1. 5070/21/M/J/16 QA4a

A4(a)	All **three** conditions correct (2 marks) **Two** correct conditions (1 mark) • Temperature: 350 to 500 °C • Pressure: 150 to 1000 atmospheres • Catalyst: iron	2

2. 5070/21/M/J/16 A6

A6(a)(i)	Global warming / ice caps melting / sea level rising (1)	1
A6(a)(ii)	Rotting vegetation (1)	1
A6(a)(iii)	Ozone depletion (1)	1
A6(b)	Correct 'dot-and-cross' diagram for $CFCl_3$ (1)	1
A6(c)(i)	Reaction of nitrogen with oxygen / $N_2 + O_2 \rightarrow 2NO$ (1)	1
A6(c)(ii)	NO (is reduced) to make N_2 / $2NO \rightarrow N_2 + O_2$ (1) CO (is oxidised) to make CO_2 / $2CO + O_2 \rightarrow 2CO_2$ (1)	2
A6(d)	HNO_2 (1)	1

3. 5070/21/M/J/16 B9d

B9(d)(i)	Produces carbon monoxide which is toxic or poisonous gas / reaction involves a very high temperature (1)	1
B9(d)(ii)	Saves crude oil / crude oil can be used to make other chemicals / coal or coke is less of a finite resource than crude oil (1)	1

4. 5070/22/M/J/16 QA4a

A4(a)	**All three** conditions correct (2 marks) **Two** correct conditions (1 mark) Temperature 350 to 500 °C Pressure 1 to 10 atmospheres Catalyst vanadium(V) oxide / vanadium pentoxide / V_2O_5	2

5. 5070/22/M/J/16 QA6

A6(a)	Correct 'dot-and-cross' diagram for carbon dioxide (1)	1
A6(b)(i)	From fields / from farms / fertilisers (1)	1
A6(b)(ii)	**1 mark each of any three from:** • Eutrophication • Increased growth of algae / algal bloom / fast growth of algae • This blocks out sunlight / plants can't photosynthesise • Plants (beneath the surface) die **AND** get decomposed by bacteria that use up oxygen • Other aquatic organisms die because of lack of oxygen	3
A6(c)	Chlorination – kills bacteria or microbes (1) Filtration – removes insoluble materials / removes solid / removes named solid (1) Use of carbon – removes odours / removes (unpleasant) tastes (1)	3

6. 5070/21/O/N/16 QA2 b to c

A2(b)	add calcium oxide / add lime / add calcium hydroxide / add calcium carbonate (1) base (reacts with the acid) / neutralising (the acid) (1)	2
A2(c)	rate increases as pH increases (then remains constant) (1)	1

7. 5070/21/O/N/16 QA6

A6(a)	nitrogen 78% AND oxygen 21% (1)	1
A6(b)(i)	correct 'dot-and-cross' diagram with two pairs of bonding electrons and four non-bonding electrons on each of the two oxygen atoms (1)	1
A6(b)(ii)	Ar (1)	1
A6(c)	argon is unreactive / argon is inert / argon does not react (1) air would react with sodium / air would react with titanium / air would react with the reaction mixture / argon prevents sodium reacting with air / argon stops titanium reacting with air / to exclude air (1)	2
A6(d)	any suitable e.g. lamps / bulbs / lasers (1)	1

8. 5070/21/O/N/16 QB7e

B7(e)	One mark each for any **two** suitable points e.g. : • fills landfill sites • litter • when burnt greenhouse gases given off / burning produces poisonous gases • get caught in birds / fish gullets (causing choking / death)	2

9. 5070/22/O/N/16 QA3d

A3(d)(i)	$C_5H_{12} + 8O_2 \rightarrow 5CO_2 + 6H_2O$ correct formulae (1) correct balance dependent on correct formulae (1)	2
A3(d)(ii)	Any **two** of: carbon monoxide/carbon/water (1) carbon monoxide is toxic/carbon monoxide is poisonous (1)	2

10. 5070/22/O/N/16 QB7

B7(a)	vanadium pentoxide/vanadium(V) oxide/V_2O_5 (1)	1
B7(c)(ii)	at 250 °C reaction is slow(er)/at 450 °C reaction is fast(er) (1)	2
	idea of compromise temperature/idea of balance between lower yield and faster rate (1)	
B7(e)	$SO_3 + 2HBr \rightarrow SO_2 + Br_2 + H_2O$ (1)	1

