Name of the Student:_____
Max. Marks : 23 Marks **Time : 23 Minutes**

Mark Schemes

Q1.

(a) (i) $(K_p) = (p_z)^2/(p_x)(p_y)^3$
(penalise use of square brackets, allow ())
1

(ii) **X** (22–6)/4 = 4 (MPa)
(mark is for value 4 only, ignore units)
1

Y obtained by multiplying value for **X** by 3
*(allow conseq on wrong value for **X**)*
1

Y 4.0 × 3 = 12 (MPa)
(mark is for value 12 only)
1

(iii) $K_p = 6.0^2/4.0 \times 12.0^3 = 5.21 \times 10^{-3}$
*(allow conseq on wrong values for **X** and **Y** e.g.$6^2/3 \times 9^3 = 0.165$)*

(if K_p wrong in (a)(i) CE)
1

MPa^{-2}
(allow any unit of P^{-2} provided ties to P used for K_p value)
1

(b) high pressure expensive (due to energy or plant costs)
1

(Rate is) slow (at lower temperatures)
1

[8]

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Q2.

D

[1]

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Q3.

(a) *(must state correct effect on yield or rate to score the reason mark)*

T effect: higher temp: yield greater or shifts equilibrium to right;

1

effect: higher temp: rate increased;

1

reason: endothermic

OR

more particles have $E>E_a$

1

OR

more successful/productive collisions;

1

P effect: higher pressure: yield less or shifts equilibrium to left;

1

effect: higher pressure: rate increased;

reason: increase in gas moles L to R

OR

greater collision frequency;

(Q of L mark)

1

(b) M1 equilibrium moles of CO = 62.8 - 26.2 = 36.6

1

M2 equilibrium moles of H_2 = 146 – 2(26.2) = 93.6

1

M3 total no moles = 36.6 + 93.3 + 26.2 = 156.4

1

M4 partial pressure = mole fraction x total pressure

1

M5 $$K_p = \frac{PCH_3OH}{PCO \times P^2H_2}$$

1

M6 $$= \frac{\left(\frac{26.2}{156.4} \times 9.50\right)}{\left(\frac{36.6}{156.4} \times 9.50\right) \times \left(\frac{93.6}{156.4} \times 9.50\right)^2}$$

$$\frac{(0.168 \times 9.5)}{(0.234 \times 9.50) \times (0.598 \times 9.5)^2}$$

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$$\frac{(1.59)}{(2.22)\times(5.60)^2}$$

1

M7 0.022(1) $2.2(l)\times10^{-8}$ $2.2(l)\times10^{-14}$

1

M8 MPa^{-2} kPa^{-2} Pa^{-2}

1

If no subtraction lose M1, M2 and M3)
(If ×2 missed in M2, lose both M2 and M3)
(If M1 gained but moles of H_2 = 73.2 (i.e. double CO), M2 and M3 lost)
(If M1 gained but mol H_2 = 2(146 – 26.2), M2 and M3 lost)
(If M1 and M2 correct but M3 lost for CE, penalise M6 also)
(M4 can be gained from the numbers in the expression for M6 even if these numbers are wrong)
(If K_p contains [ ] lose M5 but then mark on)
(If chemically wrong expression for K_p, lose M5, M6 and M7 (allow M8 conseq on their K_p))
(If divided by 9.5, or not used 9.5 at all, lose M6 and M7 (and M4))
(If tried to convert to kPa and is factor(s) of 10 out, penalise in M6 and allow M8 for kPa^{-2})

[14]

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