

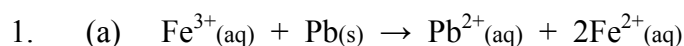
TEE CHEMISTRY

SOLUTUONS

Part 1

- | | | | | | |
|------|-------|-------|-------|-------|-------|
| 1. a | 6. b | 11. b | 16. d | 21. c | 26. b |
| 2. b | 7. a | 12. a | 17. c | 22. c | 27. a |
| 3. c | 8. b | 13. c | 18. c | 23. b | 28. c |
| 4. b | 9. a | 14. c | 19. d | 24. d | 29. a |
| 5. d | 10. d | 15. d | 20. b | 25. a | 30. d |

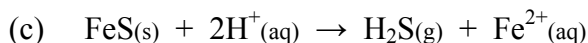
Part 2



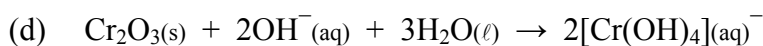
Metal dissolves and the yellow/brown colour slowly fades (no ppt on metal and pale green colour of Fe^{2+} is unlikely to be observed).



White ppt formed. (Most likely solution will turn milky indicating a small amount of ppt).



Solid dissolves, bubbles of colourless foul smelling gas produced.
Smell is of rotten eggs.

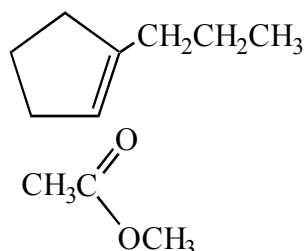


Green solid dissolves to form a deep green solution.

2. (a) Vinegar solution contains more H^+ (and H_3O^+) than water. As the $[\text{H}^+]$ and $[\text{H}_3\text{O}^+]$ increases, $[\text{HCO}_3^-]$ and $[\text{CO}_2(\text{aq})]$ increases. This causes more $\text{CO}_2(\text{g})$ to be produced. This means that less CO_2 needs to be dissolved for the solution to become saturated.

- (b) Add a base. This will reduce $[\text{H}^+]$ and $[\text{H}_3\text{O}^+]$ and so reduce $[\text{CO}_2(\text{aq})]$ allowing more $\text{CO}_2(\text{g})$ to dissolve before the solution becomes saturated.
* Reduce temperature.

3. 1,1,2-trichloroethene
4-chloro-2,2-dimethylpentane



4.

Describe test	Observation for sodium sulfate	Observation for sodium sulfite
Add an acid eg. HCl	No observable reaction	May observe bubbles of colourless gas. Detect an acrid smell

Sulfuric acid solution and Hydrochloric acid solution

Describe test	Observation for sulfuric acid solution	Observation for Hydrochloric acid solution
Add a solution containing Ba ²⁺ [could also add solution containing Ca ²⁺ or Ag ⁺ but these must be concentrated to observe a ppt with SO ₄ ²⁻] OR Dil Sol ⁿ if Ag ⁺	White precipitate produced	Clear colourless solution.
	little or No ppt	Heavy white ppt.

5. Can be any 3 of: P³⁻, S²⁻, Cl⁻, Ar, K⁺, Ca²⁺ or Ga³⁺6. (a) Anode Ag → Ag⁺ + e⁻
Cathode Ag⁺ + e⁻ → Ag(b) Anode Ni → Ni²⁺ + 2e⁻
Cathode Ni²⁺ + 2e⁻ → Ni

7. (a) Aluminium, Al or Silicon, Si

(b) Oxygen, O₂(c) hydrogen sulfate, HSO₄⁻
hydrogen sulfite, HSO₃⁻
hydrogen sulfide, HS⁻(d) water, H₂O
ammonia, NH₃(e) sodium chloride, NaCl
hydrochloric Acid, HCl(f) hydrogen chloride, HCl
hydrogen bromide, HBr
hydrogen iodide, HI(g) 1 - propanol, CH₃CH₂CH₂OH2 - propanol, $\begin{array}{c} \text{OH} \\ | \\ \text{CH}_3\text{CHCH}_3 \end{array}$ propanoic acid, $\begin{array}{c} \text{O} \\ // \\ \text{CH}_3\text{CH}_2\text{C} \\ \backslash \\ \text{OH} \end{array}$

8. KOH is a strong base so $[\text{OH}^-] = 1 \times 10^{-5} \text{ mol L}^{-1}$ therefore $[\text{H}^+] = 1 \times 10^{-9}$
therefore $\text{pH} = 9$ $\text{KOH}_{(s)} \rightarrow \text{K}^+_{(aq)} + \text{OH}^-_{(aq)}$ - fully ionised

NH_3 is a weak base $\text{NH}_{3(aq)} + \text{H}_2\text{O}_{(l)} \rightleftharpoons \text{NH}_4^+_{(aq)} + \text{OH}^-$, low ionisation
therefore $[\text{OH}^-] = 1 \times 10^{-5} \text{ mol L}^{-1}$ even though $[\text{NH}_3] = 1 \text{ mol L}^{-1}$

$$\left[\text{Note \% ionisation of } \text{NH}_3 = \frac{10^{-5}}{1} \times 100 = 0.001\% \right]$$

9.

