Equilibria Practice Test
Mark Scheme

Mr Cole Chemistry

Name .... Class: ....

Start Time .... End Time .... Time Taken ....

Time allowed: 48 minutes

INSTRUCTIONS TO CANDIDATES

- This document is designed to be used as a practice test.
- Complete the test under exam conditions in one sitting.
- Optional: before marking it, go through the paper with a set of notes and improve your answers.
- Mark the test using the mark scheme make corrections on the paper.
- Complete the table on the front page.
- Improve your notes so that they better reflect your weaknesses.

Make a note of your strengths and weaknesses for future revision.

Success Criteria	Questions in paper	Mark	Out of	%	Rank Order
Le Chatelier's Principle	1a, 2a, 2b, 2c, 4		13		
Calculating Kc	3a, 3b		7		
Calculating from Kc	2d, 3c		8		
Calculating Kp	1b, 5, 6		10		
Interleaving: energetics	2e		2		
Applying K_c and K_p to explanations	3d, 7		4		
Total			44		

Mark schemes

Q1.

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

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

$$\frac{(1.59)}{(2.22) \times (5.69)^2}$$

1

M7 0.022(1) 2.2(l)$\times 10^{-8}$ 2.2(l)$\times 10^{-14}$

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]

Q2.

(a) Lower yield at higher temperature

Allow converse arguments

Higher yield at lower temperature

1

So, equilibrium has shifted backwards/left/in the endothermic direction to oppose the increase in temperature

So, equilibrium has shifted forwards/right/in the exothermic direction to oppose the decrease in temperature

1

Ignore reference to pressure

(b) Increase

1

Lower yield at higher pressure

Higher yield at lower pressure

1

So, equilibrium has shifted backwards/to the side with fewest number of moles to oppose the increase in pressure

So, equilibrium has shifted forwards/to the side with highest number of moles to oppose the decrease in pressure

1

Ignore reference to temperature

(c) Increases the rate of forwards and reverse reactions equally

1

(d) $K_c = \dfrac{[NH_3]^2}{[H_2]^3[N_2]}$

M1: K_c expression

1

$0.118 = \dfrac{[NH_3]^2}{\left[{}^{0.0285}/_{0.150}\right]^3\left[{}^{0.0870}/_{0.150}\right]}$

M2: converts moles to concentration; divides mole quantities by 0.150

1

$0.118 = \dfrac{[NH_3]^2}{[0.190]^3[0.580]}$

$[NH_3]^2 = 4.69 \times 10^{-4}$

M3: calculation of $[NH_3]^2$

1

$[NH_3] = 0.0217$ mol dm^{-3}

M4 = √M3

1

$n(NH_3) = 0.0217 \times 0.150 = 3.25 \times 10^{-3}$ mol

M5 = M4 × 0.150 (allow ecf on an incorrect volume used in M2)

If K_c upside down then can still score 4)

1

(e) $K_c = \dfrac{1}{0.118} = 8.47$

Allow 8.45 − 8.5

1

Units – mol^2 dm^{-6}

1

[13]

Q3.

(a) Initial amount of A = 6.4×10^{-3}

If M1 wrong can score max 3

M1

Equ A = $6.4 \times 10^{-3} - 2x \therefore x = 1.25 \times 10^{-3}$

If incorrect x can score max 3

M2

B = $9.5 \times 10^{-3} - x = 8.25 \times 10^{-3}$

Allow 2 or more sig figs

M3

C = $2.8 \times 10^{-2} + 3x = 0.0318$

M4

D = $x = 1.25 \times 10^{-3}$

M5

(b) $K_c = \dfrac{[C]^3[D]}{[A]^2[B]}$

Penalise ( ) but mark on in (b) & (c)

1

Units = mol dm^{-3}

If K_c wrong no mark for units

1

(c) M1 for correct rearrangement $[A]^2 = \dfrac{[C]^3[D]}{K_c\,[B]}$ or $[A] = \sqrt{\dfrac{[C]^3[D]}{K_c\,[B]}}$

If K_c wrong in (b) can score 1 for dividing by correct volume

M1

M2 for division of mol of B, C and D by correct volume

If K_c correct but incorrect rearrangement can score
1 for dividing by correct volume

M2

$$[A]^2 = \frac{[{}^{1.05}/_{0.5}]^3[{}^{0.076}/_{0.5}]}{116 \times [{}^{0.21}/_{0.5}]}$$

M3 for final answer: [A] = <u>0.17</u> (must be 2 sfs)

M3

(d) (All) conc fall: (ignore dilution)

OR K_c = mole ratio × 1/V

1

Equm moves to side with more moles

If vol increases, mole ratio must increase

1

To oppose the decrease in conc

To keep K_c constant
If only conc of A falls CE=0
If pressure falls CE=0

1

[13]

Q4.

D

[1]

Q5.

B

[1]

Q6.

D

[1]

Q7.

D

[1]