

HABER PROCESS

Mark scheme

Question 1

Question	Answer	Extra information	Marks
(a)	reversible		1
(b)	catalyst		1
(c)	recycled	allow re-used	1
(d)	(Q) S R P	allow 1 mark if one letter in correct place.	2
Total marks			5

Question 2

Questions	Answers	Extra information	Marks
(a)	air		1
(b)	recycle (unreacted) nitrogen and hydrogen	allow re-use allow N ₂ and H ₂	1 1
(c)	$N_2 + 3H_2 \rightarrow 2NH_3$	allow correct multiples	1
Total marks			4

Question 3

Questions	Answers	Extra information	Marks
(a)(i)	(gas X) nitrogen / N ₂		1
	(gas Y) hydrogen / H ₂		1
(ii)	cooled		1
(b)	any two from: <ul style="list-style-type: none"> • save materials / resources • save energy / fuels • reduce costs • reduce waste 		2
(c)(i)	low		1
	high		1
(ii)	40(%)		1
(iii)	any two from: <ul style="list-style-type: none"> • using these conditions, the yield is still high • higher pressures would increase yield but energy costs would be higher or <p>higher pressures would increase yield but would make the plant expensive to build</p> <ul style="list-style-type: none"> • the temperature of 450°C would not need a lot of energy or <p>at 450°C the reaction would be faster than at lower temperatures</p>		2
Total marks			10

Question 4

Questions	Answers	Extra information	Marks
(a)(i)	200		1
(ii)	rate of reaction (too) slow	allow converse ignore references to yield / cost	1
(iii)	400		1
(iv)	lower yield	allow converse accept shifts equilibrium to left allow favours the backward	1

		reaction allow favours side with more (gaseous) molecules allow lower rate	
(b)	(gases) cooled ammonia liquefied	it = ammonia accept ammonia condensed accept ammonia cooled below boiling point for 2 marks	1 1
Total marks			6

Question 5

Questions	Answers	Extra information	Marks
	increases		1
	quickly at first then slows	ignore levels off allow rate of increase slows for first two marking points	1
	at any number in range from 160 – 220 (atmospheres)	allow any number in range 60 – 66 (%)	1
Total marks			3

Question 6

Questions	Answers	Extra information	Marks
(a)	(nitrogen and hydrogen) recycled	allow (nitrogen and hydrogen) reused	1
(b)(i)	jobs lost	accept mines closed or local economy damaged	1
(b)(ii)	any one from: <ul style="list-style-type: none"> • nitrates / fertilisers cost less • more crops / food can be grown • food costs less • nitrates / fertilisers more widely available 		1
Total marks			3

Question 7

Questions	Answers	Extra information	Marks
(a)	natural gas	allow correct answer shown in box if answer line blank	1
(b)(i)	450	allow correct answer shown in box if answer line blank	1
(ii)	iron	allow correct answer shown in box if answer line blank	1
(iii)	The catalyst lowers the activation energy.		1
(c)	(the gases are) cooled		1
	ammonia condenses	allow ammonia liquefies	1
	nitrogen and hydrogen are recycled	if no other mark awarded allow ammonia is separated for 1 mark	1
Total marks			7