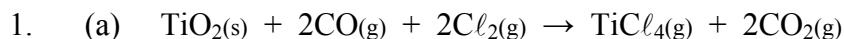
Species	Structural formula showing all valence electrons	Draw shape of molecule or ion
Tellurium (IV) oxide TeO_2		
Chloric acid HClO_3		
Germanate ion GeO_3^{2-}		



- (b) (i)
- Increase concentration of $\text{CO}(g)$
 - Operate at higher temperature (reaction is likely to be endothermic)
 - Remove $\text{CO}_2(g)$
- (ii)
- Equilibrium never allow to become established
 - Increasing $[\text{CO}]$ by increasing pressure will also increase $[\text{CO}_2]$ by the same amount therefore no effect
 - Increasing $[\text{CO}]$ by adding CO is not economically viable.
 - Higher temperature would require more energy, more expense in construction and more maintenance therefore not economical
- (c)
- Remove carbon
 - Add other metals eg. W, Mo, V, Ni, Cr etc.

11. hydrogen bonding
dispersion forces
dipole - dipole attraction

PART 3



(b) $n(\text{CO}) = \frac{PV}{RT} = \frac{105.0 \times 3.00 \times 10^3}{8.315 \times 1223} = 30.98 \text{ mol}$

$n(\text{TiO}_2)_{\text{pure}} = \frac{1}{2} n(\text{CO}) = \frac{1}{2} (30.98) = 15.45 \text{ mol}$

$m(\text{TiO}_2)_{\text{pure}} = nM = 15.45 \times 79.88 = 1237.17 \text{ g}$ [M(TiO₂) = 79.88 g mol⁻¹]

$m(\text{Rutile}) = \frac{100}{93} \times 1237.17 = 1300.29 \text{ g} = 1.33 \times 10^3 \text{ g} = 1.33 \text{ kg}$

2. (a) $n(\text{C}) = n(\text{CO}_2) = \frac{V_{\text{STP}}}{22.41} = \frac{0.6047}{22.41} = 0.0269 \text{ mol}$

$m(\text{C}) = nM = 0.02698 \times 12.01 = 0.32407 \text{ g}$

$\% \text{C} = \frac{0.32407}{1.376} \times 100 = 23.55\%$

$m(\text{H}) = \frac{2.016}{18.016} \times 0.4052 = 0.04534 \text{ g}$

$\% \text{H} = \frac{0.04534}{1.376} \times 100 = 3.2952\%$

$n(\text{OH}^-) = n(\text{KOH}) = cV = 0.1845 \times 0.0573 = 0.01028$ and
 $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$ and $\text{HBr} \rightarrow \text{H}^+ + \text{Br}^-$

$n(\text{Br}^-) = n(\text{H}^+) = n(\text{OH}^-) = 0.01028 \text{ mol}$

$m(\text{Br}) = nM = 0.01028 \times 79.90 = 0.821372 \text{ g}$

$\% \text{Br} = \frac{0.821272}{1.573} \times 100 = 52.22\%$

$\% \text{O} = 100 - (23.55 + 3.2952 + 52.23) = 20.935\%$

	C	H	O	Br
%	23.55	3.986	20.935	52.22
n in 100 g	$\frac{23.55}{23.01} = 1.9608$	$\frac{3.986}{1.008} = 3.269$	$\frac{20.935}{16.00} = 1.3084$	$\frac{52.22}{79.90} = 0.6536$
Simplest ratio	$\frac{1.9608}{0.6536} = 3.00$	$\frac{3.269}{0.6536} = 5.002$	$\frac{3.269}{0.6536} = 5.002$	$\frac{0.6536}{0.6536} = 1.00$
	3	5	2	1

Empirical formula is C₃H₅O₂Br

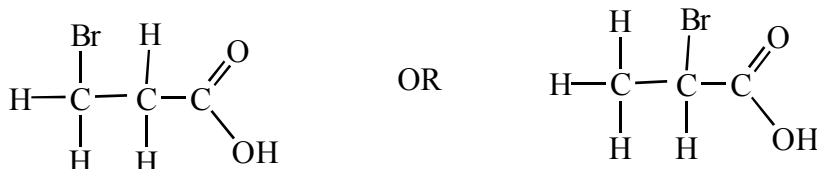
(b)

$$n(\text{Compd}) = \frac{PV}{RT} = \frac{55.0 \times 0.6347}{8.315 \times 523} = 8.027 \times 10^{-3} \text{ mol}$$

$$M = \frac{m}{n} = \frac{1.228}{8.027 \times 10^{-3}} = 152.978 \text{ g mol}^{-1}$$

$$M(\text{C}_3\text{H}_5\text{O}_2\text{Br}) = 152.970 \text{ g mol}^{-1}$$

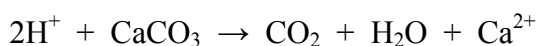
As the molecular mass is the same as the empirical formula mass then molecular formula is the same as the empirical formula ie $\text{C}_3\text{H}_5\text{O}_2\text{Br}$.



