Kirkcaldy High School

Chemistry

Advanced Higher

Unit 2 – Physical Chemistry

TUTORIAL ANSWERS

(a) Chemical Equilibrium

1. 50.
2. 160.
3. 9.6
4. 8
5. 0.5
6. 0.00096
7. 9
8. 0.73
9. 0.00852
10. 0.027478
11.

(a)

(i) 50 %

(ii) Unwanted side-reactions

(b) This would not work. A catalyst cannot change an equilibrium constant.

(c) This would work as the equilibrium would shift to the products to re-establish equilibrium but the equilibrium constant would not change.

12.

(a) Line 1: Reaction A or C – fewer numbers of moles in the products than reactants.
Line 2: Reaction D or E – no change in the number of moles of gas on either side of the reaction
Line 3: Reaction B – greater number of moles in the products than reactants.

(b) No effect.

13.

(a) $K = \frac{[NO_2]^2}{[NO]^2[O_2]}$

(b) The position of equilibrium lies to the products.

(c) K will increase as the position of equilibrium shifts towards the products.

(d) 0.015 mol l^{-1}

14.

(a)

(i) 1×10^{-5} mol l^{-1}

(ii) 0.00233 gl^{-1}

(b) It will not change

(c) It will decrease.

15. 0.79

16.

(a) ethoxyethane layer = 0.0223 mol l^{-1}

Aqueous layer = 0.0148 mol l^{-1}

(b) 0.066

17.

(a) aqueous layer = 0.062 mol l^{-1}

Cyclohexane layer= 0.093 mol l^{-1}

(b) 1.5

18.

(a) 0.568 mol l^{-1}

(b) 34.05 g

19. 1 x 100 cm^3 extraction, 8.88 g extracted

2 x 50 cm^3 extractions, 9.6 g extracted

20.

(a) 1 x 200 cm^3 extraction, 3.75 g extracted

(b) 2 x 100 cm^3 extractions, 4.2 g extracted

21. 0.70

22. -8.8

23. 4.4

24. 0.44

25. 0.40

26. 0.027 mol l^{-1}

27. 1.35×10^{-5} mol l^{-1}
28. 1.58×10^{-10} mol l^{-1}
29. 1.07×10^{-13} mol l^{-1}
30. 1.42 mol l^{-1}
31.

    (a) 5×10^{-13} moll^{-1}
    (b) 0.01995 mol l^{-1}

32.

    (a) 0.035
    (b) 1.46

33.

    (a) 1.57×10^{-14} mol l^{-1}
    (b) 13.8

34.

    (a) 1.79 mol l^{-1}
    (b) 5.58×10^{-15}

35.

    (a) 3.31×10^{-4}
    (b) 3.02×10^{-11}

36. 0.001342 mol l^{-1}
37. 0.2 mol l^{-1}
38. 7.4×10^{-4} mol l^{-1}
39. 0.498 mol l^{-1}.
40. 1.47×10^{-5} mol l^{-1}
41. 2.88
42. 2.22
43. 1.74
44. 2.51
45. 2.72
46. 0.0513
47. 0.0871
48. 0.0537

49. 0.00257
50. 0.00631
51. 3.7
52. 1.9
53. 4.1
54. 3.04
55. 4.84
56. 5.16
57. 4.43
58. 4.8
59. 4.87
60. 4.15
61. 4.46
62. 3.87
63. 3.6
64. 5.17
65. 4.46
66. $\frac{[\text{acid}]}{[\text{salt}]} = 2.14$
67. $\frac{[\text{acid}]}{[\text{salt}]} = 0.4$
68. $\frac{[\text{acid}]}{[\text{salt}]} = 0.28$
69. $\frac{[\text{acid}]}{[\text{salt}]} = 3.55$
70. $\frac{[\text{acid}]}{[\text{salt}]} = 2.29$

(b) Reaction Feasibility

1.

(a)

(i) $-367\ JK^{-1}mol^{-1}$

(ii) $-208.4\ JK^{-1}mol^{-1}$

(c) 567 K

2.

(a) The formation of the strong covalent bonds in Al_2O_3 releases a lot of energy compared to that required to break the interactions in the elements. This leads to a large and negative **Δ**H and **Δ**G.

