

- 1 (a) sodium hydroxide solution [1]
 warm [1]
 (only) ammonium phosphate gives off ammonia / gas (which will turn red litmus paper blue) [1]
or:
 sodium hydroxide solution [1]
 dissolve fertiliser in water [1]
 Ca^{2+} gives (white) ppt [1]
or:
 flame test [1]
 Ca^{2+} brick red / orange / orange-red [1]
 NH_4^+ no colour [1]
- (b) iron catalyst [1]
 pressure 150–300 atmospheres [1]
 temperature 370–470 °C [1]
 $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$ [1]
note: units required for temperature and pressure
- (c) potassium / K [1]
- (d) (needs to be soluble / in solution (to be absorbed by plants) [1]
 (ii) base [1]
 proton acceptor [1]
- (e) plant growth depends on soil acidity or pH / plants have optimum pH (for growth) [1]
 add $\text{Ca}(\text{OH})_2$ / CaO / CaCO_3 / lime / slaked lime / quicklime / limestone [1]
- 2 (a) (i) nitrogen 2+5 [1]
 (ii) needs three electrons [1]
 to complete energy level [1]
- (b) expensive metal / iron cheaper / better catalyst [1]
 (ii) high pressure favours side with smaller volume / fewer moles [1]
 this is right hand side / product / ammonia side [1]
 (iii) recycled / sent over catalyst again [1]
accept used again
 (iv) advantage high yield [1]
 disadvantage slow reaction rate etc [1]

[Total: 9]

- 3 (a) (i) air (liquid) [1]
 petroleum **or** crude oil **or** alkanes **or** methane **or** water **or** steam **or** steam reforming **or**
 suitable aqueous solution e.g. brine or sea water [1]
NOTE: cannot crack methane
- (ii) iron [1]
- (iii) (as a) fertiliser **or** to make fertilisers **or** to make nitric acid [1]
- (b) (i) concentrations/macroscopic properties do not change [1]
accept amounts stay the same
NOT no change
rate of forward and back reactions equal [1]
- (ii) it decreases with increase temperature [1]
or it increases with decrease temperature [1]
- (c) (i) shows an increase either a line **or** curve [1]
 (any decrease = 0)
- (ii) increase pressure favours the side with lower volume or molecules or moles [1]
 that is RHS **or** products side [1]
 ignore any mention of rates

[Total: 10]

- 4 (a) (i) iron [1]
- (ii) advantage higher yield [1]
 explanation lower temperature favours the exothermic reaction
 (that is the forward reaction) [1]
- (b) (i) Sent over the catalyst again **or** used to make more ammonia [1]
NOT just reused
- (ii) It has the highest boiling point [1]
- (c) (i) $\text{CO}_2 + 2\text{NH}_3 = \text{CO}(\text{NH}_2)_2 + \text{H}_2\text{O}$ [2]
 Not balanced [1]
- (ii) Any comment based on deficiency of PK/or ONLY provides Nitrogen as a
 nutrient [1]
NOT soil pH
- (d) Correct diagram for urea [3]
 one error ONLY [2]
 two errors ONLY [1]
 three errors 0

[TOTAL = 11]

- 5 (a) from methane [1]
and water [1]
- OR** electrolysis [1]
suitable electrolyte [1]
- OR** alkane [1]
cracking [1] [2]
- (b)(i) iron [1]
- (ii) lower temperature moves equilibrium to right [1]
because forward reaction is exothermic [1]
- (c)(i) H—H [1]
endothermic [1]
endothermic [1]
exothermic [1]
- (ii) More heat given out than taken in [1]
 $-2328 + 945 + 1308 = -75(\text{kJ})$ [1]
- OR** More heat given out bond forming than taken in bond breaking [2]
Must mention bond breaking and forming [2]

TOTAL = 10

- 6 (a) dissolved **or** solution in water [1]
NOT aqueous **NOT** soluble in water [1]
l liquid and g gas
- (b) 6 electrons in bond between two nitrogen atoms [1]
2 electrons on each nitrogen [1]
ignore any coding of electrons with dots **or** crosses
- (c) decreases **or** reaction stops **or** rate becomes zero [1]
- (ii) concentration **or** number of effective collisions [1]
decreases [1]
used up **or** less chemical **or** less collisions etc [1] only
- (iii) greater initial slope [1]
same final point [1]
as long as new curve touches the original curve near
the top allocate the mark
- (iv) greater surface area [1]

TOTAL = [10]