**Memo – Rates and Equilibrium**

**QUESTION 1**

1.1 Two✓ tablets , one tablet is half

 the mass of all the contents of a

 powder. ✓ (2)

1.2 By grinding the grand-pa into a powder:

* the surface area✓ that the liquid in stomach can collide with increases.
* This results in more successful collisions✓, therefore
* and a faster rate of reaction. ✓ (3)

1.3.1

* Set-up done correctly✓
* Set-up **labelled** ✓
* (The flask, reactants & apparatus labeled) (2)

Gas syringe

 stopper

 Zinc Flask

 HCl

(allowed to leave one label)



1.3.2 Dependent variable: **time** to

 complete the reaction ✓ (1)

 - Rate of reaction

 -Amount of gas released in …min

1.3.3

1. Use mass meter to weigh same mass of Zn granules & powder
2. Measure the same volume of HCl for each investigation.
3. Set up apparatus as in diagram using Zn granules.
4. Use the stopwatch and record the time it takes for all the H2 gas to be released.
5. Repeat with Zn powder.
6. Compare the time it took in both investigations for all the H2 to be released.

1.4

Volume of gas ✓✓ Zn powder

collected ✓✓ Zn granules

 time (4)

1.5

* Temperature of the Acid ✓
* Concentration of the Acid✓
* Atmospheric Pressure ✓ (3)
* Time (if specified time stated in which investigation was done)
* Mass of Zn
* Vol. of acid

1.6 No✓, it would increase the

 caffeine levels✓ in the person or

 could cause restlessness,

 excitement, muscle tremor. ✓ (2)

**QUESTION 2**

2.1.1 Iron oxide acts as a catalyst✓and speeds up the reaction✓

 (2)

 2.1.2 Technology in those days were not developed to build containers that could withstand such high pressures✓ /discovery of catalyst and conditions of temp. ✓ & pressure✓

 (3)

2.2.1 Insert the scale on each axis.✓✓(2)

2.2.2 Label the lines on the graph

 representing the amount of N2✓

 and the amount of H2✓ (2)

 relative to mol ratio!

* + 1. Plot amount of product (NH3) versus time (s) on the same axes. ✓✓✓ ✓ (4)

2.3.1 time✓ (1)

2.3.2 60 s✓after 60 s the [ ] of reactants and products remain constant. ✓ (2)

 2.3.3 Yes✓it is a dynamic equilibrium, which means it appears that the reaction has stopped but microscopically ✓the reactants are still combining to form products and the product is decomposing to form reactants✓ (3)

2.3.4 At t = 10s there is still a high

 concentration✓ of reactants thus

 rate of forward reaction fast.

 At t = 50s the rate slows down

 as concentration of product more

 than reactants and reaction

 nearing equilibrium. ✓ (2)

2.3.5

N2(g) ✓ + 3H2(g) ✓  2NH3(g) ✓ ✓balancing (3)

2.3.6 Kc = [NH3]2

 [N2] [H2]3 ✓

 = 0,3 2

 \_\_\_\_2\_\_\_\_\_✓dividing by 2

 = 0,2 0,25 3 ✓substitution

 2 2

 =115,2✓ (4)

2.4 on graph (-1 if **relative** changes not shown on graph)

 N2 : H2 : NH3

 X ; 3x ; 2x

 (from balanced equation)

 N2 x = 3 squares up (1 square)

 H2 3x = 9 squares up (3 squares)

 NH3 2x = 6 squares down (2 squares

 (3)

 **[31]**

**Question 3**

3.1 H2 √ (1)

3.2

 

 appropriate heading- 1 mark

 appropriate scale: 1 mark

 label of axids : 1 mark

 plotting of points- 1 mark

 smooth curve- 1 mark (5)

3.3 2.2 s √ (2.1- 2.3 s) (1)

3.4 Rate goes down progressively with time.√ At the start of the reaction the number of H+ ions is at a maximum. √ As the ions react with the metal the number of fruitful collisions decreases. √ (3)

3.5 So the reaction goes to completion.√ (1)

3.6.1 Curve A on graph.

 Flattened out at same volume- 1 mark

 Flattens out after a longer time- 1 mark (2)

