

- 1 (a) (making) fertilisers / nitric acid / nylon / explosives / urea
(for) cleaning products (allow oven cleaner) / refrigeration
- (b) equilibrium / reversible
- (c) (nitrogen) air / atmosphere [1]
(hydrogen) methane / water / steam / alkane / named alkane / hydrocarbon / crude oil
or petroleum / natural gas [1]
- (d) iron [1]
- (e) (i) rate increases / faster
More (effective) collisions [1]
(ii) yield decreases [1]
(forward reaction) exothermic / reverse reaction endothermic / high temp
favours endothermic reaction [1]
- (f) (i) yield increases [1]
less / fewer molecules or moles or volume on RHS OR / high pressure
favours reaction which produces fewer molecules or moles or volume [1]
(ii) particles / molecules closer / more particles per unit area or volume / more
molecules per unit area or volume / more concentration / particles have less
space between them **and** more collisions [1]
(iii) safety issues / higher cost [1]
- (g) 3 bond pairs between N & H [1]
Lone pair on N [1]
- (h) (proton / H⁺ acceptor
(ii) $2\text{NH}_3 + \text{H}_2\text{SO}_4 \rightarrow (\text{NH}_4)_2\text{SO}_4$ [2]
Formula of $(\text{NH}_4)_2\text{SO}_4$ (1)
The rest (1)

[Total:18]

- 2 (a) faster reaction rate (1)
 higher collision rate (1)
 greater yield **or** favour RHS (1)
 pressure favours products because it has lower volume/fewer product molecules (1) [4]
- (b) higher temperature favour endothermic reaction (1)
 this is the back reaction/left hand side/reactants (1)
 reduce yield (1) [3]
- (c) greater surface area (1) [1]
- (ii) increase reaction rate (1)
 can use a lower temperature to have an economic rate (1)
 and not decrease yield (by increasing temperature). [2]
- (d) lower the temperature (1)
 only ammonia will liquefy (1)
OR
 add water (1)
 only ammonia will dissolve (1)
OR
 increase pressure (1)
 only ammonia will liquefy (1) [2]
- (e) second line $+3 \times 155 = + 465$
 third line $-3 \times 280 = (-)840$
 fourth line $-3 \times 565 = (-)1695$
 all **three** correct (2)
 two correct (1)
- $1170 + 465 = 1635$
 $840 + 1695 = 2535$
 both numerically correct (1)
 exothermic reaction with some reasoning (1) [4]

[Total: 16]

- 3 (a) (i) any Group 1 metal [1]
ACCEPT: lithium
- (ii) $2\text{Pb}(\text{NO}_3)_2 \rightarrow 2\text{PbO} + 4\text{NO}_2 + \text{O}_2$ [2]
PbO [1]
COND balancing [1]
- (iii) the metal in a (i) is **more reactive** than lead [1]
more reactive metals have **more stable** compounds [1]
OR has stronger (ionic) bonding [1]
- (b) (i) speed / rate of forward reaction = speed / rate of back reaction [1]
OR macroscopic properties do not change / constant (with time)
- (ii) goes darker **OR** goes brown [1]
COND lower pressure favours side with more moles [1]
COND this is NO_2 side **OR** reactant side **OR** goes left [1]
- (iii) exothermic [1]
low temperatures favour the exothermic reaction **or**
low temperatures moves equilibrium to right / product side / towards N_2O_4 [1]
- (iv) forward reaction is bond forming [1]

- 4 (a) (i) accept all metals excluding Group I (lithium is acceptable) [1]
not lead **accept silver**
- (ii) M nitrite / nitrate(III) [1]
not nitride
- (b) (i) exothermic [1]
not reverse reaction is endothermic as the question asks about the forward reaction
cond forward reaction favoured by low temperature / reverse reaction favoured by high temperature [1]
 second mark only scores if exothermic is correct.
- (ii) position of equilibrium to right / forwards / more products / more N₂O₄ / lighter colour [1]
 because this side has smaller volume / fewer moles [1]

- (c) if the final answer is between 86–89% award all 4
 if the final answer is between 66–67% award 3 marks (M_r of 32 must have been used)
 for all other answers marks can be awarded using the mark scheme as below and applying ecf if necessary

number of moles of O₂ formed = $0.16/24 = 0.0067/0.00667$ or $1/150$

number of moles of Pb(NO₃)₂ in the sample = $0.0133/0.013$ or $1/75$

mass of one mole of Pb(NO₃)₂ = 331 g

mass of lead(II) nitrate in the sample = 4.4(1) g

percentage of lead(II) nitrate in sample = 88.3% (**allow** 88–89) [4]

mark **ecf** in this question but **not** to simple integers

if mass of lead(II) nitrate > 5.00 only marks 1 and 2 available

If divides by 32 (not 24) only last 3 marks can score consequentially