1 (a (i)	willow (tree) and / or aquatic plants → moose → wolf arrows point from food to feeder ; organisms are in the correct order in the food chain ;	**[2]**	**ignore** the Sun at the start of the food chain
(ii)	*the three organisms can be in any order in the table* willow tree / aquatic plants / shoots / plants – producer / 1st / 1 ; moose – primary consumer / 2nd / 2 ; wolf – secondary consumer / 3rd / 3 ;	**[3]**	**ignore** autotroph **ignore** herbivore **ignore** carnivore / top consumer
(iii)	competition ; food supply / food for moose / food for wolves ; water ; shelter / 'nest' sites / space / territory ; mates ; competition with other types of predators ; disease / parasites ; hunting / poaching ; pollution ; rate of reproduction ; habitat, loss / destruction ; AVP ;	**[max 2]**	**A** intraspecific competition **A** numbers of other competitors **A** interspecific competition **R** predation / new predator

Question	Answers			Marks	Additional Guidance
1 **(b)** **(i)**	*two marks for the correct answer* *if no answer or incorrect answer, one mark for correct working*				
	answer for two marks	1.3 **;;** **A** 1.30	1.4 **;;** **A** 1.42		
	working for one mark	*either* $\dfrac{56\,000}{4\,320\,000}$ (x 100) *or* **A** 1.296 / 1.2963, etc. **ignore** 1.29	*either* 4 320 000 – 380 000 = 3 940 000 *or* = $\dfrac{56\,000}{3\,940\,000}$ (x100) *or* **A** 1.421 / 1.4213, etc.	**[2]**	

1	**(b) (ii)**	*this question can be answered in terms of energy flow (left column) or predator-prey relationships (right column)*	
		energy is lost, between / within, trophic levels / along food chain **;** **A** from moose to wolf	low numbers of wolves **;** **A** wolves die
		energy lost, in respiration / as heat / in metabolism **;**	little predation **;**
		use of figure with units from Table 6.2 to illustrate / 1.3% / 1.4% **;** **A** ecf from (b)(i)	more moose, reach reproductive age / have offspring **;**
		energy used in maintaining body temperature **;**	numbers of moose increase **;**
		moose / wolf, is an, endotherm / homeotherm **;**	more food for wolves **;**
		energy lost in movement **;**	more wolves, reach reproductive age / have offspring **;**
		energy used in muscle contraction **;**	numbers of wolves increases **;**
		energy in food, not eaten / egested / passed out in faeces **;**	more predation **;**
		energy lost in, excretion / urine **;**	greater competition between wolves **;**
		wolves not very successful at catching prey **;**	*idea that* wolf population reaches carrying capacity / reaches maximum for resources available **;**
		more energy available for moose (than for wolf) **;**	**A** not enough energy available for more than 50 wolves
		no other source of food for wolves but, moose **;**	
		AVP **;** e.g. some / AW, energy is not used for growth	**[max 5]**
			[Total: 14]

Question		Expected Answers	Marks	Additional Guidance
2 (a)		log / exponential (phase) ;	[1]	
(b)	1 2 3 4 5	decomposition of waste ; by bacteria / microorganisms ; reduces oxygen available ; eutrophication / algal bloom ; results in death of (aquatic) plants and animals ;	max [3]	**ignore** pollution / contamination unqualified
(c)		secondary consumer / third trophic level ;	[1]	
(d)	1 2 3 4 5 6 7 8	seaweed at a lower trophic level (than salmon) ; **ora** energy is lost, between / within, trophic levels / along food chain ; reference to 10% energy transfer / **ora** ; (energy lost in) respiration / heat / (named) metabolic process ; (energy lost in) movement / muscle contraction ; reference to (more) material that is, inedible / not digestible (in longer food chains) ; (energy lost in) excretion / urine ; *idea that* less fuel required to farm seaweed / AW ;	max [3]	**A** seaweed are producers / first trophic level
			[Total: 8]	

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3	**(a)**	1.8 / 1.83 / 1.825, mm ;	[1]	
	(b)	nitrogen fixation ; convert nitrogen into, ammonia / NH_3 / ammonium ions / NH_4^+ ; convert ammonia to amino acids ;	max [2]	
	(c) **(i)**	photosynthesis ; carbon dioxide + water / CO_2 + H_2O ; use of, <u>light</u> (energy) / <u>sunlight</u> ;	max [2]	
	(ii)	translocation / mass flow ; phloem ; as sucrose ; from, source / leaf ; then from phloem to root nodule by diffusion ;	max [2]	
	(d)	active, transport / uptake ; use of, energy / ATP (from respiration) ; use of, proteins / carrier molecules, in membrane ;	max [2]	

		Answer	Marks	Guidance for Examiners
4	**(a)**	**V** – lag (phase) ; **W** – log phase / exponential (phase) ; **X** – stationary / plateau (phase) ;	[3]	
	(b)	temperature ; pH ; oxygen concentration ; consistency / turbidity / density ;	max [2]	
	(c)	*(Penicillium)* has no (individual) cells / has hyphae ; measuring mass is easier (compared with counting) ; measuring mass is more accurate / valid (compared with counting) ;	max [1]	
			[Total:6]	