3.6.2 Less surface area and chance of effective collisions reduces.√ Same final volume of gas when reaction is complete because excess of metal is used with same volume and concentration of acid.√ (2)

3.7.1 Curve B on graph

 Flattened out at same volume- 1 mark

 Flattens out after a shorter time steep curve- 1 mark. (2)

3.7.2 At high temperature many more ions have the activation energy to react therefore more effective collisions√ in a given unit of time, so the reaction is faster√. Same final volume because as excess metal is used with the same volume and concentration of acid.√ (3)

3.8 For an equal volume of HCl there are fewer H2 ions√ therefore fewer effective collisions between the ions and the metal.√ (2)

 **22 marks**

**Question 4**

4.1.1 $K\_{c}= \frac{[CO\_{2}]^{16}[H\_{2}O]^{18}}{[C\_{8}H\_{18}]^{2}[O\_{2}]^{25}}$ 1 mark – products over reactants; 1 mark- correct exponents (2)

4.1.2 It is the number that shows us to what extent the reactants have changed into products√ by the time the equilibrium position is reached.√ or ratio of product√ over reactants√ at equilibrium. (2)

4.2.1 ΔH is –ve.√ This tells us that as temperature increased√ the equilibrium shifted to the left favouring the endothermic reaction.√ Hence the forward reaction is exothermic. (3)

4.2.2 Yes.√ The production of NO(g) is bad for the atmosphere as it combines with O2 to form brown NO2 gas. Since the catalytic converter has a reduction catalyst√ to decompose NO into N2 and O2√, less NO2 is formed. √ (4)

4.3.1 Reaction lies to the left√√ (2)

4.3.2 In a closed system, √ if the equilibrium is disturbed, the equilibrium position will change in order to oppose√ the disturbing influence and re-establish equilibrium.√ (3)

4.3.3 Since the forward reaction is endothermic,√ increasing temperature will drive the reaction to the right√ to oppose√ this increased temperature? More NO is produced.√ (4)

4.3.4 Since the reaction is endothermic using Le Chatelier’s principle, reducing temperature will drive the reaction in reverse√ to increase temperature, thus causing more N2 and O2 to be produced√. This will aid the catalytic converter, and a reduced amount of NO will be produced.√ (3)

 **23 Marks**

5.1 It is easier to form products from reactants because the activation energy is much less, than the energy required to form reactants from products. (2)

5.2 CO is poisonous √ (1)

5.3.1 Part of the action of catalytic converters is to speed up√ the complete oxidation of petrol (C8H18) and carbon monoxide (CO) from incorrectly tuned engines without being used up themselves. √ (2)

5.3.2 It ensures that converting products to CO2 √minimises the danger of CO poisoning. √ (2) [7]

**Question 6**

6.1 Any statement that refers to the relationship between the dependent

and independent variables. (2)

|  |  |
| --- | --- |
| Checklist  | Marks  |
| Criteria for hypothesis |  |
| Statement that can be proved true or false (not an aim)  | √ |
| Statement refers to relationship between dependent and independent variables | √ |

Examples

A larger mass of metal will produce more gas.

OR

A larger mass of metal will produce less gas. (2)

6.2



Appropriate heading √ Independent variable on X-axis √ X-axis correctly labelled with unit √ Y-axis correctly labelled with unit √points correctly plotted with best fit line drawn √√ (6)

6.3 The initial steep gradient indicates a rapid reaction rate initially√, until about 0,8g of metal had been added at which time the reaction rate decreased√ and levelled off to 380 cm3, √ indicating no further gas production as the acid had been used up and the reaction had stopped√. (4)