11. 5070/21/M/J/17 A5b(ii)

A5(b)(ii)	$C_2H_5OH + O_2 \rightarrow 2C + 3H_2O$ **OR** $C_2H_5OH + 2O_2 \rightarrow 2CO + 3H_2O$ Correct products (1) Balancing (1)	2
A5(f)(ii)	Do not decay / do not decompose naturally / not attacked by bacteria or microbes	1

12. 5070/22/M/J/17 A5d(ii)

A5(d)(ii)	Decomposes / decays / will not fill up land-fill sites / less litter / no need for incineration	1

13. 5070/22/M/J/17 QA6c

A6(c)	Idea that combustion **AND** respiration increase levels of carbon dioxide / carbon in the atmosphere (1) Idea that photosynthesis reduces levels of carbon dioxide / carbon in the atmosphere (1) Idea that these processes balance each other (1)	3

14. 5070/22/M/J/17 QB9

B9(a)	Fuel	1
B9(b)	Decomposing vegetation	1
B9(c)	Climate change / global warming	1

15. 5070/22/O/N/17 QB8

B8(c)	Nitrates soluble (in water) / nitrates dissolve (easily) (1)	1
B8(d)	One mark each for any two of: • (Nitrate causing) excessive growth of algae • Bacterial growth (on dead algae) • Idea of making water deoxygenated so animals / organisms can't live	2

16. 5070/22/O/N/17 QB9b

B9(b)(i)	Burning fossil fuels / burning named fossil fuel / volcanoes (1)	1
B9(b)(ii)	It is reformed / it is not used up / it is unchanged at the end of the reaction (1)	1
B9(c)(i)	Energy humps of both the uncatalysed and catalysed reaction shown and labelled with catalysed reaction below the uncatalysed and hump drawn correctly form reactants line to product line. (2 marks) If 2 marks not scored allow 1 mark for one or two energy humps drawn correctly from reactants line to products line (1)	2
B9(c)(ii)	Exothermic because energy of reactant greater than energy of products (or reverse argument) (1)	1

17. 5070/21/O/N/18 Q6d

6(d)(i)	78%	1
6(d)(ii)	nitrogen oxides are converted to nitrogen (1) (nitrogen oxides are removed) by reaction with carbon monoxide (1)	2
6(d)(iii)	lightning	1

18. 5070/21/O/N/18 Q7

7(a)	$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ correct formulae for reactants and products (1) balanced equation – dependent on formulae (1)	2
7(b)(i)	rise in sea levels / melting of polar ice caps / desertification / more extreme weather patterns (1)	1
7(b)(ii)	photosynthesis absorbs carbon dioxide AND respiration releases carbon dioxide (1) the amount of carbon dioxide absorbed is roughly equal to the amount of carbon dioxide released (1)	2

19. 5070/22/O/N/18 Q6d

6(d)(i)	burning fossil fuels (containing sulfur) / volcanoes	1
6(d)(ii)	sulfur dioxide reacts with oxygen **AND** rain / sulfur dioxide reacts with oxygen to form sulfur trioxide **AND** sulfur trioxide reacts with rain / sulfur dioxide reacts with water to form sulfurous acid **AND** sulfurous acid oxidised by oxygen (2) if two marks not scored 1 mark for: sulfur dioxide reacts with rain / sulfur dioxide reacts with water / sulfur dioxide forms sulfurous acid (in the atmosphere) (1)	2

20. 5070/22/O/N/18 Q7

7(a)(i)	$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$ (2) If 2 marks not scored, award one mark for correct formulae (1)	2
7(a)(ii)	(sun)light (1) chlorophyll (1)	2
7(a)(iii)	glucose can be used to make a fuel / glucose (can be fermented) to make ethanol	1

21. 5070/21/M/J/19 Q4

4(a)	78%	1
4(b)	**Any three from:** fractional distillation (1) (liquid) air heated / (liquid) air vapourised (1) idea that different components have different boiling points (1) (gases with) lowest boiling point come off at the top / highest boiling point at the bottom / gases come off at different levels (in the column) (1)	3
4(c)	used to **make** fertilisers / used to **make** ammonia (1)	1
4(d)(i)	sulfur dioxide / nitrogen dioxide (1)	1
4(d)(ii)	global warming / ice-caps melting / sea-level rising (1)	1
4(d)(iii)	incomplete combustion of carbon (-containing compounds) / incomplete combustion of hydrocarbons (1)	1