3. (a)

$$n(\text{CaCO}_3) = \frac{M}{M} = \frac{22.3}{100.09} = 0.2228 \text{ mol} \quad [M(\text{CaCO}_3) = 100.09 \text{ g mol}^{-1}]$$

$$n(\text{HNO}_3) = cV = 4.10 \times 98.0 \times 10^{-3} = 0.4018 \text{ mol}$$



$$n(\text{CaCO}_3)_{\text{to use all HNO}_3} = \frac{1}{2} n(\text{HNO}_3) = \frac{1}{2} (0.4018) = 0.2009 \text{ mol}$$

There is 0.2228 mol therefore CaCO_3 is in excess and HNO_3 is LR

$$n(\text{CO}_2)_{\text{produced}} = \frac{1}{2} n(\text{HNO}_3) = \frac{1}{2} (0.4018) = 0.2009 \text{ mol}$$

$$V(\text{CO}_2)_{\text{STP produced}} = n \times 22.41 = 0.2009 \times 22.41 = 4.502 \text{ L}$$

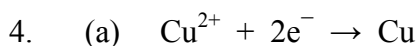
$$V(\text{CO}_2)_{\text{collected at STP}} = \frac{92.3}{100} \times 4.502 = 4.1551 = 4.16 \text{ L}$$

$$\begin{aligned} \text{(b)} \quad n(\text{CaCO}_3)_{\text{left}} &= n(\text{CaCO}_3)_{\text{initial}} - n(\text{CaCO}_3)_{\text{used}} \\ &= 0.2228 - 0.2009 \\ &= 0.0219 \text{ mol} \end{aligned}$$

$$\text{(d)} \quad n(\text{Rh}) = \frac{m}{M} = \frac{0.281}{102.9} = 2.7308 \times 10^{-3} \text{ mol}$$

$$n(e^-) = 3n(\text{Rh}) = 3(2.7308 \times 10^{-3}) = 8.1924 \times 10^{-3} \text{ mol}$$

$$t = \frac{n(e^-) \times 96490}{I} = \frac{8.1924 \times 10^{-3} \times 96490}{15.0 \times 10^{-3}} = 52699 \text{ s} = 878.3 \text{ minutes} = 14.6 \text{ h}$$



$$\begin{aligned} \text{(b)} \quad n(\text{Cu}) &= \frac{m}{M} = \frac{1.37}{63.55} = 0.02168 \text{ mol} \\ n(\text{e}^-) &= 2n(\text{Cu}) = 2(0.02156) = 0.04312 \text{ mol} \\ n(\text{e}^-) &= \frac{q}{96490} = \frac{It}{96490} \\ \therefore I &= \frac{n(\text{e}^-) \times 96490}{t} = \frac{0.04312 \times 96490}{2.55 \times 60 \times 60} \end{aligned}$$

$$\text{(c)} \quad n(\text{Rh}) = \frac{m}{M} = \frac{1.48}{102.8} = 0.01439 \text{ mol}$$



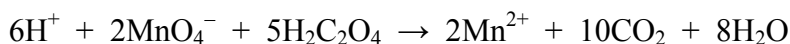
$$\begin{aligned} n(\text{e}^-) &= Xn(\text{Rh}) = 0.04312 \\ X(0.01439) &= 0.04312 \\ \therefore X &= \frac{0.04312}{0.01439} = 2.996 \approx 3 \end{aligned}$$

The charge on the rhodium ion is +3

5.

	Rough Estimate (mL)	1 st trial (mL)	2 nd trial (mL)	3 rd trial (mL)	4 th trial (mL)
Initial reading	0.39	15.59	30.27	3.42	1.87
Final reading	15.59	30.27	44.56	18.15	16.51
Volume used	15.20	14.68	14.29	14.73	14.64

$$V_{\text{Average}} = \frac{14.68 + 14.73 + 14.64}{3} = 14.68 \text{ mL}$$



$$n(\text{MnO}_4^-) = cV = 5.00 \times 10^{-6} \times 14.68 \times 10^{-3} = 7.34 \times 10^{-8} \text{ mol}$$

$$n(\text{H}_2\text{C}_2\text{O}_4)_{20\text{mL}} = \frac{5}{2} \times n(\text{MnO}_4^-) = 1.835 \times 10^{-7}$$

$$n(\text{H}_2\text{C}_2\text{O}_4)_{\text{in sample}} = n(\text{H}_2\text{C}_2\text{O}_4)_{\text{in } 250 \text{ mL Dil}} = \frac{250}{20} \times 1.835 \times 10^{-7} = 2.294 \times 10^{-6} \text{ mol}$$

$$m(\text{H}_2\text{C}_2\text{O}_4)_{\text{in sample}} = nM = 2.294 \times 10^{-6} \times 90.036 = 2.065 \times 10^{-4} \text{ g.}$$

$$[\text{M}(\text{H}_2\text{C}_2\text{O}_4)] = 90.036 \text{ g mol}^{-1}$$

$$\text{Conc in ppm} = \frac{2.065 \times 10^{-4} \times 10^3}{98.6 \times 10^{-3}} = 2.09 \text{ ppm}$$

For answers to Part 4 please see the Extended [Answer Question Answers](#)