(b) "ammonium chloride dissolves spontaneously in water" as **Δ**G<0. "Drop in temperature" and **Δ**H>0.

(c) $10\ JK^{-1}mol^{-1}$

3.

(a) $413\ JK^{-1}mol^{-1}$

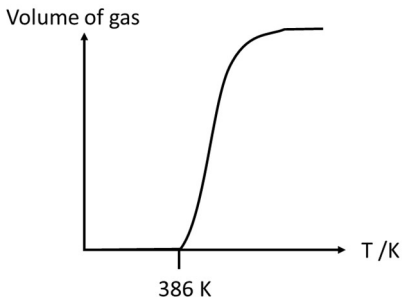
(b) 550 K

(c) When 2,3-dimethylhexane is produced (reaction A) it will be converted into 1,2-dimethylcyclohexane (reaction B) thus promoting reaction A towards producing more 2,3dimethylhexane. This will continue until all the octane is used up.

4.

(a) $334.2\ JK^{-1}mol^{-1}$

(b) 386 K



5.

(a) Use the information in the table to calculate the free energy change in the following reactions

(i) -774 $kJmol^{-1}$

(ii) -134 $kJmol^{-1}$

(b) Yes, as they are both below zero.

6.

(a) 47 $kJmol^{-1}$

(b) No.

7. 400 K
8. 332 K
9. D
10. C
11. B
12. B
13.

(a) 5438 K

(b) It would spontaneously decompose to oxygen and hydrogen

14.

(a) -70.5 $kJmol^{-1}$

(b) -56 $JK^{-1}mol^{-1}$

(c) 1259 K

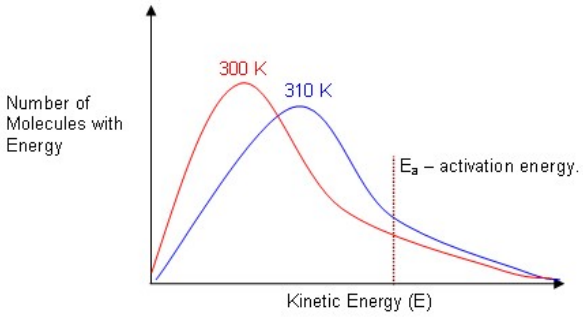
(c) Kinetics

1. A
2. B
3. D
4. B
5. D
6. B
7.

(a) rate = k $[H_2][I_2]$

(b) 0.016075 mol $l^{-1}s^{-1}$

(c)



At the higher temperature there are more molecules with energy above the activation energy.

8.

(a) rate = k$[H_2O_2][I^-]$

(b) 0.022 $lmol^{-1}s^{-1}$

9.

(a)

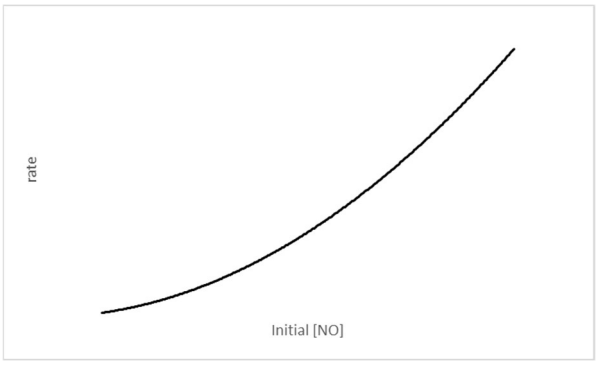
(i) 1

(ii) 2

(b) rate = $k[H_2][NO]^2$

(c) 2 667 $l^2mol^{-2}s^{-1}$

(d)



10.

(a) $O{=}O^{+}{-}O^{-} \longleftrightarrow O^{-}{-}O^{+}{=}O$

(b)

(i) $O_3(g) + O(g) \rightarrow 2O_2(g)$

(ii) Catalyst

(c)

(i) 2

(ii) 5.97×10^9 $lmol^{-1}s^{-1}$

11.

(a) $CO(g) + NO_3(g) \rightarrow NO(g) + CO_2(g)$

(b) x = 4, y = 4

(c)