22. 5070/21/M/J/19 Q9c

| 9(c)(i)	will rot away / will not leave litter / no need to use land-fill sites (1)	1

23. 5070/22/M/J/19 Q6

6(a)	removal of salt(s) (from sea water) (1)	1
6(b)(i)	fertilisers (1)	1
6(b)(ii)	eutrophication (1)	1
6(c)(i)	filtration (1)	1
6(c)(ii)	carbon / charcoal (1)	1
6(c)(iii)	chlorine (1)	1

24. 5070/21/O/N/19 Q4f

4(f)	CFCs destroy ozone / deplete ozone (1) more (harmful) uv will get to the Earth's surface / more skin cancer / more eye cataracts	2

25. 5070/21/O/N/19 Q9d

9(d)(i)		1
9(d)(ii)	cannot be broken down (by organisms) / cannot be broken by biological means / cannot be decomposed (by bacteria) / cannot be decayed (by fungi)	1
9(d)(iii)	gets stuck in gullets of birds / gets stuck in gills of fish / blocks drains / litter / burning causes toxic gases to be emitted / burning causes greenhouse gas emissions	1

26. 5070/22/O/N/19 Q7

7(a)	vanadium(V) oxide	1
7(c)	product to right of reactants and reactant level above product level (1) enthalpy change shown as downward arrow and labelled (1) activation energy drawn as energy hump above product level and labelled with upward arrow (1)	3
7(d)	sulfur / water	1
7(e)	(making) detergents / fertilisers / battery acids	1

27. 5070/21/M/J/20 Q7a

7(a)	(increased) greenhouse effect / global warming (1)	1

28. 5070/22/M/J/20 Q9

9(a)	acid rain / one effect of acid rain e.g. acidification of lakes or killing trees etc. (1)	1
9(b)	$4FeS_2 + 11O_2 \rightarrow 2Fe_2O_3 + 8SO_2$ correct formulae for reactants and products (1) balanced – dependent on correct formulae for reactants and products (1)	2
9(c)	food preservation / antioxidant / making sulfuric acid / bleaching wood pulp (1)	1

29. 5070/21/O/N/20 Q8c

8(c)	erodes (buildings) / corrodes (metalwork) / reacts with (mortar)	1

30. 5070/22/O/N/20 Q4

4(e)(i)	cracking (hydrocarbons) / electrolysis (of water)	1
4(e)(ii)	any **two** from: • water is only product / no other product than water • no pollutants made / no harmful exhaust fumes / no harmful gas made • greater efficiency / less heat loss / more energy per gram of fuel • (hydrogen is) renewable source of fuel / uses renewable source of fuel / uses renewable source of energy	2

31. 5070/21/M/J/21 Q5

5(b)	acid rain / erodes buildings / corrodes buildings	1
5(c)	sulfur dioxide reacted with oxygen to make sulfur trioxide (1) this reaction uses a V_2O_5 catalyst / temperatures between 450 and 600 °C / 1 to 10 atmosphere pressure (1) sulfur trioxide reacted with $H_2SO_4(l)$ to make oleum which is then reacted with water (to make sulfuric acid) (1)	3
5(d)	bleaching (wood pulp) / preservative	1

32. 5070/21/M/J/21 Q6

6(a)(i)	methane	1
6(a)(ii)	global warming	1

33. 5070/22/M/J/21 Q3a

3(a)(iii)	makes poisonous gases / makes poisonous fumes	1
3(b)(i)	can be decomposed naturally / can be broken down by bacterial action	1

34. 5070/22/M/J/21 Q5 c and d

5(c)	(reaction with) nitrogen (1) **AND** **Any two conditions from:** Fe (catalyst) (1) 400 to 500 °C (1) 200 to 400 atmosphere (pressure) (1)	3
5(d)	making margarine / fuel cells / fuel	1

35. 5070/22/M/J/21 Q6

6(a)	acid rain	1
6(b)	calcium carbonate	1
6(c)(i)	$N_2 + O_2 \rightarrow 2NO$	1

36. 5070/21/O/N/21 Q2

2(a)	21(%)	1
2(c)	air liquefied (1) <u>fractional</u> distillation (1)	2
2(e)(i)	photochemical / redox	1
2(e)(ii)	lightning	1
2(f)	(more) skin cancer / (more) sunburn / (more) harm to eyes	1

