) + 2e \rightarrow Cu(s)$ *

b $Cu(s) \rightarrow Cu^{2+}(aq) + 2e$ *

c copper electrode *

d The leaf is coated with the metallic paint so that it can acts as a conductor (cathode)* and allows Cu (s) to form on the surface of the leaf.* Ag is used in preference to a more reactive metal such as Zn which would displace Cu from solution.

e No change * as the n(Cu^{2+}) formed at the anode equals n(Cu^{2+}) converted to Cu at the cathode.* (Impurities in the anode would effect the amount of Cu^{2+} formed provided the impurities were stronger reductants than Cu. Possibly some H^+ from H_2SO_4 could produce some $H_2(g)$ at the cathode making Cu^{2+} more [ ] in solution.) – Allow for a sensible idea.

[1 + 1 + 1 + 2 + 2 = 7]

9. a $H_2(g) \rightarrow 2H^+(aq) + 2e$

b Continuous supply of reactants and removal of products
Gaseous reactants
Electrodes act as a gas, liquid and solid interface for ion/electron exchange
Electrodes also function as a catalyst
(Any 2 sensible but correct answers. ½ mark per correct answer up to 1 mark)

c high cost
poisoning of electrodes/catalyst can easily occur
Slow reaction rate at the electrodes
Low PD produced, on 1.23 V / cell.
(Any 2 sensible but correct answers. 1 mark each)

d No greenhouse gases released
Higher energy output/gram of fuel.
(Any sensible but correct answer. 1 mark)

[1 + 1 + 1 + (1 + 1) = 5]

END of ANSWERS