6.4 Temperature. √ Same concentration of acid√ - (Not state of division (2)

6.5 160 - 170 cm3 √ √ (2) [16]

|  |  |  |
| --- | --- | --- |
| 7.1 | 10% |  |
| 7.2 | Haber process | Accept Haber-Bosch |
| 7.3 | exothermic |  |
| 7.4.1 | Scales per axis350o Points500o pointsBest fit for 350Best fit for 500 | 1 each |
| 7.4.2 | 350oC 70 atm | Both correct ca applies |
| 7.4.3 | Smooth curve between the other 2 graphs | Do not award if points have been drawn, ca applies |

|  |  |  |  |
| --- | --- | --- | --- |
| 8.1 | Reversible (NOT equilibrium) | Accept “may be in equm” | 1 |
| 8.2 | Particles must collideWith sufficient energyCorrect orientation | Any 2 | 11 |
| 8.3 | Add a catalystIncrease tempIncrease pressureIncrease concentration | Do not accept increase surface area or wtteMark 1st 4 | 1111 |
| 8.4 | Reaction has reached equilibrium |  | 1 |
| 8.5 | Increase in temp favours forward reaction/endoSo A is used up |  | 11 |
| 8.6 | [A] will increaseInc. P favours side with least moles of gasSo reverse will be favoured |  | 111 |
| 8.7.1 | Kc = [B][C] [A] | [p]/[r] for 1 mark All correct for 2 marks | 2 |
| 8.7.2 | 12 =  so 12 =  so x = 0,25dm3 | Apply CA from 8.7.1Award 2 for correct substitution, 1 for answerSubtract 1 for incorrect unit | 21 |
|  |  |  | 18 |

9.1 By grinding the calcium carbonate , the surface area that the acid particle can collide with, increases. This results in more collisions, therefore more successful collisions and a faster rate of reaction. (4)

9.2

**a) LABELLED DIAGRAM of experimental set-up:** (4)

* Container (beaker/flask/etc.) with solids and acids
* The beaker and reactants labelled
* A measuring device (scale/syringe/collection over water)
* Stopwatch

**b) Variables that Susan are dealing with:** (2)

 **Independent variable(s):** surface area (size of particles)

 **Dependent variable(s):** time to complete the reaction/volume of gas collected over time/mass of the reactants and products over time,

**BUT NOT ‘time’**

9.3 Volume of gas collected

 (4)

Mass loss

* 1. Temperature of the Acid (just ‘Temperature’ one mark)

Concentration of the Acid

The nature of the reactants (using calcium carbonate and hydrochloric acid in every test)

If ‘Pressure’, then -1 mark (4)

**[18]**

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10.1.1 Title

 Axes labelled

 Key

 Data of bleach plotted correctly (-1 for every point not correct)

Data of diluted bleach plotted correctly (-1 for every point incorrect) (7)



10.1.2 The higher the concentration of the bleach, the faster the rate at which the dye concentration changes (1)

10.2.1 The Δ C over time, rate at which reactant used / produce formed (2)

10.2.2.1

 (2)

Rate of reaction = (2,50 – 0,40)/2

 = 1,05 mol/dm3/min

 10.2.2.2

Rate of reaction = (2,50 – 0,70)/2

 = 0,70 mol/dm3/min (1)

10.3 The concentration of the bleach and that of the dye are decreasing; less particles to collide, so less efficient collisions and therefore rate of reaction decreases. (3)

**[16]**

* 1. Zn + 2HCl 🡪 ZnCl2 + H2 ✓ for products ✓ for balancing (2)
	2. Increase surface area of solid (Zn)✓; increase concentration of acid solution✓; use a catalyst✓ (2 max if not specific as to what surface

 area/concentration to be increased; mark in order & no mark for increase in pressure) (3)

* 1. Temperature increase increases the average kinetic energy of the molecules✓; so more frequent collisions occur✓; and molecules have more energy to overcome the activation energy✓ (greater % of successful collisions) (3)

 **[8]**

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 12.1 B (3)

12.2 A system where (a reversible reaction in a closed system)✓ has the equal rates✓

for the forward and reverse reactions. (2)

12.3.1  (2)

12.3.2 There are more products than reactants. (2)

 12.4 What would happen to the concentration of the CO if

* + 1. increase✓
		2. increase✓
		3. no change✓
		4. increase ✓
		5. no change. ✓ (5)

12.5 Only changing temperature (7.4.1) would affect the value of the Kc?✓ (2)

 **( if T + another , only 1 mark)**

 **[16]**