37. 5070/21/O/N/21 Q9

9(a)	hydrogen: (cracking) hydrocarbons (1) nitrogen: air (1)	2
9(e)	**Any three from**: (nitrates) increase growth of algae / (nitrates) increase growth of water plants / algal bloom (1) plants (on surface) block sunlight and plants die (1) bacteria feed on dead plants and use up oxygen (1) (without oxygen) fish die / (without oxygen) water organisms die (1)	3

38. 5070/22/O/N/21 Q2

2(a)	carbon monoxide (1) octane (1)	2
2(c)	decomposition of vegetation / decomposition of plants	1
2(d)	greenhouse (1) global warming (1)	2
2(e)	mention of nitrogen oxides and carbon monoxide (as the pollutants / reactants) (1) nitrogen / N_2 (in exhaust gases) (1) carbon dioxide / CO_2 (in exhaust gases) (1)	3

39. 5070/22/O/N/21 Q9a

9(a)(i)	air **AND** water	1
9(a)(ii)	vanadium(V) oxide	1

40. 5070/21/M/J/22 Q9

9(a)	$N_2 + 3H_2 \rightleftharpoons 2NH_3$ balanced equation (1) use of reversible symbol (1)	2
9(c)(i)	eutrophication	1
9(c)(ii)	idea that nitrate fertilisers are very soluble / nitrate fertilisers are more soluble	1
9(d)(i)	reduce soil acidity / raise pH of soil	1
9(d)(ii)	$2NH_4NO_3 + Ca(OH)_2 \rightarrow Ca(NO_3)_2 + 2NH_3 + 2H_2O$ (1) ammonia is lost / ammonia is formed (1)	2

41. 5070/22/M/J/22 Q10c

10(c)(i)	pesticides / herbicides / heavy metal **ions** / detergents	1
10(c)(ii)	chlorination (1) filtration / sedimentation / screening (1) use of carbon (1)	3

42. 5070/21/O/N/22 Q2 b

2(b)(i)	glucose AND oxygen	1

43. 5070/21/O/N/22 Q3d

3(d)	poisonous / toxic	1

44. 5070/21/O/N/22 Q4a(i)

4(a)(i)	iron	1

45. 5070/22/O/N/22 Q2

2(a)(ii)	kill bacteria / water treatment	1
2(d)	*importance:* reduces amount of **ultraviolet** (radiation) reaching Earth (1) *problems with depletion:* (more) skin cancer / (more) cataracts / (more) sunburn (1)	2

46. 5070/22/O/N/22 Q4

4(a)	to improve crop yield / to improve plant growth / to add minerals lost when plants are harvested	1
4(b)	ammonia is produced (1) (ammonia) escapes (from the soil) / ammonia is a gas (1)	2

47. 5070/22/O/N/22 Q5d

5(d)(iii)	conserves ores	1

48. 5070/22/O/N/22 Q6

6(a)	78(%)	1
6(d)(i)	car exhaust fumes / vehicle engines / fossil fuel powered power stations	1
6(d)(ii)	(chemical) erosion / corrosion	1

49. 5070/21/M/J/23 Q9

9(b)	$N_2 + O_2 \rightarrow 2NO$ (1)	1
9(c)	acid rain / photochemical smog / respiratory problems (1)	1
9(d)	reacted with CO to make nitrogen (1)	1

50. 5070/21/M/J/23 Q10

10(b)(i)	carbon monoxide (1)	1
10(b)(ii)	land-fills (are filled) / accumulation of plastics in oceans (1)	2
	chemically unreactive / do not dissolve in water (1)	

51. 5070/22/M/J/23 Q9c

9(c)(i)	climate change / sea-level rising / ice caps melting (1)	1
9(c)(ii)	**Any two from:**	2
	absorbs thermal energy (from the Earth) (1)	
	reflection of thermal energy (back to the Earth) / emission of thermal energy (towards the Earth) (1)	
	reduces or stops loss of thermal energy into space (1)	
9(d)	carbon dioxide + water $\rightarrow$ glucose + oxygen (1)	1

52. 5070/22/M/J/23 Q10c

10(c)	**Any two from:**	2
	Land-fills (may fill up) (1)	
	accumulation of plastics in oceans (1)	
	formation of toxic gases during **burning** (1)	