

Equilibria

Mark Scheme 4

| | |
|-------------------|-----------------------|
| Level | International A Level |
| Subject | Chemistry |
| Exam Board | CIE |
| Topic | Equilibria |
| Sub-Topic | |
| Paper Type | Theory |
| Booklet | Mark Scheme 4 |

Time Allowed: 64 minutes

Score: /53

Percentage: /100

Grade Boundaries:

| A* | A | B | C | D | E | U |
|------|-------|-----|-------|-------|-----|------|
| >85% | 77.5% | 70% | 62.5% | 57.5% | 45% | <45% |

1 (a) (i) $C_2H_5NH_2 + HA \rightarrow C_2H_5NH_3^+ + A^-$ (HA can be H_2O , HCl etc.) [1]
 Allow \rightleftharpoons instead of arrow

(ii)

| | | |
|-------------------|--|--------------------|
| most basic | | least basic |
| ethylamine | | phenylamine |

[1]

(iii) ethylamine > NH_3 due to electron-donating ethyl/alkyl group [1]
 phenylamine < NH_3 due to delocalisation of lone pair over ring [1]
[4]

(b) (i) $C_6H_5OH + OH^- \rightarrow C_6H_5O^- + H_2O$ (or with $Na^+/H_2O/A^-$) [1]

(ii) pKa of nitrophenol is smaller/ K_a is larger because it's a stronger acid/dissociates more than phenol [1]
 stronger because the anionic charge is spread out moreover the NO_2 group or NO_2 is electron-withdrawing [1]

(iii) pKa = 1.0 [1]

(iv) Nitro group increases acidity / electron-withdrawing groups increase acidity [1]
[5]

(c) (i) **B** is phenyldiazonium cation, $C_6H_5-N^+ \equiv N$ [1]

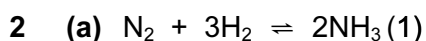
(ii)

| reaction | re | conditions |
|----------|---|--|
| Step 1 | $NaNO_2 + HCl$ or HNO_2 [1] | $T < 10^\circ C$ [1] |
| Step 2 | H_2O / aq | heat/boil/$T > 10^\circ$ (both) [1] |
| Step 3 | HNO_3 NB $HNO_3(aq)$ OK for both | dilute (both) [1] |

[4]

[5]

[Total: 14]



(b) temperature between 300 and 550°C (1)

correct explanation of effect of temperature on rate of formation of NH_3 **or** on position of equilibrium (1)

catalyst of iron **or** iron oxide (1)

to speed up reaction **or** to reduce E_a (1)

(c) manufacture of HNO_3
or explosives
or nylon
or as a cleaning agent
or as a refrigerant (1)

[1]

(d) fertiliser in rivers causes excessive growth of aquatic plants/algae (1)

when plants and algae die O_2 is used up/fish or aquatic life die (1)

[2]

(e) (CO by incomplete combustion of the hydrocarbon fuel (1)

NO by reaction between N_2 and O_2 in the engine (1)

(ii) CO toxic/effect on haemoglobin (1)

NO toxic/formation of acid rain (1)

[4]

(f) (platinum/Pt – allow palladium/Pd **or** rhodium/Rh (1)

(ii) $2\text{CO} + 2\text{NO} \rightarrow 2\text{CO}_2 + \text{N}_2$ (1)

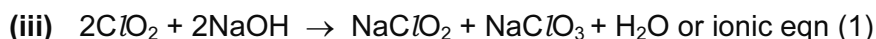
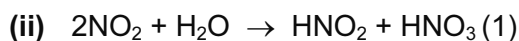
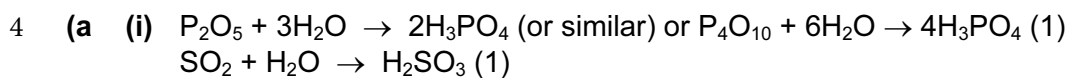
[2]

[Total: 14]

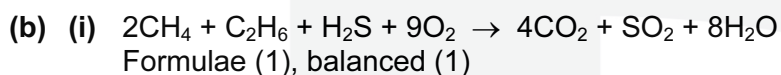
- 3 (a) (i) A few nanometres (accept 0.5–10 nm) (1)
- (ii) Graphite/graphene (1)
- (iii) van der Waals' (1)
Carbon atoms in the nanotubes are joined by covalent bonds (1)
(as are the hydrogen atoms in a hydrogen molecule)
or no dipoles on C or H₂ or the substances are non-polar [4]
- (b) More hydrogen can be packed into the same space/volume (1) [1]
- (c) If a system at equilibrium is disturbed, the equilibrium moves in the direction which tends to reduce the disturbance (owtte) (1)
- When H₂ is removed the pressure drops and more H₂ is released from that adsorbed (1)
- The equilibrium $\text{H}_{2\text{adsorbed}} \rightleftharpoons \text{H}_{2\text{gaseous}}$ (1)
- Equilibrium shifts to the right as pressure drops (1) [4]

[Total: 9]

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— TUITION —



[4]



(ii) (The SO_2 produced) causes acid rain (1)
or consequence of acid rain – defoliation etc. – or respiratory problem

(iii) 1000 dm^3 contains 50 dm^3 of H_2S
this is $50/24$ (= **2.083** moles) (1)
 $M_r(\text{ethanolamine}) = 24 + 7 + 14 + 16 = \mathbf{61}$
therefore mass = $2.083 \times 61 = \mathbf{127(.1)g}$ (1) (or ecf)

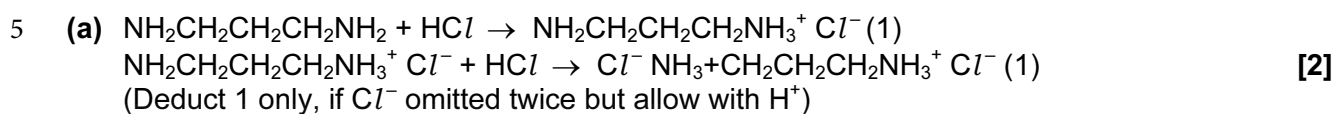
(iv) acid-base (1)

(v) $\Delta H = \Delta H_f(\text{rhs}) - \Delta H_f(\text{lhs})$
 $= \{(3 \times 11 - 2 \times 242)\} - \{(2 \times -21 - 297)\} - 1$ for each { } in which there is an error
 $= -451 + 339$
 $= -112 \text{ (kJ mol}^{-1}\text{)}$ (2)

[8]

[Total: 12]

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(b) starts at 11.3 and finished as 1.6 (1) [2]
steep portions at 10 cm^3 and 20 cm^3 volume added (1)

[Total: 4]

