1 Memorandum: Chemical Equilibrium

1.1	D (If this was an irreversible (single arrow) reaction the answer would have been C (1 mol CH_3OH) because H_2 is the limiting agent and 2 mol H_2 produces 1 mol CH_3OH. This is a REVERSIBLE reaction in a sealed container. As soon as CH_3OH is produced, CH_3OH molecules will start to do the reverse reaction. There will always be less than 1 mol CH_3OH.)
1.2	$K_c = \frac{[NO]^4}{[NH_3]^4[O_2]^5}$ $K_c = [CO_2]$
1.3	$K_c = \frac{[PCl_3][Cl_2]}{[PCl_5]} = \frac{(0{,}15)(0{,}37)}{(0{,}10)} = 0{,}56$
1.4	$c = \frac{m}{M \times V} = \frac{5{,}6}{28 \times 3} = 0{,}0667$ mol CO $K_c = \frac{[CO_2]}{[CO]}$ $2{,}78 = \frac{[CO_2]}{(0{,}0667)}$ $[CO_2] = 0{,}19$ mol.dm^{-3}
1.5	(see table below)
1.6	(see below)

1.5

	3 A(g) ⇌	5B(g) +	2C(g)
$n_{initial}$	3,70	0	0
n_{react}	(-)1,44	(+)2,40	0,96
$n_{equilibrium}$	2,26	2,40	0.96
$c = \frac{n}{V}$ (mol.dm^{-3})	0,57	0,60	0,24

$$3{,}70 \times \frac{38{,}8}{100} = 1{,}44$$

$$K_c = \frac{[B]^5[C]^2}{[A]^3} = \frac{(0{,}60)^5(0{,}24)^2}{(0{,}57)^3} = 2{,}42 \times 10^{-2} \quad (0{,}024)$$

1.6

$$n = \frac{m}{M} = \frac{48}{160} = 0{,}3 \text{ mol } Br_2$$

$$n = \frac{m}{M} = \frac{21{,}3}{71} = 0{,}3 \text{ mol } Cl_2$$

	Br_2(g) +	Cl_2(g) ⇌	2BrCl(g)
$n_{initial}$	0,3	0,3	0
n_{react}	(-)x	(-)x	(+)2x
$n_{equilibrium}$	0,3 -x	0,3-x	2x
$c = \frac{n}{V}$ (mol.dm^{-3})	$\frac{0{,}3-x}{2}$	$\frac{0{,}3-x}{2}$	x

$$K_c = \frac{[BrCl]^2}{[Br_2][Cl_2]}$$

$$7 = \frac{x^2}{(\frac{0{,}3-x}{2})^2}$$

$$2{,}64 = \frac{x}{(\frac{0{,}3-x}{2})}$$

$$1{,}32(0{,}3-x) = x$$

$$x = 0{,}17$$

$$[BrCl] = 0{,}17 \text{ mol·dm}^{-3}$$

2.1	C Base lowers the $[H^+]$.
2.2	a. Decreases b. Increases c. Stays constant (Solid has no effect on equilibrium) c. Stays constant
2.3	a. More blue b. More green c. More blue ($AgNO_3$ lowers the $[Cl^-]$) d. No change (Water is a pure solvent and has no effect on equilibrium) e. More green
2.4	a. Decreases b. Decreases c. No change d. Increases

3.1	N_2(g) + 3 H_2(g) ⟶ 2NH_3(g) Must be a SINGLE ARROW.
3.2	From t = 0 s to t = 60 s more N_2 and H_2 are produced. The $[N_2]$ and $[H_2]$ increases and therefore the rate of the reverse reaction increases.
3.3	a. Volume is decreased. Therefore both the concentrations and pressure increase As a result the rates of the reactions INCREASE as shown on the graph. b. The concentrations of the REACTANTS AND PRODUCTS increase, therefore the rates of both FORWARD AND REVERSE reactions increases. c. REVERSE (Reverse above forward rate in graph, therefore higher rate than forward) d. The volume is decreased and the equilibrium is disturbed by the increase in pressure. According to Le Chatelier's principle the system reacts to decrease the pressure by making less moles of gas. Therefore the reverse reaction is favoured. e. The K_c stays the same. (No change in temperature)
3.4	a. Decreased. The rates of the reactions decreased as shown by the graph. b. Exothermic. The equilibrium is disturbed by an decrease in temperature According to Le Chatelier's principle the system reacts to raise the temperature. It favours the exothermic reaction that emits energy. The graph shows that the forward reaction is favoured. Therefore the forward reaction must be exothermic. c. The K_c value increases. The forward reaction is favoured. It produces more product and less reactants and K_c increases.
3.5	Catalyst was added.
3.6	No change. Both forward and reverse reaction have the SAME INCREASE IN RATE.